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An Unmanned Ship Navigation Environment Monitoring System Based on Millimeter Wave Radar

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Abstract: With the rapid development of artificial intelligence, maritime technology is continuously advancing, and unmanned surface vessels (USV) are gaining significant attention as emerging waterborne transportation vehicles. Environmental monitoring during the navigation of USV is a critical component. This paper employs multiple millimeter-wave radars and utilizes a multi-hypothesis tracking algorithm to successfully achieve data association, data fusion, and target tracking for millimeter-wave radar data. Finally, the proposed method is validated through real ship experiments, providing a solid theoretical foundation for autonomous navigation of USV in the future.

Keywords: USV; Navigational Environment Monitoring; Millimeter-Wave Radar; Multi-Hypothesis Tracking Algorithm

1. Introduction

With the flourishing development of global economic globalization, maritime transportation plays a pivotal role in this process. Not only is the variety of vessels steadily increasing, but their numbers are also on a gradual rise, rendering maritime traffic increasingly complex. However, this trend is accompanied by a surge in maritime accidents, resulting in substantial economic losses and human casualties. Statistical data indicates that nearly 50% of maritime accidents are attributable to ship collisions.

In this context, with the continuous advancement of sensor technology and intelligent control technology, unmanned surface vehicle (USV) unmanned ship system technology has become a hot topic at present^[1]. USV are capable of performing a variety of traditional maritime tasks, including maritime management, hydrological monitoring, underwater testing, and maritime search and rescue operations^{[2][3]}. As they do not require onboard operators, USV are particularly well-suited for executing unconventional missions, especially in hazardous waters, without the need to consider human-related psychological and physiological factors. Leveraging advanced control systems, communication systems, and monitoring equipment, USV can conduct continuous, round-the-clock surveillance of specific water areas, such as polluted waters or ship accident scenes. Furthermore, USV offer advantages such as high safety, ease of operation, modularity of monitoring equipment, and intelligence. They can execute maximum tasks with minimal energy consumption, making them highly promising, especially in light of the rapid

advancements in big data, cloud computing, neural networks, artificial intelligence, and modern control engineering.

However, achieving autonomous navigation on water for USV hinges on the swift and efficient autonomous path planning, which primarily depends on their precise environmental perception. Environmental perception serves as the cornerstone of this capability. Traditional methods rely on single sensors for data acquisition, each having its advantages and limitations, thereby falling short of meeting the comprehensive environmental data requirements for USV.

In previous research endeavors, RUIZ and colleagues^[4] attempted to employ a five-line vertical scanning laser radar for environmental and obstacle detection. They initially preprocessed radar data, performed image segmentation based on jump points, and then utilized Kalman filtering to predict the positions of known obstacles. Finally, a clustering method was employed to unify fragments of the same obstacle, although it lacked effective differentiation between static and dynamic obstacles. Furthermore, Qiu Yiming^[5] conducted research on surface target perception based on visible light, focusing on the "Huster-68" unmanned vessel. This study involved the processing of surface video to obtain information on water boundaries, surface target positions, and their motion speeds. In a similar vein, PENG Y and colleagues^[6] proposed an obstacle detection algorithm and avoidance method based on 2D laser radar. They utilized filtering and clustering algorithms for point cloud data processing to extract obstacle positions. Additionally, Song H^[7] introduced a collision avoidance system designed for safe navigation of unmanned vessels in dynamic environments. This system comprised a

fuzzy controller based on laser radar sensors for obstacle detection.

But these approaches have their limitations. Therefore, this paper proposes an innovative method for monitoring the navigation environment of unmanned ships based on millimeter wave radar. The method uses three millimeter-wave radars, each of which covers a detection range of 120 degrees, and realizes 360-degree all-round monitoring of the ship through appropriate Angle arrangement, thus ensuring the safe navigation of the unmanned ship. These three millimeter-wave radars realize target correlation and tracking through multi-target tracking algorithm, providing an efficient and reliable solution for environmental monitoring of unmanned ships. The experiment proves that this system has important reference value in the practical application of unmanned ships, and provides solid theoretical support for the autonomous navigation of unmanned ships in the future.

2.Method

2.1 Millimeter Wave Radar Coordinate Conversion

According to the user manual of millimeter wave radar, the geometric center of the most prominent part of the front of the millimeter wave radar is the origin of the coordinate system of the millimeter wave radar sensor. Three millimeter wave radars are used in this system, which are radar No. 1, Radar No. 2 and radar No. 3. The installation positions of the three radars are shown in Figure 1:



Figure 1. Millimeter wave radar installation

The x axis and y axis of the coordinate system of radar No. 1 are converted into the coordinate system of the ship, and the right hand coordinate system rule is also used to make the coordinate system of the millimeter wave radar coincide with the coordinate system of the ship.

When coordinate conversion is performed on the No. 2 and No. 3 Millimeter wave radars, the radar coordinate system needs to be rotated to a suitable position, and the coordinate conversion diagram is shown in Figure 2:

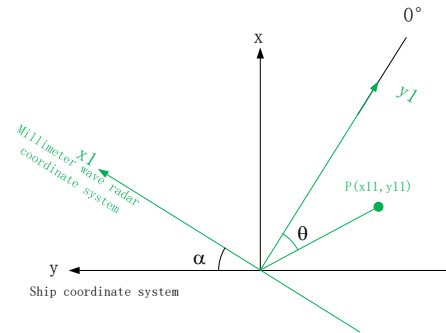


Figure 2. Coordinate system transformation diagram

The ship's coordinate system is established with the installation position as the center, and the coordinate system used by the millimeter wave radar for data measurement is also a rectangular coordinate system with the triangular center of gravity of the three millimeter wave radars as the origin, and the measurement results that the coordinate system of the millimeter wave radar needs to move 8 cm in the negative direction of the y axis. In Figure 2, the x-y coordinate system is the ship coordinate system, and x1-y1 is the millimeter wave radar coordinate system.

When the millimeter wave radar obtains data, the data of the target point is the distance in x direction, the distance in y direction, the relative acceleration in x direction, and the relative acceleration in y direction.

When the point p(x11, y11) is converted from the x1-y1 cartesian coordinate system to the x-y cartesian coordinate system, the coordinates of the converted point are p(x11z, y11z). When alpha is positive, the conversion formula is formula (1):

$$\begin{aligned} x11z &= (y11-0.08) \times \cos(\alpha) + x11 \sin(\alpha) \\ y11z &= x11 \cos(\alpha) - (y11-0.08) \times \sin(\alpha) \end{aligned} \quad (1)$$

When alpha is negative, the conversion formula is formula (2) :

$$\begin{aligned} x11z &= (y11-0.08) \times \cos(\alpha) - x11 \sin(\alpha) \\ y11z &= x11 \cos(\alpha) + (y11-0.08) \times \sin(\alpha) \end{aligned} \quad (2)$$

2.2 Millimeter wave radar multi-target correlation and tracking

The task of multi-object detection and tracking primarily involves detecting targets in complex and noisy environments while continuously estimating the motion parameters of these detected targets. In the context of ship navigation, a vessel's awareness of its surrounding environment is of paramount importance. This includes the detection of obstacles and the determination of operational parameters of other vessels, all of which occur within the operating range of the ship. Accurately determining the relative positions, headings, and speeds of other vessels in relation to one's own ship is crucial for collision prevention and ensuring safe navigation, especially in conditions of limited visibility. During ship navigation, functions such as collision warnings, collision avoidance, and route planning heavily rely on the effectiveness of environmental monitoring.

In the field of target tracking, there are typically several stages, including point acquisition, data association, tracking filtering, and track management. Figure 3 illustrates the target tracking process.

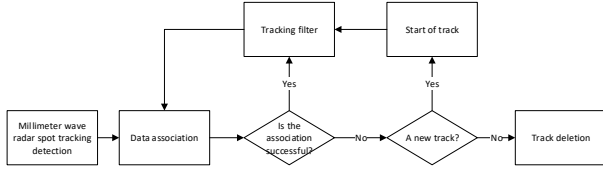


Figure 3. Target tracking flow chart

Multiple Hypothesis Tracking (MHT) is an advanced algorithm used to solve complex target tracking problems. It was first proposed by D.B. Reid at the end of 1980s^[8]. The algorithm mainly includes: cluster formation, hypothesis generation, probability calculation of each hypothesis and hypothesis reduction. Under ideal conditions, MHT is considered to be the optimal method for dealing with data interconnection^[9].

(1) Hypothesis generation

Suppose the interconnection hypothesis set at time t is J^t , then from J^{t-1} and the latest measurement set, the J^t set is obtained, as follows:

$$S(t) = \{S_n(t), n = 1, 2, \dots, N_t\} \quad (3)$$

The first $S_n(t)$ is obtained by the interconnection of J^{t-1} , and then extended by $S_2(t)$ to all sets to form a new hypothesis.

Where $S_t = \{S(1), S(2), \dots, S(t)\}$ represents cumulative measurements from the beginning to the current moment.

There are three possible state definitions for each hypothesis:

- ① the goal is an existing goal.
- ② This goal is a new goal.
- ③ The target is false alarm. Each target can be connected to at most one current time measurement, and that measurement must fall into its confirmation region.

(2) Calculation of probability

P_i^k is the probability of hypothesis J_i^k , $P_i^t = (J_i^t | S_t)$.

Among them, J_i^t can be regarded as the joint hypothesis of

S_{t-1} and the correlation hypothesis Ψ_h of the current number data measurement. According to literature^[8], it can be obtained:

$$P_i^t = (J_i^t | S_t) = \frac{1}{c} P(S(t) | J_g^{t-1}, \Psi_h, S_{t-1}) \times P(\Psi_h | J_g^{t-1}, S_{t-1}) P_g^{t-1} \quad (4)$$

Where c is the normalization factor, as follows:

$$P(S(t) | J_g^{t-1}, \Psi_h, S_{t-1}) = \prod_{n=1}^{N_t} f(n) \quad (5)$$

If the n measure comes from false alarm or noise, $f(n)=1/v$; If the measurement comes from the target, $f(n) = M(S_n(t); \hat{S}_n(t|t-1), D_n(t))$, the compliance expectation is $\hat{S}(t|t-1)$ and the variance is the information covariance matrix $D_n(t)$.

It is assumed that N_{DT} , N_{FT} and N_{NT} represents the number of current measurement data belonging to existing tracks, the number of false alarms, and the number from new targets respectively. According to reference^[10], the second item in the formula can be obtained as follows:

$$P(\Psi_h | J_g^{t-1}, S_{t-1}) = \frac{N_{FT}! N_{NT}!}{N_t} \times \prod_b P_{Db}^{\delta_b} (1 - P_{Db})^{1-\delta_b} \times P_{N_{FT}}(\beta_{FT} V) P_{N_{NT}}(\beta_{NT} V) \quad (6)$$

Put formula (6) into formula (4) to get the formula for calculating the hypothesis probability:

$$P_i^t = \frac{1}{c} \frac{N_{FT}! N_{NT}!}{N_t} \times V^{-N_{FT}-N_{NT}} \prod_{n=1}^{N_t} \{S_n(t); \hat{S}_n(t|t-1), D_n(t)\} \times \prod_b P_{Db}^{\delta_b} (1 - P_{Db})^{1-\delta_b} \times P_{N_{FT}}(\beta_{FT} V) P_{N_{NT}}(\beta_{NT} V) \times P_g^{t-1} \quad (7)$$

(3) Hypothetical reduction

Hypothesis generation is a primary factor affecting the complexity of the Multiple Hypothesis Tracking (MHT) algorithm. Therefore, simplifying and pruning hypotheses have become crucial directions for algorithm improvement. Typically, methods like low-probability hypothesis removal and hypothesis merging are employed for hypothesis simplification and pruning. This study adopts the K-best optimal hypothesis generation and N-scan pruning methods to facilitate the engineering implementation of the MHT algorithm.

The K-best optimal hypothesis generation method is a technique that enumerates K hypotheses with the highest confidence without exhaustively considering all possible scenarios. It constructs a cluster-based assignment matrix, with measurements as rows and tracks, new tracks, and false alarms as columns. Elements in the assignment matrix represent the negative logarithm of the likelihood probability between measurements and tracks or the negative logarithm of the probability that a measurement comes from a new track or a false alarm. Based on this assignment matrix, we employ the algorithm proposed by Murty^[11]. Initially, a queue containing all possible assignments is constructed, and then the Hungarian algorithm is used to find the best linear assignment in each iteration. Subsequently, this best assignment is removed from the assignment queue, and the process continues to find the next best assignment. This loop is repeated K times to identify K hypotheses with the highest confidence and probability.

The N-scan pruning method is a technique that controls the number of hypotheses by restricting the depth of the track tree^[12]. When the depth of the track tree exceeds N, the N-scan pruning method searches for the leaf node with the highest confidence in the current track tree. It retains the branch with the root node where the highest-confidence leaf node resides while eliminating the other branches.

In summary, hypothesis generation significantly impacts the complexity of the MHT algorithm, making hypothesis simplification and pruning key directions for algorithm enhancement. This study employs the K-best optimal hypothesis generation and N-scan pruning methods to advance the engineering implementation of the MHT algorithm.

3. Experiment

3.1 Pool experiment

Before conducting experiments in this study, an artificial water tank (as shown in Figure 4) was set up to assess the environmental detection capabilities of the millimeter-wave radar.



Figure 4 Artificial water tank



Figure 5 Millimeter-wave radar environmental detection experiment

In the artificial water tank, experiments were conducted using multiple millimeter-wave radars for object recognition and tracking, as depicted in Figure 5. The system provided detection results for the buoys placed throughout the entire autonomous navigation process of the unmanned surface vehicle, as shown in the figure.

The relative position diagram of the unmanned ship and obstacles is shown in Figure 6, which shows the relative position of obstacles relative to the coordinate system of the unmanned ship during navigation.

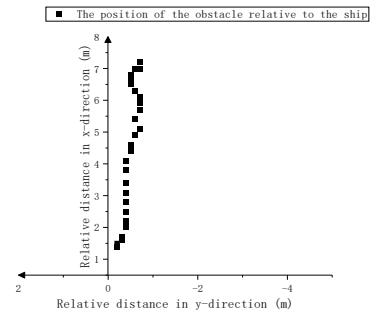


Figure 6 Map of the relative position of unmanned ships and obstacles

Figure 7 shows the relative distance between an unmanned boat and an obstacle detected during navigation.

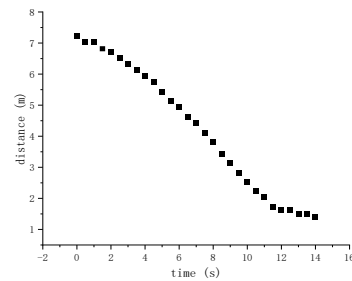


Figure 7 Relative distance between unmanned ships and obstacles

As shown in Figure 8, the relative velocity between the unmanned boat and the detected obstacle during navigation

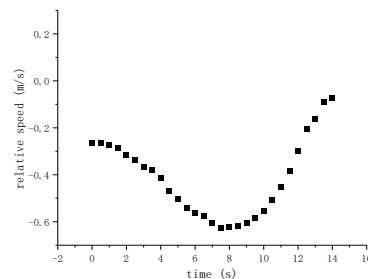


Figure 8 Relative speed between unmanned ships and obstacles

4. Conclusion

This paper discusses the current state of environmental perception in unmanned surface vessels (USV). Addressing the shortcomings of existing approaches, a navigation monitoring system for intelligent ships is proposed, which relies on millimeter-wave radar technology. The system is constructed using three millimeter-wave radars. In this system, the radars are initially installed at specific angles, and the data collected by these radars undergoes processing using a multi-hypothesis tracking algorithm. This processing

includes data of a system for monitoring the navigation environment of intelligent small vessels using millimeter-wave radar. The reliability and accuracy of this system are validated through real ship experiments. However, it's worth noting that during actual navigation, the size of the waves can affect millimeter-wave radar navigation monitoring. Therefore, future research will focus on mitigating interference caused by water surface ripples to continually optimize the construction of this control platform.

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Research on the Study of Cultural Classics and the Cultivation of News Communication Talents

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Abstract: The conflict and difference of civilizations are currently the forefront of academic issues and the core issue of education. Contemporary cultural construction is facing an important turning point from "westernization of China" to "sinicization of the West". There is a serious contradiction between the historical mission of cultural inheritance and the lack of traditional culture in the cultivation of journalism and communication talents. This article analyzes how to position the role of traditional culture at the current stage and analyzes the "useful use" of traditional culture in the cultivation of journalism professionals from three aspects, and preliminary considerations were made on how traditional cultural dissemination can be integrated with the cultivation of news professionals.

Keywords: Cultural Classics, News Communication Talents

1. INTRODUCTION

In the training mode of news and communication talents, emphasizing the reading and learning of cultural classics is based on a rational judgment of the development trend of contemporary culture, and is a deep reflection on the historical mission of cultural inheritance and the lack of traditional culture in news and communication. Reading cultural classics will make future news and communication workers become inheritors and disseminators of traditional culture. For a long time, in universities, our positioning of traditional culture education has been "a fundamental course to enhance students' humanistic qualities." And our role in traditional culture is also more inclined towards its "useless use."

Believing that traditional culture is the fundamental knowledge that constitutes the bottom layer of students' thinking, it is the knowledge that subtly constructs students' worldviews and values, and its role is difficult to perceive, but it is also indispensable. News dissemination is not limited to information transmission from a theoretical perspective, but rather to information integration and transmission from the perspective of social development needs and the information acquisition needs of the people. At the same time, a large amount of information is mixed with important information related to social development and people's living standards, and the connotation and power conveyed by this information will directly affect the quality of social development.

In the process of news dissemination, corresponding talents must be based on the actual situation, go to the scene, and walk into the lives of the masses, to convey more authentic information. Therefore, it is crucial to pay attention to the practicality of talent cultivation. In the era of media integration, cultivating news dissemination talents also needs to have a clear career direction, which is to adhere to the cultivation concept of practicality. Journalism itself has strong vocational education characteristics and belongs to an applied discipline. Practicality is very important for journalism, and only news communicators with strong practical experience can disseminate high-quality news. Focusing on differences is

a major trend in the contemporary world, which is most typically reflected in the theory of deconstruction.

Subsequently, feminism, postcolonialism, new historicism, as well as Western Marxism, especially the theories of the Frankfurt School, all had a deconstructive color. Many scholars have pointed out that deconstructionism is the inheritance and further development of structuralism. Indeed, both theories are based on examining the relationships between things, but deconstructionism and structuralism are completely different. The overall theoretical pursuit of structuralism is to find the laws that encompass all things, and its "structure" involves the systematization of knowledge. But in the view of deconstructionist theorists, structure is by no means the origin and center of anything, it comes from differences and is determined by them.

2. THE PROPOSED METHODOLOGY

2.1 The conflict and difference of civilizations are not only the forefront of academic research but also the core issue of education today.

As a journalist, one must first abide by the professional ethics of journalism and establish a sense of news orientation. The Code of Professional Ethics for Chinese Journalists clearly stipulates: "promote scientific theories, disseminate advanced culture, shape a beautiful soul, promote social integrity, enhance social responsibility, and resolutely resist content with vulgar style and harmful to people's physical and mental health", and "safeguard the legitimate rights and interests of interviewees, respect the legitimate demands of interviewees, do not disclose personal privacy, and do not defame others. However, in the current era of self-media, there are more and more news aimed at gaining popularity and attracting attention. The reform of news and communication talent cultivation involves many fields and is directly related to concepts, methods, and systems. In the process of reform, most institutions have not accurately positioned the focus of the reform. For example, some universities have focused on

improving students' comprehensive abilities in the process of innovating professional talent cultivation models.

However, the overall reform of universities lacks a solid foundation and guarantee, the perspective of mechanism formulation is not perfect, and targeted analysis and optimization of problems are not implemented based on the actual situation. It only cultivates students based on their individual abilities, resulting in the loss of effectiveness and scientific of the overall cultivation model. The lack of a basic constraint system directly leads to a gradual deviation from the essence and core concepts of talent cultivation in the later stage. In addition to the above cultivation concepts, the concept of keeping up with the times is also a concept that needs to be followed in the process of cultivating news and communication talents.

News communication itself is closely related to the development of the times, technological progress, and environmental changes. In the process of cultivating talents, only by keeping up with the times can the value of cultivating talents be ensured. The overall demand of structuralism is to seek similarities, while deconstructionism precisely seeks differences. Derrida's coined term 'difference', a unique deconstructive term, clearly reflects the tendency to seek differences in thinking. The ideology of deconstruction has greatly influenced postmodernism, which has two main characteristics: one is deconstruction centered and anti-centered, and the other is the emphasis on vulgarity and anti-elitism. Overall, it is deconstruction centered and advocates diversity.

Aphasia "does not mean that we cannot speak, but that our discourse content and language are both Western, rather than our own. As Mr. Cao Shunqing said, "After the May Fourth Movement, Chinese culture and academia embarked on a path of Westernization, leaving us in a serious state of 'aphasia'. We found ourselves always following the west and never surpassing them. The result of this great river change is that today we not only forget our own traditions, but also are left behind by world academia, Yang Pu's psychoanalysis of Zhu Ziqing's "Moonlight in the Lotus Pond" using Freudian psychoanalytic theory is a typical manifestation of "Westernization".

In the training requirements for journalism and communication professionals formulated by the Ministry of Education, it is emphasized that students should have broad cultural and scientific knowledge and be senior specialized talents in journalism and communication who can work as editors, journalists, and managers in news, publishing, and publicity departments. The broad cultural and scientific knowledge and advanced specialized talents highlight the cultural content of cultivating news and communication talents, rather than being proficient in a certain technology as a "craftsman". This passage is a classic example of Laozi's argument on the unified law of syndrome differentiation. Although this passage is not many words long, it has a rigorous and progressive argumentation system. Firstly, the concept of dialectical unity between beauty and ugliness, as well as between good and evil, is proposed. Furthermore, from point to surface, a series of dialectical and unified concepts such as existence, difficulty, length, pitch, pitch, sound, and context are introduced. From quantitative to qualitative changes, it is demonstrated that the law of dialectical unity is the main law of Dao change.

2.2 The Role of Traditional Culture in the Cultivation of Journalism Talents

The typical feature of postcolonial theory is to criticize Western cultural hegemony, and feminism also uses the differential ideas of deconstruction to deconstruct male centeredness. In addition, hermeneutics, the Frankfurt School, and Foucault's discourse theory all have a strong deconstructive color. If we want to sort out the 2018 internet buzzwords, I'm afraid "Zuo Ba" will become one of the top ranked ones. Since Dr. Sun became an internet celebrity, there have been endless reports on the popularity of seat bullies on the internet, even forming a happy and harmonious seat bullies' family. For this phenomenon, we cannot help but think, is such reporting beneficial for purifying social atmosphere or accelerating the decline of the world? What is the news value of Zuo Ba? The result we see is that one blockbuster is reported, and countless blockbusters follow one after another.

Enable talents to have access to many contemporary transmission tools and understand their basic audience orientation, usage methods, and value generated. However, in the actual training process, this innovative strategy of the times is not fully implemented. For example, although students are aware of the important impact of the Internet in news media communication, there are shortcomings in the specific use and development methods of network platforms. The poor correlation between information dissemination and the development and use of new media limits the era transformation of talent development, leading to a closed-door situation in the development of news media.

In the era of media integration, news and communication personnel are also facing a more severe environment. To cultivate high-quality talents, it is necessary to carry out professional and curriculum reforms, to cultivate talents that meet the development needs of the media integration era. Therefore, the school of journalism at Fudan university has implemented a "2+2" undergraduate training reform model. In the process of cultivating news and communication talents, different universities should combine their own advantages and teaching traditions and explore a highly distinctive news and communication talent cultivation model while adhering to the laws and standards of news and communication talent cultivation. For example, actively adding new majors that combine "network and new media", adjusting and setting up traditional news and communication courses, and adding courses related to new media.

The conclusion is that if the 'sage' grasps this law, they will act on the principle of inaction. The argumentation process is concise and rigorous, reflecting the speculative beauty of Laozi's philosophy. The training system involves mechanisms, concepts, and methods. Firstly, both universities and social enterprises and institutions need to formulate optimization mechanisms based on their own development concepts and directions, create a sound cultivation system, and optimize the institutional system in combination with the actual growth needs of talents and the development needs of the field of news and communication, ensuring that the institutional system can become the main basis for innovation in talent cultivation plans.

Under the trend of economic information globalization, the process of cultivating news and communication talents in the era of media integration still needs to strengthen external cooperation, to improve the internationalization level of news and communication talent cultivation and maximize the

professional level of news and communication personnel. In the process of strengthening foreign cooperation, there are differences in the actual situation of different universities, so in the process of news dissemination and foreign cooperation, they also face different situations. So, in the actual training process, universities can gradually deepen foreign cooperation from shallow to deep, from point to surface.

3. CONCLUSION

As an effective classroom teaching method, we suggest that students first preview the original text of cultural classics before class. The teacher selects students to read and explain the original text in class, and then the teacher elaborates on the original text. Based on students' understanding of the original text, the teacher delves into the cultural knowledge and issues related to the original text, expands the knowledge range of students' cultural traditions, and achieves the goal of applying what they have learned. Only in this way can they avoid jumping into the air and learn true knowledge, only then can we cultivate a rigorous and solid learning style. We need to shift the positioning of traditional culture as a useless tool for enhancing human qualities and explore and explore the useful uses of traditional culture. It is more important to effectively introduce the essence of traditional culture into the cultivation of news professionals, not only reflected in relevant courses, but also more importantly in students' thinking, work, and learning.

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Exploring the Application Path of Machine Learning in Computer Vision Processing

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Abstract: In the current economic development of society, with the application and development of machine learning algorithms, computer vision processing technology based on this has also become a key form of technology in the field of artificial intelligence. Reasonably applying machine learning algorithms to computer vision processing can make it more suitable for human thinking and meet practical visual processing needs. Has won good honors in many large-scale recognition studies. This article mainly studies the main applications of deep convolutional neural networks in computer vision. Analyze the pooling operation and image classification object detection of deep convolutional networks and promote the application and development of deep convolutional neural networks in computer vision.

Keywords: Machine Learning, Application Path, Computer Vision Processing

1. INTRODUCTION

Convolutional Neural Network (CNN) is a well-known deep learning architecture inspired by the natural visual perception mechanisms of organisms. In 1959, Hubel et al. discovered that cells in the visual cortex of animals were responsible for detecting light in the receptive field. Inspired by this discovery, Japanese scientist Fukushima proposed a hierarchical multi-layer artificial neural network called the neurocognitive machine around 1980. The neurocognitive machine model is composed of various types of cell units, with the most important two being called "S-type cells" and "C-type cells".

Since 2014, many machine learning frameworks have been applied to image detection in computer vision processing, such as R-CNN framework, FastR-CNN framework, FastR-CNN framework, YOLO framework, and SSD framework. Among the machine learning image detection frameworks mentioned above, YOLO framework has the highest detection speed. Through practical research, it has been found that its detection speed can reach 155fps/s, but its detection accuracy is the lowest, only 52.7%; Although the Faster CNN framework has the highest detection accuracy, its detection speed is very slow. Compared to other detection frameworks, the SSD framework has advantages in both detection accuracy and detection speed.

Therefore, in specific computer vision processing, the SSD framework can be used as its image detection framework. Essentially, this convolutional neural network is the first successfully developed multi-layer neural network, and this algorithm model is more conducive to network input of multiple micro signals. At the same time as learning gradually deepens, there is a wave of information learning. Currently, convolutional neural networks have been preliminarily applied to large-scale and different machine learning applications such as natural speech processing, image recognition, and speech recognition.

The application of bionics and engineering methods. In practical applications of computer vision processing, machine learning mainly simulates human learning behavior to obtain new knowledge and skills, and summarizes and organizes

existing knowledge structures, thereby continuously improving its performance in the processing process. Artificial intelligence is a key part of the combination of machine learning and computer vision processing and is one of the important means to achieve intelligent computer vision processing. In specific combinations, machine learning techniques of bionics and engineering can be used to effectively implement various functions of computer vision processing.

2. THE PROPOSED METHODOLOGY

2.1 The main applications of mechanical learning in computer vision processing

The use of biomimetic technology can effectively simulate human visual and learning abilities. A systematic introduction to the basic components and principles of CNN is provided. Section 3 elaborates and discusses the latest research progress in various aspects of CNN, such as convolutional layers, pooling layers, activation functions, etc. in recent years. Section 4 summarizes representative CNN architectures since 1998; Section 5 introduces the application of CNN in image classification/localization, object detection, object segmentation, object tracking, behavior recognition, and image super-resolution reconstruction. Finally, prospects are made for the future research directions of CNN. In the process of processing photos, computers can use corresponding algorithms to segment semantic graphics, while also making reasonable distinctions between various main elements.

To achieve this goal, a sufficiently powerful building block is needed, which is to predict the pixel distribution in various classified images by training classifiers. This task poses many computational challenges for machine learning, especially in computers with large pixel counts, where image classification tasks require over a million training and testing sessions. The features collected from the convolutional layer can be input into the classifier for training, in theory, inputting the various information features collected by the convolutional layer into the classifier requires a lot of calculation, especially in larger image resolutions, to obtain the final calculation classification results.

However, due to the certain characteristics of local areas in the image, it is likely to be used in another field. Therefore, it is necessary to perform feature aggregation statistics on the local positions of the image, which is a pooling operation. Artificial intelligence is a key part of the combination of machine learning and computer vision processing and is one of the important means to achieve intelligent computer vision processing. In specific combinations, machine learning techniques of bionics and engineering can be used to effectively implement various functions of computer vision processing. The use of biomimetic technology can effectively simulate human visual and learning abilities. Typical pooling operations include average pooling and maximum pooling.

The maximum pooling function takes the maximum value of elements in a block as the output of the function, extracting the local maximum response of the feature plane. It is usually used for extracting low-level features and selecting the most prominent features from the input feature map. The mean pooling function takes the arithmetic mean of all elements in the calculated block as the output of the function and extracts the mean of the local response of the feature plane. The so-called artistic style transfer refers to extracting style from an existing image, such as in Van Gogh's "Night Sky", and then importing another image with other content and styles, such as a city's architectural complex. Then let the system draw the urban architectural complex again in the style of 'Night Sky'.

2.2 Art Style Transfer and Introduction of Machine Learning Algorithms

Although humans can easily recognize the style features in images, for computers, how to convert the style of one image into the style of another is an equally complex and abstract problem. Traditional image art style transfer methods are difficult to meet the requirements of practical applications in terms of visual effects. In pooling operations, if a continuous range of images is selected as the pooling position, the same neural network will appear between the two, resulting in the application of convolutional features. Therefore, these pooling works have a certain degree of translation invariance and can consistently output the same classification results within the same features and classifiers.

Compared with the convolutional features, these classification results can effectively reduce the working dimensions of the feature vectors and reduce the computational workload, enabling effective expansion and supplementation of the training data and avoiding its strong fitting effect. Convolutional layers are an indispensable part of convolutional neural network architecture, mainly used for learning feature representations of input images. Therefore, researchers are constantly trying to improve the convolutional layer in CNN architecture to improve network performance. Below are some key innovative measures in this regard. After importing an image P into the VGG (Convolutional Layer) machine learning network, a series of vectors are obtained in the first layer of the network, and intermediate vectors are obtained in each subsequent network layer. Each pixel in the network is composed of three values: red, green, and blue, representing image features.

Because VGG19 belongs to a machine learning network that has completed a series of simulated human visual system training, and the parameters have been determined, the intermediate vector obtained through parameter calculation can be used to represent this image. In this case, the feature map within a certain convolutional layer can be defined as the content of the image. Most convolutional neural network

models require image size data input, but it is easy to lose the original data in the image information during image cropping; Or adjust the aspect ratio and size of the image to avoid deformation and distortion. And pay attention to whether the roll base in the input image size has a constraint effect, ensuring that the dimensionality is fixed during the input process.

Since the application of deep learning in the ILSVRC2012 image classification competition and achieving good results, this deep learning model method has gradually been promoted in image recognition. Moreover, the emergence of new neural network models is constantly comforting their performance, promoting the rapid improvement of image feature learning in this network model. Spatial pyramid pooling (SPP) was proposed by The et al. in 2014. The key advantage of SPP is that it can generate fixed size feature vectors regardless of the size of the input feature map, and then input them into the fully connected layer. SPP will perform pooling operations on local areas in the input feature map that are proportional to the image size, in order to obtain fixed size feature vectors.

This is different from the pooling of sliding windows in previous deep networks, where the number of sliding windows depends on the size of the input image. By replacing the last Spooling layer with SPP, He aiming et al. proposed a new SPP-Net that can handle images of different sizes. Compared to the definition of image content, the definition of image style has higher difficulty. In style definition, it is not possible to randomly select a feature map within a certain layer as a style layer. Instead, it is necessary to take all feature maps within a layer and multiply them in pairs to obtain a Gram matrix, which mainly includes image color information and texture information. This matrix is the image style.

3. CONCLUSION

In the specific application of computer vision processing technology, machine learning algorithms have very good application advantages. One solution to early computer vision problems was through mathematical modeling and analysis methods. However, with the rapid development of machine learning in recent years, the combination of computer vision and machine learning has attracted more widespread attention from researchers, achieving a significant leap in the field of computer vision. Currently, people's use of deep learning is only limited to the application of simple reasoning calculations, and good research results have been achieved in the field of image and speech. This also indicates that with the in-depth research and feature extraction of convolutional neural networks, they can more effectively represent some of their features in other fields, and with the development of complex reasoning, they will delve into more aspects of artificial intelligence operations.

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A Study on the Correlation between Online Teaching Content and Student Learning Effectiveness in Adult Education

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Abstract: Online learning for adult education students has become a major learning method, which is easy to organize and facilitate learning activities, and is popular among adult education students. Conducting research on online learning for adult education students can improve their learning quality and better meet their learning needs. Research suggests that the positive correlation between teachers and students gradually increases during the initial learning phase, and then enters a stable period of positive correlation; By increasing the consideration of online teachers' investment in tutoring time and strengthening the guidance and evaluation of online teachers' behavior, the impact on students' learning outcomes will be better.

Keywords: Correlation, Online Teaching Content, Student Learning Effectiveness, Adult Education

1. INTRODUCTION

Adult education is currently an important form of education in China, playing an important role in improving the quality of the people and enhancing the literacy of workers. With the advancement of information technology, smart education has become increasingly popular due to its characteristics of easy organization and easy learning activities. Online learning for adult education students has become a major learning method. Conducting research on online learning for adult education students can improve their learning quality and better meet their learning needs.

The behavior of online education teachers differs from that of traditional face-to-face courses, mainly manifested in differences in interaction methods. As a successful example of online education, the "tutoring for distance learning: a Teacher's Handbook" written by Open University in the UK points out that the quality of open and distance learning is influenced by many factors, including: "whether there are tutors and whether they are always responsive to learners' needs and provide clear and timely evaluation of learners' homework.

This study uses a certain art public elective course on a domestic MOOCO platform as the data source to desensitize personal basic information such as students' names and student numbers. Each individual is identified by a number, mainly analyzing the learning situation of students during the spring and autumn pandemic in 2020. Subsequently, data cleaning is carried out to remove noise data that is missing or incomplete in the learning process. Finally, effective records are selected. Based on the specific manifestations of online courses, big data analysis, video analysis, and tool analysis methods are used to record and analyze the behavior data of teachers and teaching objects. The data analysis and research objects are teachers' speech, activities, teaching objects' speech, practice, and meaningless behavior, focusing on 13 teacher behaviors and 11 teaching object behaviors, As a behavioral object for behavioral sequence analysis.

Through a survey of adult education students, it was found that the number of suitable daily hours for online learning is

31.18%, with "2 hours per day" accounting for the highest proportion among all options. The most favored daily duration of online learning for students is 2 hours, which may be since adult education students are all on-the-job learners, requiring a lot of energy to handle various tasks such as work and family. The daily learning duration of 2 hours can not only ensure the completion of learning tasks, but also comprehensively coordinate work and family affairs. The interaction between teachers and students is an important component of interaction. Swedish scholar Holmberg proposed in 1985 that teachers have two major teaching functions in online education. One of them is to achieve teacher-student interaction and provide learning support services to students through various two-way communication mechanisms during their learning. The average number of times is 16.8, with a standard deviation of 17.8.

2. THE PROPOSED METHODOLOGY

2.1 A survey on the current situation of online learning among adult education students

15.24% of students have not checked in once, and nearly half of them have checked in less than or equal to 10 times (48.57%). Based on the minimum time required to complete all videos of 867.95 minutes, students who have signed in 10 times need to study for nearly an hour and a half each time to achieve full progress. The issue of fewer check-in times and higher video completion progress warnings is whether students have been studying diligently for a long time after each check-in or have been playing videos and doing other things after check-in (commonly known as brushing classes). Since the platform does not record the duration of watching videos for students each time they log in to the platform, it is necessary to find the answer to this question from other aspects. The autumn data shows that the range of check-in times is 0-60, with an average of 21.55. The proportion of students who have not checked in is less, and the proportion of full marks is more. After comparison, students are less active in check-in during the epidemic period.

The online teaching behavior analysis model system constructed for the project is based on the teaching data analysis model of Carnegie Mellon University in the United States. By following the "Naïve Bayesian Model" data analysis technology as support, a ternary analysis system for online teaching data has been planned and developed, which includes three major parts: teaching behavior association mining, technical supported teaching mode analysis, and teaching mode and learning effectiveness analysis. Among them, teaching behavior association mining is the basis of online teaching data analysis system, which is mainly aimed at mining and analyzing teaching data, video data, browsing data, perception data and other data in the teaching process. Through the data analysis set component HPCA, the solution-oriented labeling tool RapidMiner, and the big data learning and analysis tool MapReduce, they are associated with the next module. The analysis of teaching modes supported by technology is the core of the system, mainly focusing on the analysis of the correlation and impact situation with various teaching contents under different teaching modes supported by technology

According to a survey of students' homework assignments and grading methods during online learning, 65.54% of them were found to have "teachers publish assignments on the platform and make online evaluations after completion", while 40.45% were found to have "teachers publish assignments on the platform and the platform automatically evaluates them after completion". Currently, adult education students' online learning homework assignments are mostly posted by teachers on the platform, requiring students to complete them. Then, the teachers make online corrections and provide grades, and students can check the homework correction results at any time. Based on the availability of data, this study comprehensively selected a course offered by Beijing Open University in the autumn semester of 2016 in the field of preschool education, involving 210 students. Excluding two students who registered for the course but did not participate in the study, the effective number of students was 208. There are 6 classes and 6 teachers. The behavior data of students and teachers comes from the backend data of the learning platform.

2.2 A correlation model between teacher behavior and student learning outcomes

The behavior data of teachers includes: the number of login times of teachers, the online time of teachers' courses, the number of on time replies from teachers (including the number of on time replies within 6 hours, the number of on time replies within 12 hours, the number of on time replies within 24 hours, and the number of on time replies within 48 hours), the number of replies from teachers, and the number of feedback words from teachers on student assignments. Among all the selected students for the 2020 spring course, 82.18% of students did not post discussions, 66.8% of students did not reply to discussions, and only 12.38% of students both posted and replied to discussions. The maximum number of published discussions is 33, with an average of 6.62; The maximum number of replies and discussions is 83, with an average of 15.89.

The above data indicates that most students did not complete assignments and chapter quizzes in a timely manner and did not actively participate in discussions. However, the overall level of completed tasks was relatively high. There are a total of 13 teachers teaching this course, and there are significant differences in the teaching methods of these teachers, which are reflected in: knowledge teaching as the focus, practical demonstration as the main focus, heuristic teaching as the

main focus, and guiding reflection as the main focus. The teaching method mainly based on knowledge teaching focuses on content explanation and blackboard writing, while the teaching method mainly based on practical demonstration focuses on courseware demonstration and guidance, The teaching method based on heuristic teaching focuses on questioning and assigning tasks, while the teaching method based on guiding reflection focuses on evaluation, activity organization, and management.

According to a survey of students' main problems with online learning, 28.69% believed that they were not proficient in using learning platforms, learning software, etc., 27.81% believed that poor internet access prevented smooth learning, and 27.21% believed that there was a lack of interaction in online learning and delayed feedback on learning issues. Data shows that the difficulties faced by adult education students in online learning mainly include inadequate use of learning platforms and software, poor internet access, lack of interaction in online learning, and a lack of learning atmosphere in online teaching. These difficulties affect students' learning effectiveness and hinder the improvement of their learning quality. Does the level of feedback from teachers affect students' online time, thereby affecting their posting and ultimately affecting their grades?

Taking the four assignments in this course as an example, Table 5 shows that as the assignments progress, especially to assignments 3 and 4, the teacher's feedback level (reflected in the number of feedback words) is related to the number of text clicks ($r=0.155$, $r=0.170$), number of text visits ($r=0.183$, $r=0.178$) There is a correlation between the number of multiple posts ($r=0.138$, $r=0.207$), the online time on the student platform ($r=0.149$, $r=0.201$), and the number of course launches ($r=2.214$, $r=0.300$) that students have completed the required posts. From this, the level of feedback from teachers on student assignments will affect students' access to learning texts, and online learning time will also be correspondingly extended. The quality of posts will be improved by posting again to improve grades.

Therefore, assuming H2 is established, the level of feedback from teachers has a significant impact on students' learning outcomes. Whether students actively participate in discussions can reflect their learning level. During the epidemic, students' enthusiasm for participating in discussions decreased, and most students did not post or reply to discussions, which indirectly indicates that students' learning engagement is insufficient. The data shows that the more discussions and replies posted, the more likely it is to receive high scores for mid-term assignments and final grades. Therefore, teachers can organize students to have a discussion every time they complete a video learning, which can include personal insights and doubts about the video. The collision of thinking between students is more conducive to learning.

3. CONCLUSION

Conduct research and analysis on the relationship between teaching technology application behavior and students' understanding and explore and analyze the correlation between teaching behavior and students' learning outcomes. The research results show that data analysis can reveal the teaching phenomena and teaching mode characteristics of the online course in preschool education, providing theoretical support for the future optimization and improvement of online teaching in this course. At the same time, it also has reference value for online teaching of other technical practice courses in preschool education. A comprehensive understanding of the

current situation and difficulties faced by adult education students in some in terms of their willingness to accept online learning, teaching methods, and targeted policy recommendations can optimize teaching effectiveness, solve problems in adult education students' online learning, and ensure the smooth progress of online learning.

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Research on the Structured System of C Language Teaching

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Abstract: Based on the actual situation of the "C Language Programming" course in IT majors, the characteristics of this course are analyzed, and a research and practice on C language teaching reform based on PI ability cultivation is proposed. Adopting a theme project oriented theoretical teaching method, constructing a "three-level" and "three combination" practical teaching system, implementing diversified evaluation and assessment methods, and improving students' practical and innovative abilities. The experimental teaching of C language is an important part of the C language curriculum. Based on the characteristics of cultivating applied talents in independent colleges, and in response to the problems encountered in experimental teaching, a plan is proposed to optimize the overall content and system of C language experimental teaching, further improving the teaching effectiveness of C language experiments.

Keywords: Structured System, C Language Teaching

1. INTRODUCTION

In the process of popularization of higher education, higher education is facing severe challenges, mainly due to the differences in abilities between the talents needed by the market and the talents cultivated by schools. Therefore, based on the characteristics of current popular education, how to take effective measures to promote education and teaching work, cultivate applied talents with practical and innovative abilities, and meet the needs of industries and enterprises is the primary problem faced by schools.

The comprehensive requirements for C language experimental courses are relatively high for students. They must not only master certain theoretical knowledge of C language, but also have a certain level of logical thinking ability and strong programming ability. The admission scores of independent college students are lower than those of ordinary undergraduate students, and their foundation is relatively weak, and their self-learning ability is poor. During the C language experiment class, students encountered problems such as not being able to write programs and making numerous grammar errors, which resulted in low initiative during class, poor quality of classroom teaching, poor self-learning ability, lack of good review habits, and inability to fully understand and consolidate the knowledge they had not learned in class.

Through a series of reforms such as teaching methods, experimental teaching, and evaluation methods, students' interest in learning is enhanced, basic skills are strengthened, comprehensive applications are oriented, and engineering abilities and qualities are cultivated. The purpose is to cultivate applied talents with strong practical and innovative abilities that can serve regional economic and social development. Graduates should have a solid knowledge foundation and a wide range of knowledge. Having good basic qualities, including scientific literacy and humanistic qualities. Having a rigorous scientific attitude, strong sense of innovation, independent thinking ability, and strong practical ability; Having a sound personality, such as a sense of responsibility, teamwork, and teamwork spirit.

The purpose of C language experimental teaching is to write programs, emphasizing results over processes, neglecting the training of students' thinking styles, and lacking the cultivation of students' innovative abilities. Students cannot draw inferences from each other and cannot flexibly apply the knowledge they have learned. Independent colleges aim to cultivate applied talents, with the core of cultivating students' practical abilities, social adaptability, and employment and entrepreneurship abilities. Different majors have different requirements for the purpose of C language experimental teaching. C language experimental teaching is not closely integrated with the talent cultivation mode of independent colleges, resulting in a separation of teaching positioning and training objectives. Teachers carefully design interconnected projects around teaching tasks or unit themes, with projects as the core, and construct teaching content logically according to the work process, guiding students to actively participate, inspiring students to integrate and master course knowledge points.

2. THE PROPOSED METHODOLOGY

2.1 Developing a thematic project-based theoretical teaching approach

In teaching, around the student performance management system, decompose comprehensive application examples and run through the knowledge points before and after. Firstly, by inputting and outputting student information, introduce C data types, arithmetic operations, and expressions, as well as keyboard input and screen output. Next, by adding further content to task learning, for example, the selection structure is introduced based on the judgment of whether male and female students' physical fitness test scores are qualified, and the circular structure is introduced based on whether multiple students' scores are qualified. In the assessment of language experiment courses, traditional assessment methods are changed, focusing on students' analytical, problem-solving, hands-on, and innovative abilities demonstrated during the experiment process, and standardizing the exam content, establish a comprehensive evaluation system for students' academic performance, comprehensively evaluate their

academic performance, establish a question bank for each major, provide test questions for students' self-test, stage testing, and final testing, and improve the proportion of process assessment in the total score.

Diversify the forms of process assessment, closely focusing on the cultivation goals of problem-solving and practical abilities, including classroom assignments, quizzes, after-school thinking questions, and small-scale software development. Incorporate students' entire learning process into the assessment scope and strive to comprehensively and objectively reflect their academic performance. Teachers design teaching links to engage in interactive, inspiring, and discussion-based learning, stimulate students' interest in learning, and guide them to actively learn. Utilize multimedia teaching environment to achieve human-machine interaction, teacher-student interaction, on-site programming, and combine theory with practice; Flexible use of heuristic teaching, setting problems, creating situations, and cultivating students' ability to raise, analyze, and solve problems in simple and profound terms.

In the teaching process, students are divided into small groups and organized to engage in collaborative learning. Through collaborative discussions within the group, information is exchanged, inspired, and promoted to stimulate their interest in learning. Through various forms of interaction, inspire classroom teaching and group collaborative learning, integrate project practice and training throughout the entire learning process, and cultivate students' innovative thinking, practical ability, and cooperative awareness from multiple perspectives. Teachers design teaching links to engage in interactive, inspiring, and discussion-based learning, stimulate students' interest in learning, and guide them to actively learn. Utilize multimedia teaching environment to achieve human-machine interaction, teacher-student interaction, on-site programming, and combine theory with practice; Flexible use of heuristic teaching, setting problems, creating situations, and cultivating students' ability to raise, analyze, and solve problems in simple and profound terms.

In the teaching process, students are divided into small groups and organized to engage in collaborative learning. Through collaborative discussions within the group, information is exchanged, inspired, and promoted to stimulate their interest in learning. Through various forms of interaction, inspire classroom teaching and group collaborative learning, integrate project practice and training throughout the entire learning process, and cultivate students' innovative thinking, practical ability, and cooperative awareness from multiple perspectives. The main task of the C language programming course is to cultivate students' programming ability. The traditional assessment method is based on a final exam paper to achieve the assessment purpose, mainly focusing on theory, and supplemented by practice. This way, it cannot truly assess practical ability.

2.2 Constructing a step-by-step practical teaching system

To assess students' abilities, establish diversified evaluation methods, reduce the assessment of memory content, increase the assessment of application ability, and combine grades with students' practical and innovative abilities, a new evaluation method for this course is developed, specifically including daily grades, computer exams, theoretical exams, etc. scientifically and reasonably. The usual grades include quantitative statistics of homework and engineering practice achievements, written summary materials and quality

evaluation, defense, ability, and quality evaluation, etc. Teachers use the provincial high-quality course management website to accurately assign and manage homework, program homework online and automatically score, and grades are automatically ranked. Students "feel like practicing in online games", turning passive learning into active learning, and top students stand out.

Integrate existing language video resources related to C language experimental teaching, teaching material information resources held by teachers themselves, and student learning feedback information resources, establish a teaching resource information sharing platform using the network, and place multimedia teaching courseware, videos, C language programs, and exercises on the information platform to achieve optimal resource allocation, facilitate communication and sharing between teachers and students, and solve the problem of less teacher-student meetings. When students encounter problems that cannot be solved during their learning, they should fully utilize their autonomy in learning and improve their ability to analyze and solve problems through self-study, practice, discussion, and other means. The "three levels" refer to the basic level, improvement level, and comprehensive innovation level.

The basic layer focuses on cultivating students' basic experimental abilities, enabling them to receive basic experimental training. The experimental teaching content mainly includes operational, confirmatory, and other types. Operational experiments are experiments that cultivate students' operational skills according to certain procedures and technical requirements for each knowledge unit. A confirmatory experiment is an experiment in which students complete the entire experimental process according to the requirements of the experimental purpose, to verify the theory of classroom teaching and deepen theoretical teaching.

The improvement layer focuses on cultivating students' problem-solving abilities through comprehensive programming training. The experimental teaching content mainly includes comprehensive, design oriented, and other types. Comprehensive experiments integrate various knowledge units into a systematic project, with system settings and calculations, system measurements and analysis comparisons, and plan improvements or suggestions. When establishing a teaching resource platform, it is necessary to establish a platform for teacher-student communication, teacher-student communication, and student-student communication.

The main content among teachers is to share teaching videos, courseware, and teaching experience, with the aim of improving teaching effectiveness. The main content of teacher-student communication is to answer questions, online teaching, and collect feedback from students. Teachers can promptly answer students' questions, and students can exchange learning experience with each other as the main content. Through teaching resource platforms, students can learn independently according to their actual situation, at each learning stage, students can timely understand their mastery of the knowledge they have learned through self-test questions on the platform.

3. CONCLUSION

In the teaching of C language programming, conducting research and practice on teaching reform based on PI ability cultivation, adopting a theme project-oriented theoretical teaching method, constructing a "three level" and "three combination" practical teaching system, and implementing

diversified evaluation methods can help expand students' thinking, stimulate their enthusiasm and initiative, and gradually improve their comprehensive application and innovation abilities, Solve the problem of disconnection between course theory teaching and engineering practice. Propose to optimize the content and system of C language experimental teaching. Focusing on the talent cultivation mode of independent colleges, with the principles of emphasizing basic knowledge, practical application, and ability cultivation, optimize the design of teaching content, methods, assessment mode, teaching plan, and integration of teaching resources. Detailed exploration was conducted on how C language experimental teaching can adapt to the talent cultivation mode of independent colleges.

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Game Modeling Algorithm of the Belt and Road Fusion of Chinese Information Based on Information Fusion and Prediction Model

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Abstract: This paper analyzes the characteristics of the full-ballistic flight of aerospace vehicles, and designs an overall scheme of multi-source information fusion navigation system based on redundant configuration of navigation sensors for the needs of navigation in different stages of full-ballistic flight of aerospace vehicles. The trading countries and product combinations that bring the greatest opportunities to foreign trade, the noise in the participants' own decision-making, the rewards of neighbors, and the pressure of public opinion on the betrayal by the Internet on the "Belt and Road" countries' game strategy selection, use simulation methods to test the correlation. Conclusion, and discussed our country's coping strategies.

Keywords: Game Modeling Algorithm, Belt and Road Fusion, Chinese Information, Aerospace Information Fusion

1. INTRODUCTION

The "Belt and Road" initiative includes two components, the "Silk Road Economic Belt" and the "21st Century Maritime Silk Road" [1]. It was proposed by Chinese President Xi Jinping in his speeches in Kazakhstan and Indonesia in 2013. It is the background of today's world economy. It is an important strategy to fully communicate the trade exchanges of countries along the route and provide a new impetus for China's exports [2]. The report of the 19th National Congress of the Communist Party of China pointed out that it is necessary to focus on the construction of the "Belt and Road", adhere to both importing and going global [3], follow the principle of extensive consultation, joint contribution and shared benefits, strengthen openness and cooperation in innovation capabilities, and form a land-sea linkage, east-west two-way mutual aid. Open pattern [4].

The "Belt and Road" construction adheres to the principles of consultation, co-construction, and sharing, and is open and inclusive [5]. It is not a solo piece by one country, but a chorus of countries along the route. Cross-border credit cooperation, as an important measure for the industry to tackle tough problems [6], is an important pen and ink to compose this chorus, and it is the consensus and urgent development needs of various countries. On the road of building a well-known think tank in China [7], the International Cooperation Center has always been exploring and actively innovating around the great initiative of the "Belt and Road". Through this meeting, the International Cooperation Center of the National Development and Reform Commission and its subordinate units will further improve international cooperation information [8], Research and build a long-term mechanism for the credit system, and comprehensively promote the construction of the social credit system [9].

In addition, in order to improve the reliability of the navigation system of the space shuttle and other space shuttles [10], in addition to the multi-source integrated navigation technology, the redundant design of the same type of navigation sensors is usually adopted [11]; The core of the integrated navigation system is the reliability of the inertial navigation system. The inertial navigation system has

attracted much attention because of its unique advantages of continuous, autonomous and reliable work [12], and has become the key equipment of the aerospace vehicle navigation system. Its algorithm performance is directly the key factors affecting the navigation performance of aerospace vehicles. Different navigation [13] reference frame arrangement methods have corresponding effects on the performance of the navigation system [14]. The existing traditional geographic reference frame navigation arrangement methods have their shortcomings when applied to the navigation of aerospace vehicles. Inertial navigation systems can be continuous, autonomous and reliable [15]. The unique advantages of the work have attracted much attention and become the key equipment of the aerospace vehicle navigation system. Its algorithm performance is a key factor that directly affects the navigation performance of the aerospace vehicle [16]. Different navigation reference system arrangement methods have corresponding effects on the performance of the navigation system [17]. The existing traditional geographic reference system navigation arrangement methods have their shortcomings when applied to the navigation of aerospace vehicles. Quantitative assessment of the country's export opportunities [18].

Therefore, we will identify and investigate China's export opportunities in other ASEAN countries (Brunei, Cambodia, Indonesia, etc.) [19], as well as China's export opportunities to 18 countries in West Asia (Iran, Iraq, Turkey, etc.), 8 countries in South Asia (India, Pakistan, Bangladesh, etc.) [20], 5 Central Asian countries (Kazakhstan. In 2017, China hosted the "Belt and Road" International Cooperation Summit Forum in Beijing. The summit achieved 76 major items in five categories: policy communication [21], facility connectivity, unimpeded trade, financial integration, and people-to-people bonds, more than 270 specific achievements. In October 2018, the "Belt and Road" International Cooperation Cities Credit Alliance [22] Summit, co-hosted by the International Cooperation Center of the National Development and Reform Commission of China and the Jinan Municipal People's Government, was held in Jinan, Shandong Province. Build an exchange and cooperation platform for alliance members to share information, resources, and

achievements, and establish a credit information sharing mechanism among alliance members [23]. To sum up, the environmental adaptability, accuracy, and reliability of the navigation system for aerospace vehicles to fly across the sky for a long time. In addition, considering the needs of aerospace vehicles in different flight stages and flight control tasks, their navigation reference coordinate systems will also change. Different flight environment characteristics and motion characteristics across the sky [24].

2. THE PROPOSED METHODOLOGY

2.1 The Aerospace Information Fusion and Prediction Model

Kalman of the Massachusetts Institute of Technology proposed the Kalman filter theory and successfully applied it to the system of the American Apollo program. Therefore, the Kalman filter theory directly affects the establishment of the optimal estimation theory, and it is still the field in the field at home and abroad. The research focus of information fusion application technology. Experience the overseas life of Chinese employees. The program fully presents the infrastructure interconnection between China and countries along the "Belt and Road" initiative, the investment direction and the industrial layout of the countries along the route. Chinese-funded enterprises are "going out" Overcoming many difficulties in the process of "localization", integrating and coexisting with other countries' cultures, and enhancing the audience's understanding of the "Belt and Road" initiative.

In filter 1 of the DSM model, countries with too high political or commercial risks will be screened first, followed by countries with small macroeconomic scales and slow or regressive macroeconomic trends. And When the aerospace vehicle is in different flight stages, different flight environments will lead to different navigation technology problems, such as the inability to transmit electromagnetic waves in the black-barrier area and the failure of some sensors due to changes in environmental conditions during long-duration flight, as well as large overload and The impact of high dynamic flight with drastic changes in angular velocity on sensor equipment, etc.

Different from traditional aircraft, aerospace vehicles need to fly across the sky and the flight environment is harsh. Relying on the inertial navigation system alone cannot meet the high-precision navigation performance requirements of aerospace vehicles; while the traditional single inertial/satellite, inertial/astronomical combination Navigation systems, due to their respective shortcomings, are the main battlefield of information warfare in modern air and space battlefields, and navigation information is an indispensable part of them. In the process of full ballistic flight, the aerospace vehicle must overcome the multi-stage working problem of the navigation system and the problem of navigation system failure.

2.2 The Belt and Road Integrates Chinese Information

Targeted research on a navigation system with high adaptability and reliability for aerospace vehicles. The federated filtering algorithm is different from the traditional centralized filtering. As a decentralized processing algorithm, it processes information through a two-level decentralized structure. with fusion. First, a main navigation system is selected as the public reference system, usually the inertial navigation system is selected, and then other navigation systems and the main navigation system are combined into a combined system. The full ballistic flight cycle of an

aerospace vehicle can be divided into an ascending segment and an on-orbit segment, return to the reentry segment and the landing segment.

A single inertial navigation system will accumulate errors over time during operation, which will eventually lead to the divergence of navigation information. Therefore, a suitable multi-source integrated navigation system is constructed for different flight stages of aerospace vehicles. The main idea of EKF is to integrate nonlinear The function is expanded by Taylor series at a certain point, and the higher-order terms of the expansion are directly ignored and discarded. Through such a process, an approximate first-order linearization model of the system can be obtained, which is convenient to use Kalman filter to deal with the problem of state estimation. The main role of filter 1 is to remove some countries that lack trade potential early in the overall screening process, so that subsequent filters can focus on a refined "country-product" combination. Using the ONDD risk indicator and per capita GDP, after the first round of filtering, a total of 101 countries were retained that met the two sets of criteria.

Based on the size and growth of demand in these markets (determined in 2) and the relative market share of the exporting countries (determined in filter 4), the overall screening process makes the table divide the country's actual export opportunities (determined in filters 1 to 4). 3) are classified into 20 units. Star and Wilson (1995) proposed a model in which participants have different levels of policy complexity. They distinguished three levels of reasoning: level-0 reasoners, level-k reasoners, and level-k-1 reasoners, with different levels of reasoning. The players choose different strategies in the repeated game, and some new rules are introduced into the structured model of decision rules. The "five links" of the "Belt and Road" allow countries along the route to cooperate more smoothly, and at the same time, the cooperation of the countries along the route will also affect each other through the "Belt and Road". In this context, the threat of future cooperation from a third country is more significant for China-Singapore credit reporting cooperation.

2.3 The Game Modeling Algorithm for Integrating Chinese Information along the Belt and Road

According to the above analysis, China has a high share of REOs with high or high "potential" market shares in countries along the "Belt and Road" (units 11 to 20), which account for 99.7067% of the total value. China For most REOs, China has more export opportunities in the market with a larger share. The structured model of decision-making rules shows that different types of decision-makers appear at different frequencies, get different payments and benefits, and the decision-makers choose There are also differences in optimal strategies; at the same time, the model also incorporates the observation method of information search into the game, and makes a better explanation for the results of some endogenous factors and information factors affecting decision-making.

Most of the time, the aerospace vehicle is in a maintenance state, but in the orbit change stage, the navigation system needs to provide accurate attitude and position information. In the orbit maintenance phase, the astronomical navigation system and the satellite navigation system are used to provide attitude information and position information, respectively. When maneuvering, the inertial navigation system is used to provide navigation information. For the multi-information fusion integrated navigation system of aerospace vehicles, the position information of the satellite navigation system and the

celestial vector information of the ultraviolet sensor do not need to be used at the same time, and one of them is selected according to the actual situation. Therefore, the inertial/satellite/star sensors and inertial /star sensor/ultraviolet sensor two combination modes are simulated and verified.

Among these 59,032 real export opportunities, most of the real export opportunities (REO) can be traced back to Turkey (15% of the countries along the "Belt and Road"), the United Arab Emirates (11.42%) and the Philippines (9.88%). The actual export opportunities of other countries are more or less distributed in the remaining countries along the "Belt and Road". The potential value of China's exports to countries along the "Belt and Road" is enormous, and China has a relatively large or large market share in the vast majority of actual export opportunities. Therefore, export promotion strategies should focus more on maintaining stability and long-term growth.

3. CONCLUSIONS

In the simulation process of this study, the initial matrix of the game is set as the prisoner's dilemma matrix, and the game type of the "Belt and Road" countries may also be the deer hunting game or the snowdrift game; The potential export value of countries along the "One Road" route is huge, and China has a relatively large or large market share in the vast majority of actual export opportunities. In the follow-up research, the random distribution of decision-making types and the influence of random noise in decision-making on the cooperative decision-making of the countries along the "Belt and Road" will be considered, and the interpretation scope of the research conclusions will be expanded.

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Data Fusion Analysis of Computer Culture Basic Course under the Background of Information Mining

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Abstract: This paper analyzes the problems and causes of the teaching of basic computer courses in colleges and universities under the background of information technology. From the dimensions of teaching concepts, teaching resources, teaching methods and models, and teaching methods, combined with the current mainstream information technology methods, it proposes feasible information technology and courses. The teaching integration plan discusses the reform ideas of computer basic teaching in ethnic colleges and universities, and puts forward on this basis. The path of national curriculum project-based reconstruction", and expounded its goals, specific processes and methods, and provided a new way of thinking for the implementation of the deep integration of information technology and curriculum in primary and secondary schools.

Keywords: Data Fusion, Computer Culture, Basic Course, Basic Course

1. INTRODUCTION

The proposition that "information technology has a revolutionary impact on educational development" has been agreed by the educational community, and promoting educational modernization [1] with educational informatization has also become an important strategy for educational development in my country [2]. The core connotation of "revolutionary influence" is integration and innovation. Its important feature is the integration of information technology and education [3]. This concept is reflected in many documents: the "Ten-Year Development Plan for Educational Informatization" promulgated in 2012 (2012-2020)" for the first time proposed the concept of deep integration of information technology [4] and education, and pointed out that "informatization leads the innovation of educational concepts and educational models [5], and gives full play to the supporting and leading role of educational informatization in educational reform and development" [6].

The "Thirteenth Five-Year Plan" for Educational Informatization promulgated in June 2016 further proposed to "deepen the integrated development of information [7] technology and education and teaching. The source of students in colleges and universities in ethnic areas basically comes from ethnic minority areas, and many of them come [8] from underdeveloped economies. Because of the low level of local economic development, students receive less basic computer education in middle school and lack basic [9] information knowledge and skills. Many students have not experienced systematic computer enlightenment education [10], although they have been exposed to computers. And the network, but not a system, not deep enough. Ethnic institutions [11] of higher learning have experienced more than 60 years of development in our country, and shoulder the dual responsibility of solving ethnic problems and promoting [12] the stability and development of ethnic areas. Currently in the information society, the construction of informatization is in Various fields in ethnic minority areas are also fully developed, which strongly promotes the continuous development of the regional economy, and these development [13] cannot be separated from a large number of information-based talents. The development of ethnic areas cannot be separated from ethnic college students, and ethnic college [14] students must master it at the stage of education. It is good to

adapt to the information skills of the information age, and have certain information awareness, information knowledge and information ethics, so as to better serve the economic development of ethnic areas [15].

At present, in the field of higher vocational education, the reform of "Internet +" teaching of vocational education courses is being vigorously [16] carried out. Through the investigation of the curriculum construction work of major higher vocational colleges, it is found that at present, major domestic higher vocational colleges have basically completed the preparatory [17] work for the transformation of curriculum network, and excellent curriculum groups with distinctive professional characteristics and outstanding skills training have been formed [18]. The online version of the excellent course website has also been launched. However, there are still many problems in the process of implementing network education in higher [19] vocational education. Through a large number of literature research, this researcher found that the current situation of general technology course teaching since the new curriculum [20] reform mainly consists of outdated curriculum ideas, lack of hardware facilities, lack of teachers, poor basic professionalism of teachers, teachers re-learning and improving their [21] own general technology subject knowledge There are few opportunities, as well as backward teaching methods, solidified teaching models, scarcity of curriculum resources and [22] imperfect teaching evaluation systems. All of the above aspects lead to the lack of in-depth teaching of this course, which is superficial and inefficient, and it is difficult to meet [23] the current needs of cultivating comprehensive and innovative talents with information technology literacy. Curriculum value, hardware facilities, curriculum resources, teachers [24], teaching mode and teaching evaluation all affect and to some extent restrict the curriculum implementation effect of general technology teaching in senior high schools.

It is urgent to seek better ways to cultivate students' basic ability, innovation ability and comprehensive ability in general technical course teaching, so as to meet the needs and goals of national talent training. The integration of information technology and curriculum is a new proposition put forward on the basis of the integration of information technology and curriculum, and it is a new stage of the development of information technology education application.

From the perspective of the development process of the application of information technology in education.

2. THE PROPOSED METHODOLOGY

2.1 Teaching Courses in the Context of Information Technology

The information technology and curriculum integration stage emphasizes the use of information technology to build a new teaching and learning environment, change traditional teaching concepts and methods, and improve the effect of teaching and learning. The goal is to change the traditional teaching structure; It is a higher stage of the application of information technology in education. Its core connotation is integration and innovation. The biggest difference from the previous two stages is "reforming the traditional classroom teaching structure". It is no longer a "tinkering" application of information technology. Rather, it is necessary to achieve a full range of structural changes. From these stages, the fusion stage is the key process from quantitative change to qualitative change.

University computer public basic education is the basis of information literacy for college students in the future development process. In addition to the core theme of technical ability training in curriculum setting and teaching process, there should also be attention and teaching of ethical culture and moral cultivation. It is one of the specific measures and footholds that fully reflect humanistic care. As an ethnic university, it needs to pay more attention to this. In order to fully and correctly implement and implement the ethnic policies of the party and the state, maintain the unity of students of all ethnic groups, and ensure the prosperity and stability of ethnic areas, it is necessary to strengthen information ethics and moral education from the university campus. Guide students Correctly, rationally and rationally develop, disseminate, protect and utilize information resources, so that information resources can truly become a driving force for economic and social development, rather than a carrier for propagating irrational views.

The knowledge of basic computer courses in colleges and universities is updated quickly. It is not difficult to analyze the characteristics of the "University Computer Application Fundamentals" course: the chapters are relatively independent, composed of various modules, and the knowledge points within the chapters are basically complementary to each other. These characteristics need to be considered in the teaching process. In the current information society, basic computer knowledge is closely related to society. Therefore, in addition to theoretical knowledge and practical operation on computers.

2.2 The Computer Culture Fundamentals Course

Teaching resources are an important product of information technology, an objective carrier of knowledge and skills in course teaching, as well as tools and means. The integration of teaching resources provides an important premise and foundation for the integration of information technology and curriculum teaching. Some teachers of basic computer courses in ethnic colleges and universities have relatively limited understanding of modern teaching theories, and they are not comprehensive enough in the principles, methods, and characteristics of information-based teaching design, and their grasp is not accurate enough. They are often accustomed to taking their own teaching experience as the main reference in the process of designing learning activities. Factors such as

information-based teaching platforms and resources have also become the biggest bottleneck in the process of designing information-based teaching for most teachers. The basic situation of students' information literacy is analyzed through interviews, dialogues, questionnaire reports, etc., and on the basis of mastering the basic situation, students' information awareness, information knowledge, information skills and information ethics are considered comprehensively.

The investigation shows that the course "University Computer Application Fundamentals" is of great help to the cultivation of students' innovative consciousness and innovative ability. Some students expect to improve their innovative ability through the study of this course. Most of the students who are offered information technology courses in senior high school have a good grasp of basic information knowledge, which also reflects the obvious role of senior high school information technology courses in popularizing information knowledge. General Technology is a curriculum based on life practice, focusing on innovation and creativity, and combining technology with the humanities. According to the subject orientation of general technology in the new curriculum standard, in the process of teaching practice, teachers should help students build tacit knowledge and procedural knowledge through technical practice activities based on the cultivation of students' core technical literacy.

Strengthen students' brains, use them to combine with knowledge and practice, strengthen the study and application of technical ideas and methods, develop engineering thinking and creativity; cultivate students' ability to express and reflect design, and improve their comprehensive ability to solve technical problems. The introduction of core literacy can just change the teaching status of this fragmented understanding, and make the teaching in classroom teaching show the characteristics of teaching with theory as the guide and practice as the goal. In view of the above teaching characteristics and student characteristics, this research requires teachers to actively implement the specific requirements of the general technology curriculum concept.

2.3 The Data Fusion for Computer Courses

The so-called teaching resources generally refer to the teaching resources produced and prepared by teachers in the course of classroom teaching, while the process resources are the resources generated by students in the practice link (computer operation). Both of these resources should be shared with students, so that they can explore and differentiate among different resource types. Process resources can be evaluated with reference to teaching resources. Excellent or representative errors can even be used as new process resources. Teaching resources. This process of students' participation in inquiry and analysis is precisely the key link in cultivating students' ability to discover and solve problems. Most students are unfamiliar with how to accurately and quickly obtain information and data about their majors in online resources through advanced search and Boolean operators, which reflects that some students are less efficient in obtaining information, and it is easier for them to learn online. "Network anomie" behavior occurs.

We must correctly guide the issues of browsing violence, pornography and other related websites and personal attacks on others in various ways through the Internet, and guide them in a positive and positive direction. Most students are not familiar with intellectual property protection issues such as citation rules for references, and are prone to "plagiarism"

of information. Online teaching requires students to have a high learning initiative, and teaching projects should be designed with emphasis. The practicality of the project, the content of the project should be aimed at the actual work of students, and students can solve practical problems through learning. In addition, the content of the teaching project should not be too difficult, the content is short and complete, easy to learn, and the learning effect is remarkable, which can ensure the continuous attraction of students' interest in learning and is conducive to stimulating students' intrinsic learning motivation. After the optimization of the course teaching project, the teaching content of the basic computer course is updated, and the problem that the content of the teaching material lags behind the development of the basic computer course and teaching has been solved.

The new three-dimensional textbook "Computer Application Fundamentals" (2017 edition) redesigns the project-based textbook, which increases the difficulty of the project teaching content, makes the teaching content better reflect the characteristics of integration with the major, and at the same time increases the interest of the project.

3. CONCLUSIONS

Ethnic colleges and universities have played an irreplaceable role in cultivating high-quality talents for ethnic minorities, promoting economic and social development in ethnic areas, enhancing ethnic unity, and maintaining national unity. The deep integration of information technology and curriculum is an important topic in the current development of basic education informatization. In practice, teachers are still confused about how to carry out deep integration, and there are many problems. From the perspective of curriculum, this paper proposes a fusion concept and strategy based on the reconstruction of national curriculum projects, which provides a new way of thinking and method for the field of practice. Of course, follow-up research needs to further improve and test the model.

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A Comprehensive Study on Optimized Mechanical and Kinematic Design for Holonomic Drive Rugby Ball Kicking and Passing Robots

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Abstract: This paper presents a detailed exposition of the hardware design and kinematic analysis of two specialized robotic systems, MR1 and MR2, engineered explicitly for the purpose of passing and kicking Rugby balls. Employing the advanced holonomic omnidirectional drive, both robots are meticulously scrutinized in terms of their kinematic characteristics. The passing robot is equipped with a pneumatic system, enabling it to precisely lift and pass rugby balls up to a designated distance of 2.5 meters. Conversely, the kicking robot employs a sophisticated motor-powered spring-loaded mechanism, generating a formidable force of 8.41 N. This force is adeptly harnessed to kick the rugby ball horizontally for a distance of 5 meters and vertically for 1.5 meters. The study delves into the intricacies of the electronic control system, encompassing motion planning and the meticulous orchestration of omnidirectional wheels. These wheels serve as the neural epicenter for the swift movements of the robots and are precisely controlled by Arduino Mega 2560 microcontroller boards integrated with EMS 30A H-Bridge drivers and motor controllers. The study provides a foundation for future research and development in the field of robotic sports technology, specifically in the realm of replicating human sports activities through robotic ingenuity.

Keywords: Kinematic Analysis, Omnidirectional Drive, Passing Robot, Kicking Robot, Pneumatic, Arduino Mega 2560.

1. INTRODUCTION

In the field of technological study, the mechanical replication of human sports activities is a priceless tool for expanding the design of improved athletic goods and honing the abilities of players. Due to the inherent variety among human kickers, studying kicking tactics within the context of rugby is a significant problem. Humans are naturally unable to maintain the fine control required to control elements like foot placement, pace, and precise point of contact with the ball over a series of kicks. Innovative approaches are required to overcome this fundamental constraint and promote reliable and controlled experimentation.

This study paper examines the painstaking design and execution of two robots made expressly for the purpose of passing and kicking rugby balls with astounding uniformity, duplicating the performance levels displayed by professional rugby kickers. These robots provide an unmatched opportunity to investigate the complex mechanics, kinematics, and dynamics behind the skill of place-kicking a rugby ball since they consistently perform at a level that human athletes are unable to match. These robots' design and operating settings are thoroughly discussed, enlightening the scientific community on the procedure used to ensure accuracy and dependability in mimicking human sporting motions.

Reviewing sports robots suggests two major areas of use. Research in general robotics, which covers kinematics, routing, obstacle avoidance, detection of objects, and manipulation, is the first and largest area. Here, autonomous soccer robot contests like Robocup are frequently used as benchmarks for

measuring the progress of humanoid robots [1]. Examples of humanoid robots include the Qrio [2], and Nao [3] models. Additionally, there are batting arms [4], pool-playing robots [5], and martial arts robots [6]. These robots are all powered by electric motors, which makes them all incredibly feeble and slowly moving [7].

For testing and research in sports, there is a second, smaller category of sports robots. In this case, creating powerful mechanical machines is more important than creating humanoid robots. According to Holmes et al. [8], a mechanical kicking machine for soccer and rugby balls, Adidas is funding additional studies in this field [9]. Roboleg, a robotic soccer ball-kicking leg, was created to evaluate soccer footwear and balls utilizing spring-loaded actuators [10]. However, due to issues with the control system, Roboleg was abandoned as a test robot [10].

The aim of this research is to meticulously design two distinct robotic entities, denoted as MR1 and MR2, tailored for specific functions within the realm of rugby gameplay. MR1 serves as a passing robot, while MR2 is engineered as a Kicking robot, both possessing the capability to execute consistent and powerful kicks akin to those demonstrated by seasoned professional rugby kickers. This paper critically examines the collaborative synergy between these two robots, elucidating their coordinated efforts in passing the rugby ball from MR1 to MR2 and subsequently executing a successful kick over the crossbar of the conversion post.

An omnidirectional robot platform that uses a holonomic approach for precise robot movement is used in this investigation. It offers an omnidirectional three-wheel design

for MR1 and a four-wheel design for MR2 to boost the mobility of the pass and kick robots and enable them to move in any direction and with any orientation [11-12]. The holonomic wheels on the robot allow it to travel in any direction, doing away with the need for a conventional drive mechanism. Even the kinematic model features an Omni-wheel drive that has been modified to fit the robot's size. Refer to Figure 1 for an illustration of the Omni wheel, which is differentially powered by the DC motor. With less friction and additional motion, this arrangement enables the robots to move in any direction [13]. The robot's movement will be more effective because of the reduced friction. Additionally, while the robot is moving at a high speed, its wheels can move more dynamically [14].

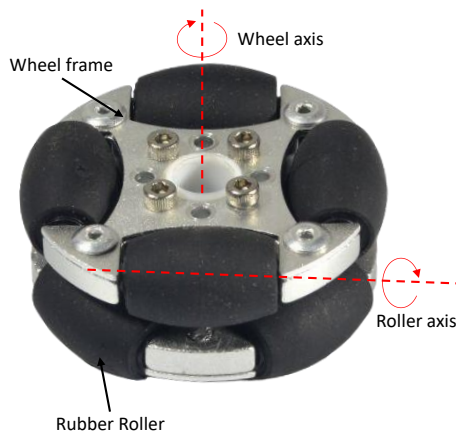


Figure 1: Omni Wheel

2. DESIGN OF RUGBY PASSING ROBOT (MR1)

The primary objective of the MR1 Rugby passing robot is to adeptly pick up a rugby ball positioned on a tee and accurately pass it to the MR2 Kicking robot, covering a distance of 2.5 meters. The foundational structure of the robot is constructed using equilateral truncated triangular elements, meticulously welded from hollow box sections of Aluminium 6061. This structural framework provides robustness and stability to the robot during its operational tasks. Additionally, the MR1 robot is outfitted with a specialized mobility system comprising three-wheel holonomic omnidirectional wheels. These wheels enable the robot to move seamlessly in various directions without the need for complex maneuvers, ensuring precise and efficient ball handling. The subsequent sections delineate the intricate components of the MR1 robot, providing detailed insights into its design and functionality.

2.1 Design of Omni-directional Platform

In the realm of omnidirectional mobile platform design, a multitude of options exist for configuring wheel assemblies. A fundamental criterion for such configurations is the necessity for the layout to facilitate sufficient constrained motions of the assemblies, ensuring both omnidirectional translation and rotation of the platform. Crucially, the stability of the platform must be maintained regardless of the internal arrangement of the assemblies, including which wheel within each assembly makes contact with the ground. To achieve a platform endowed

with three full degrees of freedom and devoid of kinematic redundancy, the simplest layout mandates three assemblies. When positioned at the apexes of a triangular framework, this arrangement not only ensures effortless platform load stability but also establishes a 120-degree orientation relationship between the three constrained motion directions, thereby conferring exceptional directional control capability.

The MR1 robot, integral to this study, adopts a truncated triangular structure and employs a three-wheel drive configuration, a choice motivated by its superior maneuverability and straightforward control mechanism. These wheels are of a specific type featuring small rollers, allowing them unrestricted movement in any direction [15]. Their primary motion occurs along the diameter, akin to conventional wheels. However, the presence of smaller rollers on the periphery permits free rotation orthogonal to the powered rotation. The omni wheels are actuated by three DC motors, each intricately coupled to omni wheels positioned at angles of 120 degrees apart. The representative coordinates of the robot, according to the inverse kinematics model, were in its centre [16]. Refer to Figure 2 which depicts a three-wheeled omnidirectional robot with a schematic view.

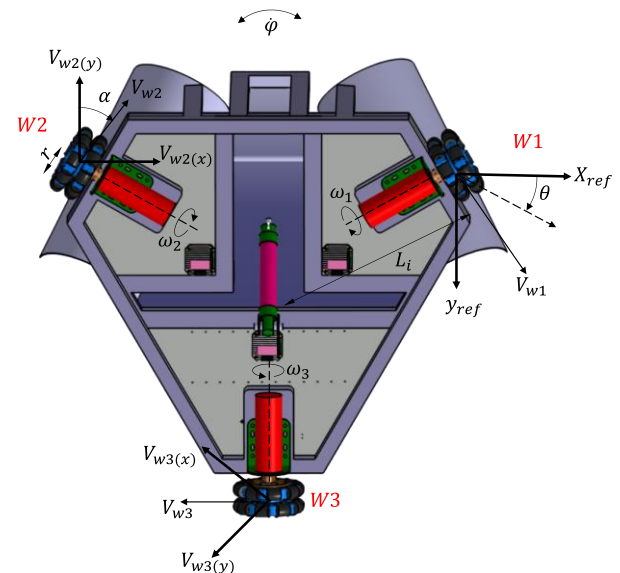


Figure 2: Three-wheel omnidirectional robot schematic view

The arrows with the numbers 1, 2, and 3 on them represent the constrained directions of movement of each assembly in the schematic Figure 2. Let φ represent angular velocity (in rad/s) of the platform's internal reference frames (X_{ref}, Y_{ref}) with regard to an absolute reference frame (x, y). Platform translational velocity is indicated by the letter $|V|$ and θ , where $|V|$ stands for the platform's magnitude (in m/s) and θ stands for the platform's direction (relative to the internal reference frame). These conventions allow for the following computation of the driving shaft velocities of the wheels, ω_i (in rad/s):

$$\omega_1 = \frac{|V|}{2R} (\sin \theta - \sqrt{3} \cos \theta) + \frac{\varphi L_1}{R} \quad (1)$$

$$\omega_2 = -\frac{|V|}{R} \sin \theta + \frac{\varphi L_1}{R} \quad (2)$$

$$\omega_3 = \frac{|V|}{2R} (\sin \theta + \sqrt{3} \cos \theta) + \frac{\phi L_3}{R} \quad (3)$$

The distance between the platform's center and the center of the wheel of the is represented by L, while R denotes the circular wheels' radius. The translational velocity |V| projections on the constrained movement directions of each assembly are shown by the first terms on the right-hand side of equations (1) through (3). The final terms stand in for the platform's rotational velocity-related components. The above equations can be slightly changed to show the one-to-one relationship between the joint and Cartesian velocities, which is essential for teleoperation and odometry calculations: if we put

$$V_x = |V| \cos \theta \quad (4)$$

$$V_y = |V| \sin \theta \quad (5)$$

Equations (1) through (3) may be expressed as:

$$(\omega_1, \omega_2, \omega_3)^T = A(V_x, V_y, \phi)^T \quad (6)$$

$$A = \frac{1}{R} \begin{pmatrix} -\sqrt{3}/2 & 1/2 & L_1 \\ 0 & -1 & L_2 \\ \sqrt{3}/2 & 1/2 & L_3 \end{pmatrix} \quad (7)$$

Since the length L_1, L_2, L_3 are positive values and A is invertible and its inverse matrix i.e., A^{-1} is given by:

$$A^{-1} = \frac{R}{L_1 + L_2 + L_3} \cdot \begin{pmatrix} \frac{(-2L_3 - L_2)}{\sqrt{3}} & \frac{(L_1 - L_3)}{\sqrt{3}} & \frac{(2L_1 + L_2)}{\sqrt{3}} \\ L_2 & (-L_1 - L_3) & L_2 \\ 1 & 1 & 1 \end{pmatrix} \quad (8)$$

$$(V_x, V_y, \phi)^T = A^{-1} \cdot (\omega_1, \omega_2, \omega_3)^T \quad (9)$$

It is evident from the kinematic relationship equations above that the rotational and translational motions are completely dissociated and can be controlled separately and at the same time, hence making the three-wheeled holonomic omnidirectional drive suitable for a Rugby passing robot movement.

2.2 Design of Rugby Passing Mechanism

The primary function of the passing robot in this study entails executing two sequential tasks: firstly, picking the rugby ball from the tee, and subsequently, delivering the ball to the kicking robot. The designated throwing distance for this task is 2.5 meters. To accomplish the passing action, a sophisticated system has been devised, encompassing two distinct components. The robot platform is equipped with a throwing arm featuring grippers, actuated by a pneumatic cylinder, thereby enabling precise ball handling. Refer to Figure 3 for the schematic design of the MR1 robot.

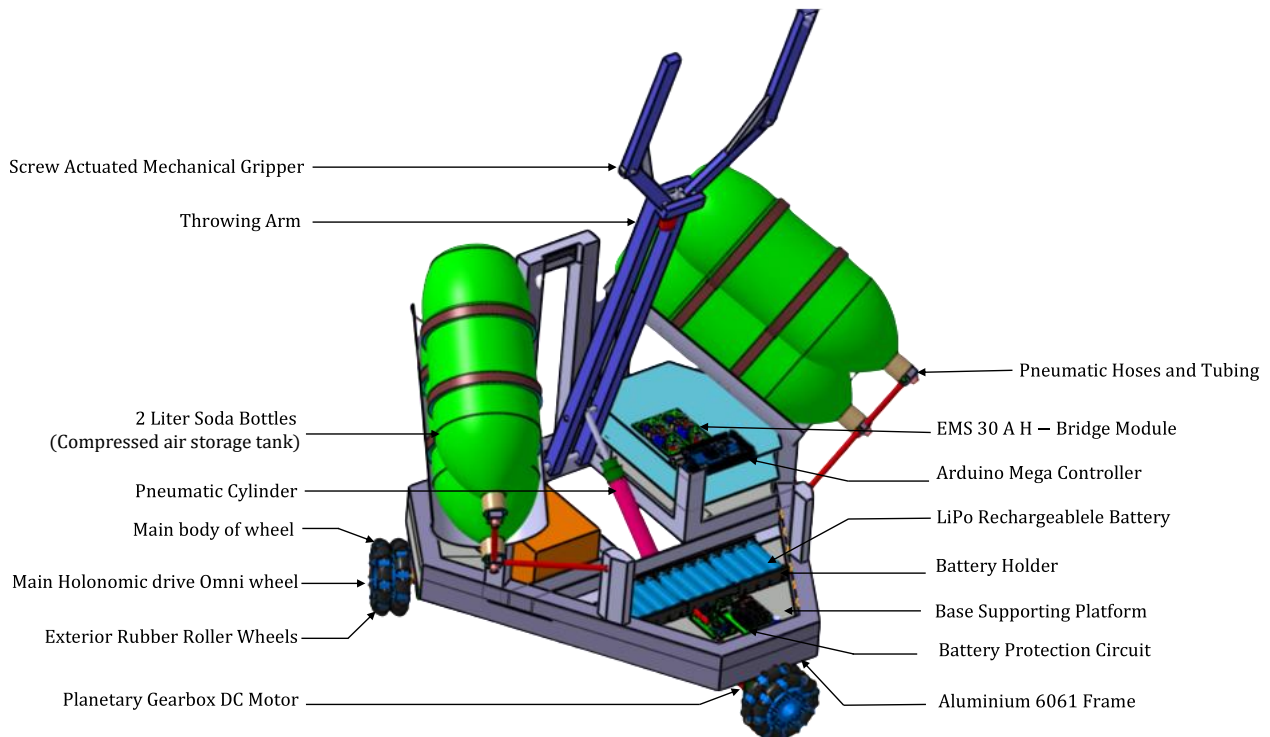


Figure 3: Three-wheeled holonomic passing robot design (MR1)

The mechanism employed for picking up the rugby ball involves a pivotal throwing arm architecture, hinged at the base of the robot platform and activated by a pneumatic air cylinder. The arm integrates a screw-actuated mechanical gripper positioned at its distal end. This gripper utilizes a screw connected to a threaded block, driven by a motor in conjunction with a speed reduction device. Rotation of the screw in one direction causes the threaded block to move correspondingly, opening or closing the gripper fingers. This screw-type actuated gripper facilitates the firm grip required to lift the rugby ball from the tee. The screw operates via a high torque 12V DC Geared motor, rotating at 300rpm and generating 3.5kgcm torque. Notably, this mechanism allows precise control of the gripper's clamping position, ensuring swift and accurate ball handling, thus optimizing efficiency.

The mechanical arm's primary function is to elevate the rugby ball from the tee using the gripper mechanism and subsequently propel it. The ball's throwing action is regulated by a pneumatic air cylinder pivotally attached to the lower end of the throwing arm. This pneumatic system, with a stroke length of 100mm and a bore diameter of 63mm, operates on the principle of pressure differentials within the cylinder. The rise in internal pressure propels the piston, which, in turn, transmits force to the object being moved. To sustain continuous operation, the robot incorporates four two-liter soda bottles, each capable of storing 100 pounds per square inch of air pressure or 6.89 bars [17]. With a total of 24 bars of air pressure across the four bottles, the system can execute eight consecutive throws of the rugby ball. To maintain consistency in performance, a pressure regulator is integrated throughout the mechanisms, ensuring stability and repeatability of results.

The potential energy (PE) stored in the compressed air cylinder at 3 bars of pressure is calculated using equation 10 as 93.6 Joules. Considering the mass of the rugby ball (0.3 kg) and the desired throwing distance (2.5 meters), the required linear acceleration (a) is determined to be 124.8 m/s², calculated by equation 11. This acceleration necessitates a torque of 1.3464 Nm using equation 12, derived from the given angular acceleration and the length of the throwing arm (60 cm) using equation 13, where I is moment of Inertia of throwing arm. Consequently, Formula 13 can be used to determine the angular force (F_a) necessary to generate a specific torque (T) about a pivot point. The computed angular force from equation 14 is of 2.244 N is needed to move the rugby ball the predetermined distance to the MR2 kicking robot. Refer to Figure 4 for a visual

representation of the throwing arm's movement, from ball pickup to release.

$$PE = Pressure \times Volume$$

i.e.

$$PE = Pressure \times \left\{ \pi \cdot \left(\frac{Bore\ Diameter}{2} \right)^2 \cdot Stroke \right\} \quad (10)$$

$$a = \frac{PE}{mass \cdot distance} \quad (11)$$

$$T = I \times \alpha \quad (12)$$

$$\alpha = \frac{a}{arm\ length} \quad (13)$$

$$F_a = \frac{T}{arm\ length} \quad (14)$$

3. DESIGN OF RUGBY KICKING ROBOT (MR2)

The MR2 Rugby kicking robot is designed with dual primary objectives: firstly, to accurately place the rugby ball at the designated try spot, where it has been previously passed by the passing robot MR1, and subsequently, to initiate the kicking action. The successful execution of the kicking action necessitates propelling the rugby ball over the crossbar of the conversion post. This crossbar, situated at a vertical height of 1.5 meters, is positioned 5 meters away from the try spot. For a goal to be achieved, the rugby ball must travel both a horizontal distance of 5 meters and a vertical distance of 1.5 meters.

The foundational structure of the MR2 robot is meticulously crafted, employing a rectangular-shaped base constructed from hollow box sections of Mild steel. The square hollow box section measures 19.81mm x 19.81mm with a thickness of

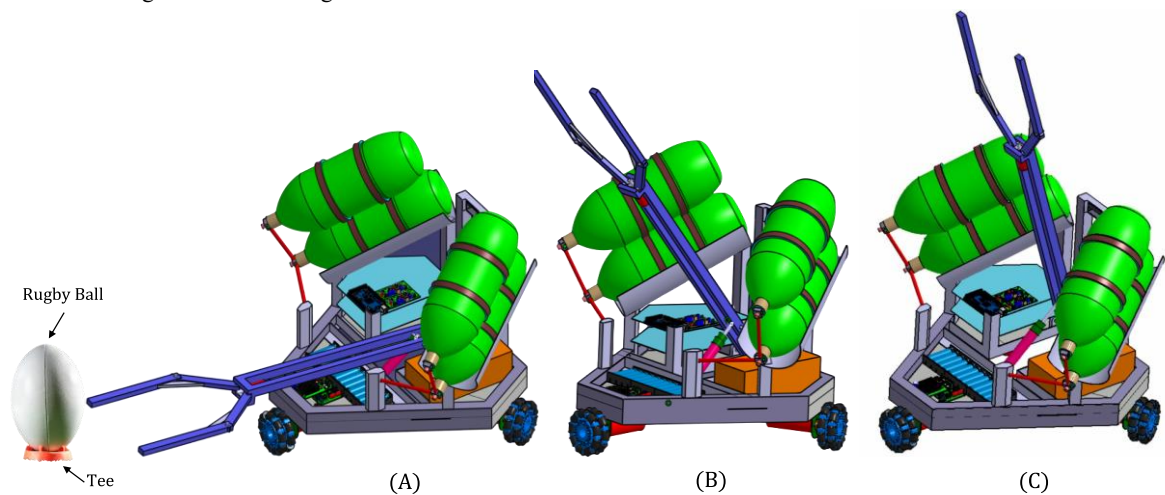


Figure 4: (A) Represent throwing arm picking rugby ball; (B, C) represent the throwing arm movement for rugby passing operation

2mm. This choice of Mild steel, owing to its inherent properties, ensures the creation of an efficient frame characterized by uniform weight distribution. Mild steel, known for its commendable shock-absorbing capacity relative to other metals available in the market, imparts strength and stability to the robot's base. This structural foundation is paramount, conferring robustness and steadfastness to the robot during its operational endeavours.

Furthermore, the MR2 robot is equipped with a specialized mobility system, integrating four-wheel holonomic omnidirectional wheels. The selection of a four-wheel drive system is underpinned by its superior maneuverability and straightforward control mechanism. These wheels are meticulously engineered to facilitate seamless movement in diverse directions, eliminating the need for intricate maneuvers. This design ensures precise and efficient execution of ball-kicking tasks. The subsequent sections of this paper delve into the intricate components of the MR2 robot, providing comprehensive insights into its meticulous design and seamless functionality.

3.1 Design of Omni-directional Platform: Inverse Kinematic Analysis

Wheel assembly configuration choices abound in the field of omnidirectional mobile platform architecture. The requirement that the arrangement enable sufficient confined motions of the assemblies, ensuring both omnidirectional translation and rotation of the platform, is a fundamental requirement for such systems. The MR2 robot has four wheels that are attached to the rectangular base's corners. These wheels can move freely in any direction since they belong to a particular type with tiny rollers. Three DC motors, each intricately connected to omni wheels, drive the omni wheels. According to the inverse kinematics model, the robot's center included its representative coordinates. Refer to Figure 5, which shows a schematic view of a four-wheeled omnidirectional robot.

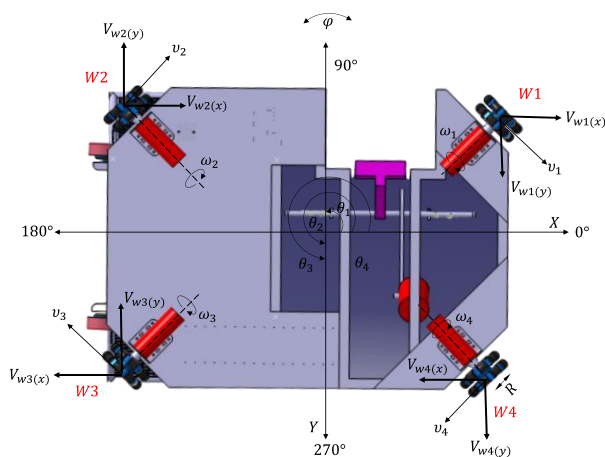


Figure 5: Schematic diagram of a four-wheeled omnidirectional robot

Kinematic modeling constitutes a fundamental aspect of robotics research, involving the analysis of robot motion through a geometric examination of stationary or moving reference coordinate frames, excluding considerations of forces, torques, or specific moments causing movement [18]. In the realm of omni-directional robots, the positioning of Omni wheels plays a pivotal role in shaping the kinematic

model. Within the domain of robotic kinematic modeling, two essential models come into play: inverse kinematics and forward kinematics. Inverse kinematics are instrumental in calculating the linear velocity of the four omni wheels, whereas forward kinematics are utilized to ascertain the linear velocity of the robot in relation to global coordinates [19].

The kicking robot, denoted as MR2, is equipped with a configuration comprising four omni wheels. The angles formed between these wheels and the robot's reference point are represented by θ_i i.e., $\theta_1, \theta_2, \theta_3, \theta_4$ along the X-axis. Each wheel's angular velocity is symbolized as ω_i represented by $\omega_1, \omega_2, \omega_3, \omega_4$ and their translational velocities are denoted as v_i , defined as v_1, v_2, v_3, v_4 . Refer to the schematic design showing the configuration of the omnidirectional robot base.

Equations (15) and (16) can be used to express the translational velocity for each wheel.

$$v_i = \sin(\theta_i)v_x + \cos(\theta_i)v_y + R\alpha \quad (15)$$

$$v_i = \omega_i \cdot R \quad (16)$$

Where R is the omni-wheel's radius, v_x is the MR2 robot's translational speed along the X-axis, and the translational velocity on the Y-axis is given by the expression v_y . The angle created by the robot's orientation is given by α . The angular speed for each motor can be obtained from equation (17) by utilizing equation (15) and performing the inverse kinematics on equation (16).

$$\omega_i = \frac{1}{R} (\sin(\theta_i)v_x + \cos(\theta_i)v_y + R\alpha) \quad (17)$$

Equation (18) can be used to give the inverse kinematics equation for every wheel derived from equation (17).

$$\begin{bmatrix} \omega_1 \\ \omega_2 \\ \omega_3 \\ \omega_4 \end{bmatrix} = \frac{1}{R} \begin{bmatrix} \sin(\theta_1) & \cos(\theta_1) & R \\ \sin(\theta_2) & \cos(\theta_2) & R \\ \sin(\theta_3) & \cos(\theta_3) & R \\ \sin(\theta_4) & \cos(\theta_4) & R \end{bmatrix} \begin{bmatrix} v_x \\ v_y \\ \alpha \end{bmatrix} \quad (18)$$

3.2 Design of Rugby Kicking Mechanism

The passing robot in this study is designed to execute sequential tasks: first, receiving the ball from the MR1 Passing robot, where a square-based basket structure is employed. This basket contains a gate that opens upon command, allowing the ball to roll into the designated try spot. The basket features a slope-like structure inclined at 40 degrees, guiding the ball precisely over the extruded glide pathway to the try or kicking zone. The gate operation is controlled by a DC motor using a rack and pinion arrangement. When the motor shaft rotates, it drives the pinion, which, in contact with the rack, converts circular motion to linear motion, facilitating the opening and closing of the gate, refer to Figure 6.

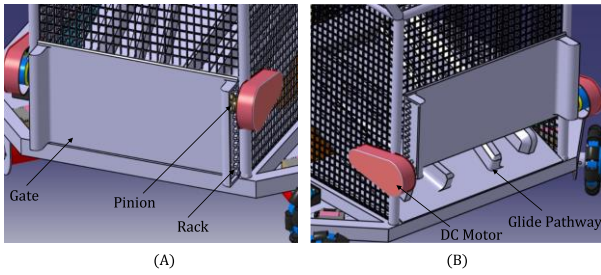


Figure 6: DC motor-powered gate opening and closing system, (A) gate closed (B) gate open

Once the ball is positioned on the ground, the robot aligns itself to initiate the kicking action. For successful kicking, the rugby ball must travel a horizontal distance of 5 meters and a vertical distance of 1.5 meters, clearing the crossbar of the conversion post.

The kicking mechanism involves a sophisticated setup featuring a kicking leg actuated by a combination of springs and motors, ensuring precise ball handling. Specifically, a kicking leg equipped with four springs, known as a four-spring-loaded kicking leg, is utilized. Refer to Figure 7 for the schematic design of the MR2 robot. Positioned at a height of 50 cm and pivoted at the upper point from the robot base, this kicking leg is actuated by a DC planetary geared motor. The motor lifts the kicking leg at an angle of 170 degrees, allowing the springs to stretch. The potential energy stored in the stretched springs is converted into kinetic energy when the springs are released, propelling the ball. The precise movement of the kicking leg is facilitated by a high-torque DC planetary geared motor with a stall torque of 23.55 kg cm. After being kicked, the ball follows a projectile motion, achieving a height of 1.5 meters and covering a total horizontal distance of 5 meters, passing through the conversion post with accuracy. To calculate the required force for kicking the ball 5 meters horizontally and 1.5 meters vertically, as well as determine the

spring stiffness, the principle of conservation of energy is applied. The potential energy stored in the stretched springs is converted into kinetic energy in the rugby ball. The calculated spring stiffness is 5.466 N/m using equation 19. The horizontal distance (d) travelled by the ball is calculated as 6.523 meters using equation 20. The potential energy stored in the spring is then determined as 6.523 J using formula 21, and the required kicking force is calculated as 8.41 N using equation 22. It was observed from equation 21 that the spring compression (x) is high, necessitating the use of four consecutive springs for optimization. Refer to Figure 8, illustrating the schematic design of the ball kicking operation.

$$k = \frac{Gd^4}{8D^3N} \quad (19)$$

Where D is the diameter of the spring coil (m), d is the diameter of the spring wire (m), N is the number of turns and G is the Modulus of Rigidity (Pa).

$$d = \frac{v^2 \sin(2\theta)}{g} \quad (20)$$

d is the horizontal distance in (m), v is the initial velocity of the ball in (m/s), θ is the angle at which the ball is kicked (in radians) and g is the acceleration brought on by gravity (about $9.81 m/s^2$).

$$PE = \frac{1}{2} kx^2 \quad (21)$$

Were,

$$x = \sqrt{d \cdot \frac{2}{k}}$$

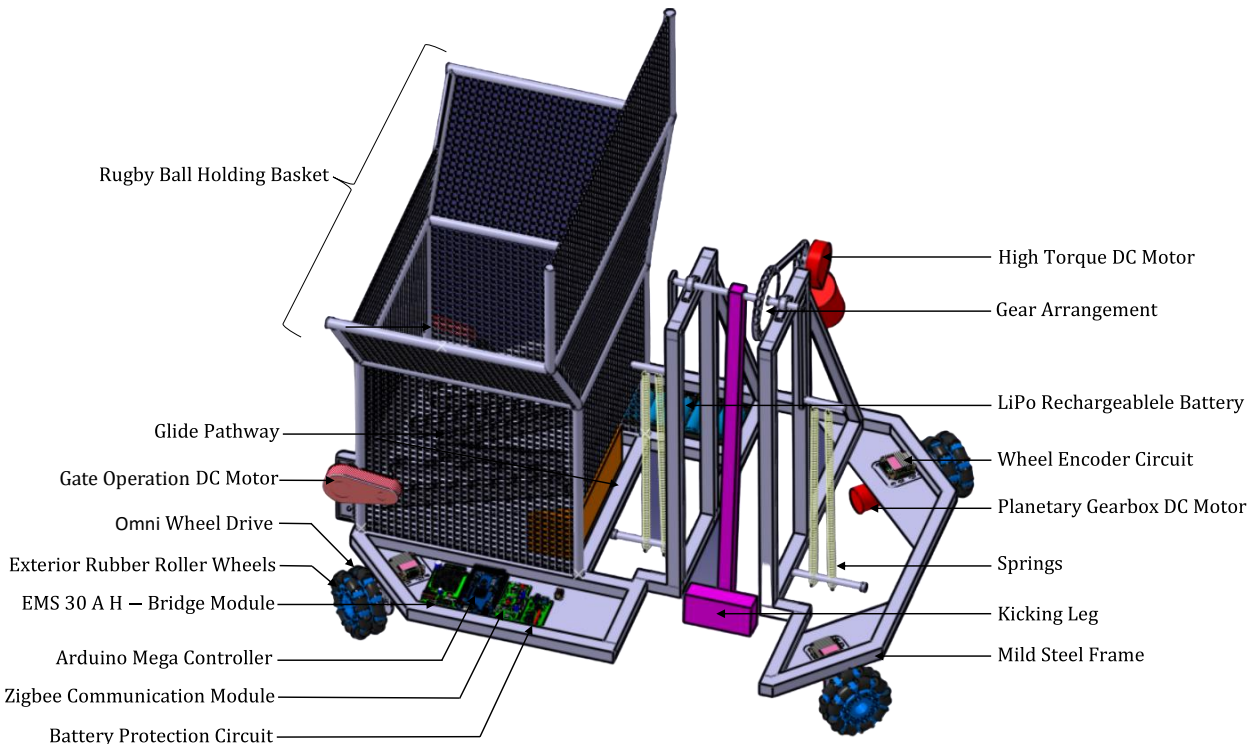


Figure 7: Four-wheeled omnidirectional kicking robot (MR2)

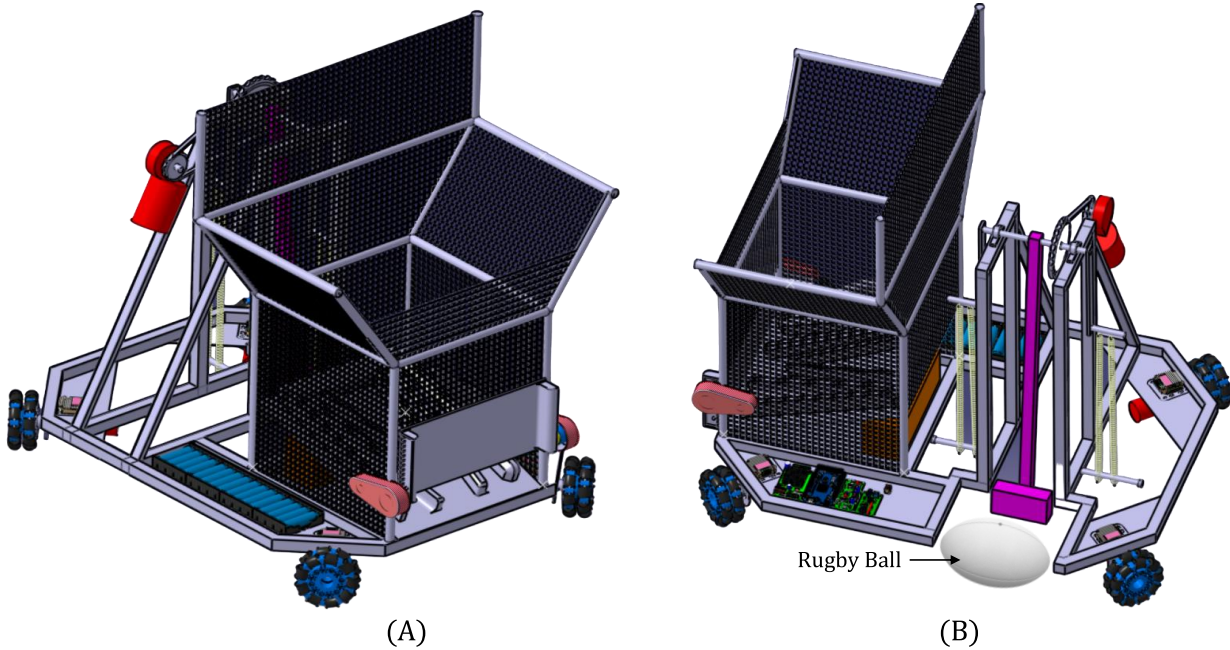


Figure 8: (A) Robot's gate open for allowing rugby ball to tumble through (B) Robot kicking the rugby ball

Potential energy (in joules) $k =$ Stiffness of the spring (N/m) $x =$ Stretch or compression of the spring from its equilibrium position (m).

$$F = \frac{2 \cdot PE}{x} \quad (22)$$

4. ELECTRONIC CONTROL SYSTEM AND POWER MANAGEMENT FOR MR1 & MR2

The Omni wheel holonomic robotic platform is controlled by a sophisticated array of electronic components that are integrated into the control system used in this investigation. This section carefully examines the diverse electronic components integral to the MR1 and MR2 robots.

4.1 DC Motor

Direct current (DC) motors serve as pivotal components in omni-wheel drive systems. In the context of our specific application, where the MR1 robot has a mass of 6 kg and the MR2 robot has a mass of 8 kg, both robots are designed with a maximum velocity of 2.5 m/s. To meet these requirements, three 12V DC planetary motors equipped with a 45 mm diameter gearbox were employed for MR1. This motor configuration features a planetary-type gearbox with a 10.2:1 reduction ratio, resulting in a rotation speed of 487 RPM and a torque value of approximately 43 N-cm. Conversely, for MR2, four 12V DC planetary motors with a 35 mm diameter gearbox were utilized. These motors incorporate a 19.2:1 reduction ratio, generating a rotation speed of 262 RPM and a torque of around 45 N-cm. Refer to Figure 9 for MR1 and MR2 motors used.

Additionally, a 12V DC planetary motor with a 35 mm diameter gearbox and a 50.9:1 reduction ratio was employed for the kicking leg rotation mechanism in the MR2 robot.

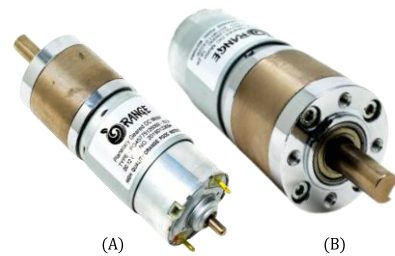


Figure 9: (A) MR1 planetary DC Motor (B) MR2 DC Motor

This motor configuration yields a rotational speed of 96 RPM and generates a torque of approximately 121.7 N-cm, fulfilling the necessary requirements for enabling the turning of the kicking leg against the opposing force exerted by the springs. For the precise operation of the gate opening and closing mechanism, two high-speed motors, specifically the Orange RS775 12V 3000RPM Base DC Motors, were integrated. These motors boast a high RPM of 3000, enhancing the efficiency of the gate's operation. Refer to Figure 10 for kicking leg operation motor and door motors.

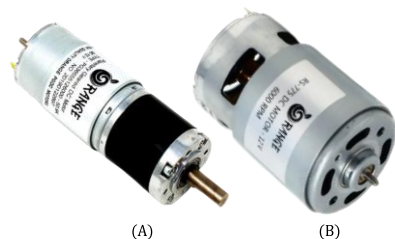


Figure 10: (A) Kicking leg DC high torque motor (B) Gate operation DC motor

4.2 Sensors

A wide range of sensors are used to offer critical feedback data in order to ensure perfect operation and movement of the passing and kicking robot. The various kinds of sensors used include:

- **Wheel Encoders:** These devices offer valuable feedback regarding the rotation of each omni wheel, enabling precise calculation of the robot's position and facilitating adjustments in its movements. Wheel encoders play a pivotal role in implementing closed-loop control, ensuring the robot adheres to its intended path.
- **IMU (Inertial Measurement Unit):** An IMU amalgamates accelerometers, gyroscopes, and, at times, magnetometers to gauge the robot's acceleration, angular velocity, and magnetic field. Processing data from these sensors enables the controller to determine the robot's orientation, detecting alterations in direction or inclination.
- **Proximity and Obstacle Detection Sensors:** Utilizing sound waves, ultrasonic sensors measure distances to nearby objects. These sensors are instrumental in detecting obstacles within short to medium ranges, allowing the robot to maintain a secure distance from objects.
- **Wheel Odometry:** Although not a conventional sensor, tracking wheel odometry data (i.e., the distance traveled by each wheel) is indispensable for estimating the robot's position accurately. This data, when integrated with inputs from other sensors, enhances navigation accuracy.
- **Wireless Communication Modules:** For control and communication, Zigbee modules are employed. Zigbee, operating within the 2.4 GHz ISM band, facilitates low-power, short-range communication between devices, making it ideal for applications demanding energy efficiency, low data rates, and secure communication within confined spaces.
- **Battery Voltage and Current Sensors:** Monitoring the power supply's voltage and current consumption is pivotal for preventing over-discharge and ensuring the robot maintains adequate power levels for safe operation.

4.3 Motor Controller and Battery Management

Both the MR1 and MR2 robots are equipped with a sophisticated control system, centered around the Arduino Mega 2560 microcontroller board [20]. This advanced microcontroller features a comprehensive array of components, including 54 digital input/output pins, a 16-MHz crystal oscillator, 15 PWM output pins, 16 analog input pins, a USB connection, a power socket, and an ICSP header. Integrated seamlessly with the Arduino Mega 2560 is the Embedded Module Series (EMS) 30 A H-Bridge, a critical component capable of facilitating a two-way drive for three and four planetary DC motors for MR1 and MR2. This H-Bridge operates within a voltage range spanning 4 to 16 volts and sustains a continuous current of up to 30 A. To enhance control

precision, the module is equipped with a load current sensor circuit, providing essential inputs to the controller.

Furthermore, each robot operates on an independent 24 V Lithium Polymer (LiPo) battery, meticulously managed by a specialized battery protection circuit. This circuit plays a pivotal role in monitoring the battery voltage, automatically disconnecting the load when the Li-Ion battery's voltage descends below the predetermined lockout threshold. This meticulous approach prevents over-discharge, ensuring the longevity and efficiency of the power supply system. For a comprehensive visual representation of the H-bridge driver and the Arduino controller, refer to Figure 11.

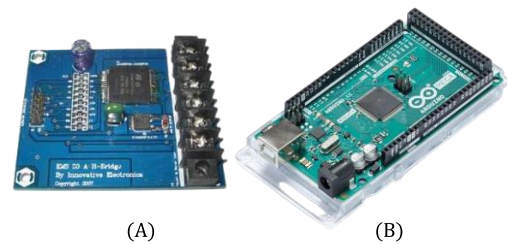


Figure 11: (A) Embedded Module Series (EMS) 30 A H-Bridge driver (B) Arduino Mega 2560

5. CENTRAL CONTROLLER FOR MOTOR MOTION CONTROL SYSTEM

Figure 12 illustrates the comprehensive real-time omni-wheel motor control system implemented for both MR1 and MR2, as presented in the block diagram. This integrated system orchestrates various real-time tasks critical to the robots' functionality, including robot kinematics, interpolations, battery management, odometry computations, sensor data processing, charging control, and error detection mechanisms. The embedded system's central objective lies in facilitating precise motor movements, responding dynamically to user inputs.

The control system is equipped with essential features such as USB connectivity and a Controller Area Network (CAN) bus, a standardized vehicle bus designed to enable seamless communication between microcontrollers and other devices, without relying on a host computer. The CAN bus interfaces with DC servo amplifiers, managing communication between the robot and the controller, as well as facilitating additional data transfer. Notably, the robots incorporate ultrasonic distance sensors to facilitate obstacle avoidance. Detection and management of errors such as follow error, overcurrent, or under-voltage lockout are meticulously handled by the servo diagnostics subsystem.

Within this intricate framework, the navigation task takes precedence, involving tasks such as interpolation and servo driver referencing. The controller assumes a pivotal role in overseeing these aspects, ensuring precise and efficient motor control, thereby enhancing the overall operational efficiency of the robotic systems.

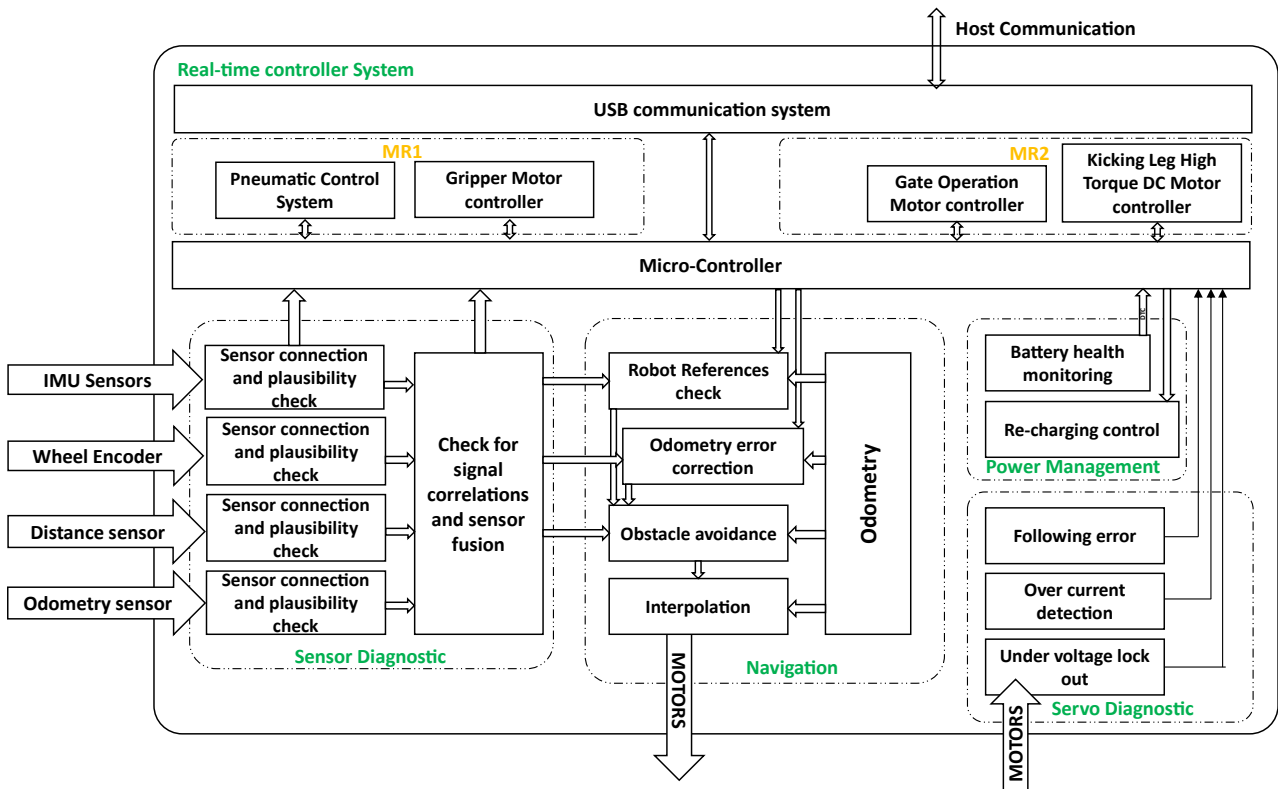


Figure 12: Block diagram of central controller system for motor motion control

6. CONCLUSION

This study stands as a pioneering effort, introducing two specialized robots, namely MR1 and MR2, meticulously crafted for the nuanced tasks of passing and kicking rugby balls, respectively. The MR1 passing robot, adorned with a holonomic omnidirectional platform, exhibits an ability to handle rugby balls deftly, achieved through a sophisticated throwing arm mechanism. Its capability to pick up the ball from the tee and execute precise passes to MR2. The robot's triangular structural configuration and intricately designed wheels facilitate seamless movement in all directions, obviating the need for intricate maneuvers. The successful amalgamation of mechanical grippers, pneumatic systems, and precise control mechanisms within the MR1 robot ensures the flawless execution of passing over a distance of 2.5 meters.

On the other hand, MR2, the kicking robot, exhibits exceptional accuracy, owing to its robust rectangular base and four-wheel holonomic omnidirectional wheels, facilitating precise ball placement and controlled propulsion. The incorporation of springs and motors in its kicking mechanism guarantees precise ball control, with the spring-loaded kicker leg mechanism generating a force of 8.41 N. This enables the robot to execute kicks with remarkable precision, propelling the ball horizontally and vertically up to 5 meters and 1.5 meters, respectively. Enhanced perception and communication abilities are achieved through sensors such as wheel encoders, IMU, proximity sensors, and wireless communication modules.

This research aims expands the horizons of robotic sports technology but also establishes an open platform for future research and development. By replicating human sports activities through robotic ingenuity, this study marks a

significant stride toward the future of sports robotics, promising innovative advancements and transformative applications in various fields.

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Construction of Financial Internal Control System in Colleges

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Abstract: The management of financial resources within Colleges is a critical aspect of ensuring their long-term sustainability and effectiveness. This abstract discusses the imperative need for the construction of a robust Financial Internal Control System (FICS) in educational institutions. The FICS is designed to mitigate financial risks, enhance accountability, and promote efficient resource allocation. This study delves into the various components of a FICS, which include policies and procedures, organizational structure, risk assessment, monitoring mechanisms, and internal audit functions. It emphasizes the importance of a proactive approach to financial control, highlighting that well-constructed FICS not only safeguards against fraud and mismanagement but also fosters a culture of transparency and responsible financial stewardship. This article explores the benefits of well-implemented FICS, such as improved decision-making, reduced financial losses, enhanced compliance with regulations, and increased donor and stakeholder trust. It also addresses the challenges and obstacles educational institutions may encounter in building and maintaining FICS. The construction of financial internal control system is not only a necessity for Colleges, but also an important tool to ensure financial stability and achieve academic goals. This summary highlights the urgency for educational institutions to prioritize the development and maintenance of strong FICS.

Keywords: financial resources; FICS; Financial; Internal Control System; colleges

1. INTRODUCTION

Colleges play a pivotal role in shaping the future by providing education and fostering intellectual growth. In pursuing these noble objectives, sound financial management is paramount. Educational institutions must efficiently allocate resources, ensure transparency, and protect their finances from risks and mismanagement. The Construction of Financial Internal Control System (FICS) emerges as a critical strategy to achieve these objectives and maintain the fiscal health of Colleges.

Amidst the complex financial landscapes of higher education, a well-structured FICS serves as a guiding compass. This system encompasses a comprehensive framework of policies, procedures, organizational structures, risk assessments, and internal audit functions. Its primary purpose is to mitigate financial vulnerabilities, instill accountability, and facilitate prudent resource allocation. In doing so, the FICS is not merely a safeguard against financial improprieties but also a catalyst for a culture of fiscal responsibility and stewardship.

This introduction sets the stage for our exploration of the Construction of Financial Internal Control System within Colleges. We will delve into the components of a robust FICS, assess the benefits it brings, examine the challenges it poses, and underscore its significance as an indispensable tool in the pursuit of educational excellence and financial sustainability. As we venture into this critical domain, it becomes evident that the implementation of an effective FICS is not optional but imperative for the continued success of higher education institutions.

2. THE IMPORTANCE OF FICS TO THE CONSTRUCTION OF INTERNAL CONTROL SYSTEMS IN UNIVERSITIES

The various components of a Financial Internal Control System (FICS) are essential to the construction of internal control systems in Colleges for several reasons. Each component contributes to the overall effectiveness of the

system, ensuring sound financial management, compliance, and safeguarding of the institution's financial resources. Let's discuss the importance of these components in more depth.

Clear financial policies and procedures are the bedrock of the FICS. They provide a standardized framework for handling financial transactions, ensuring consistency, accountability, and compliance with legal and regulatory requirements. In educational institutions, policies guide everything from procurement and budgeting to financial reporting and grant management. Defining roles and responsibilities is crucial for accountability. It prevents any single individual from having too much control over financial activities, reducing the risk of fraud and mismanagement. In Colleges, having clearly delineated roles for finance officers, department heads, and administrators ensures checks and balances. Educational institutions face various financial risks, including economic fluctuations, fraud, and misallocation of funds. Conducting risk assessments within the FICS helps identify vulnerabilities and prioritize risk mitigation strategies. This is vital for maintaining financial stability.

Control activities put policies into practice. They ensure that financial transactions are properly authorized, recorded, and reconciled. For Colleges, this helps prevent financial irregularities, such as unauthorized expenditures, and minimizes the risk of financial errors. Effective communication within the FICS ensures that financial data is transparent and accessible to the relevant stakeholders. This is vital for universities, especially when reporting to governing boards, donors, and government agencies. Transparent financial reporting promotes trust and confidence. Regular monitoring and internal audits are essential for detecting issues and ensuring that the FICS remains effective. In educational institutions, where budgets can be complex and large, monitoring helps identify discrepancies and financial inefficiencies promptly. Internal auditors provide an independent assessment of the effectiveness of financial controls, compliance with policies and regulations, and the overall integrity of financial processes. Their work is crucial in identifying and addressing financial weaknesses or inefficiencies. FICS components promoting compliance and

ethics foster a culture of financial responsibility and ethical behavior within educational institutions. This is vital for upholding the reputation of the institution and building trust among students, staff, donors, and the public. Proper record-keeping is fundamental to proving financial transparency and accountability. In Colleges, this ensures that funds are used for their intended purposes and that financial records can withstand scrutiny. The FICS should adapt to changing circumstances and emerging risks. In the rapidly evolving landscape of higher education, the ability to evaluate and enhance financial controls is essential for maintaining financial stability and adapting to new financial challenges.

Each component of the FICS is integral to constructing a robust internal control system in Colleges. The FICS not only safeguards financial resources but also promotes accountability, transparency, and ethical financial practices, which are critical for the long-term sustainability and success of educational institutions.

3. ESTABLISH FINANCIAL INTERNAL CONTROL SYSTEM

The Financial Internal Control System (FICS) is of paramount importance and holds perfect significance in the construction of financial internal control systems in universities. Here, we'll explore the key reasons why FICS is indispensable in the context of higher education institutions:

Universities are entrusted with substantial financial resources from various sources, including tuition, government funding, donations, and grants. FICS ensures that these resources are used responsibly, promoting financial stewardship and accountability. This is vital for maintaining public trust, donor confidence, and compliance with legal and regulatory requirements. Educational institutions are not immune to financial fraud. FICS components like segregation of duties, authorization processes, and internal audits are essential in preventing and detecting fraudulent activities. By establishing robust controls, universities can minimize the risk of embezzlement and financial misconduct.

The financial landscape of universities is complex, with investments, endowments, and various revenue streams. FICS includes risk assessment and control activities that help identify and manage financial risks, such as market fluctuations, unexpected costs, and compliance risks. This is crucial for maintaining financial stability. Universities need to adhere to a wide range of financial regulations, including tax laws, grant requirements, and reporting standards. FICS ensures that universities meet these compliance obligations and that financial transactions are transparent and well-documented.

Efficient resource allocation is vital for universities to achieve their academic and research missions. FICS components like budgeting, financial reporting, and monitoring mechanisms enable universities to make informed decisions about how to allocate resources optimally. Sound financial controls ensure that universities have access to accurate and timely financial data. This data is crucial for informed decision-making at all levels of the institution, from academic program planning to capital investments.

Universities rely on their reputation to attract students, faculty, and donors. Financial scandals or mismanagement can irreparably damage this reputation. FICS plays a pivotal role in preventing such incidents, preserving the institution's standing, and enhancing its attractiveness to stakeholders. Universities often rely on donations to fund various initiatives. Donors expect their contributions to be managed responsibly. A well-constructed FICS helps assure donors that

their money will be used as intended, which fosters confidence and potentially leads to increased philanthropic support.

A robust financial control system ensures that funds are available for academic programs and research initiatives. Without financial stability, universities may struggle to provide quality education and contribute to the advancement of knowledge. By providing a strong foundation for financial management, FICS contributes to the long-term sustainability of universities. It helps institutions weather economic downturns and adapt to changing financial landscapes.

The Financial Internal Control System is critically important and perfectly significant in the construction of financial internal control systems in universities. It safeguards financial resources, fosters accountability and transparency, and supports the academic and research missions of higher education institutions. Furthermore, it upholds the reputation of universities and ensures their long-term viability and success.

3.1 IMPROVE DECISION-MAKING

Constructing a robust Financial Internal Control System (FICS) in universities is imperative for prudent financial management. Key steps involve establish comprehensive financial policies and procedures that outline how funds are managed, including procurement, budgeting, and reporting. These policies provide a solid foundation for the FICS. Define clear roles and responsibilities for individuals involved in financial activities. Segregate duties to prevent conflicts of interest and fraud. Identify financial risks specific to the university context, such as endowment investments and government funding compliance. Develop strategies to mitigate these risks. Implement control mechanisms like authorization processes, internal audits, and financial reporting protocols to ensure financial transactions are in compliance with policies and regulations. Establish a robust internal audit function that regularly reviews financial processes, identifies weaknesses, and recommends improvements. Promote a culture of compliance and ethical behavior among staff and stakeholders. Create channels for reporting misconduct and protect whistleblowers. Regularly review and enhance the FICS in response to changing financial landscapes, emerging risks, and lessons learned.

Utilize data and analytics to inform decisions. Make use of financial software and reporting tools to provide accurate, real-time information. Engage relevant stakeholders, including finance professionals, auditors, and administrators, in decision-making processes. Leverage their expertise to gain different perspectives. Use scenario planning and financial simulations to model the potential outcomes of different decisions, helping you make more informed choices. Consider the financial implications and risks associated with each decision. Weigh the short-term and long-term consequences, and assess how they align with the institution's financial goals. Maintain transparent communication about financial decisions and their impacts, both internally and externally. Clearly communicate the rationale behind your choices. Encourage a culture of learning from past financial decisions. Analyze successes and failures to refine future decision-making processes.

By constructing a comprehensive FICS and incorporating these decision-making strategies, universities can maintain strong financial health and make informed choices that support their academic and financial objectives.

3.2 REDUCE FINANCIAL LOSSES

Constructing a Financial Internal Control System (FICS) in universities involves several key steps. Develop clear financial policies and procedures that define how funds should be managed, outlining guidelines for procurement, budgeting, and reporting. Define roles and responsibilities within the institution, segregating duties to prevent fraud or mismanagement. Identify financial risks specific to the university context, such as endowment investments or compliance with government funding requirements, and develop strategies to mitigate these risks. Implement control mechanisms such as authorization processes, internal audits, and financial reporting protocols to ensure that financial transactions comply with policies and regulations. Establish an internal audit function to periodically review financial processes, identify weaknesses, and recommend improvements. Compliance and Ethics: Foster a culture of compliance and ethical behavior among staff and stakeholders, and create channels for reporting misconduct while protecting whistleblowers. Regularly review and enhance the FICS to adapt to evolving financial landscapes and emerging risks.

Continuously assess and address financial risks within the institution. Identify vulnerabilities and put controls in place to mitigate them. Implement regular internal audits and monitoring mechanisms to detect and prevent financial irregularities, fraud, or mismanagement. Maintain transparent financial reporting practices to ensure that all transactions are accurately recorded and reported, reducing the likelihood of losses due to hidden financial discrepancies. Ensure that the institution complies with all relevant laws and regulations, reducing the risk of financial penalties and losses resulting from non-compliance. Prevent financial losses by segregating duties and requiring multiple approvals for significant financial transactions, reducing the risk of unauthorized expenditures. Train staff on the FICS and its components to ensure that they understand their roles and responsibilities, minimizing the chances of errors that could lead to financial losses.

By constructing a robust FICS and using it effectively, universities can significantly reduce the risk of financial losses and ensure responsible financial stewardship.

3.3 STRENGTHEN COMPLIANCE WITH TRAFFIC RULES

Constructing a Financial Internal Control System (FICS) in Colleges to enhance compliance with regulations involves several key steps.

Develop comprehensive financial policies and procedures that align with relevant laws and regulations. These policies should guide every aspect of financial management within the institution. Identify and understand the specific regulations that apply to the institution, whether they pertain to federal, state, or local authorities. Stay up to date with any changes in regulations that may affect financial management. Define roles and responsibilities within the institution, ensuring that they align with the regulatory requirements. Assign responsibilities for compliance monitoring and reporting. Implement control mechanisms to ensure compliance, such as authorization processes, record-keeping standards, and reporting procedures that are in line with the regulations. Provide training and education to staff and stakeholders about the importance of compliance and the specific regulatory requirements that apply to financial operations. Continuously monitor financial processes to ensure ongoing compliance with regulations. Create

mechanisms for reporting any compliance violations or issues. Periodically engage external auditors to review financial processes and confirm compliance with regulations. Address any issues identified during these audits promptly. Maintain comprehensive records and documentation that prove compliance with regulations. This documentation should be easily accessible for review. Foster a culture of compliance within the institution, emphasizing the importance of adhering to regulations as a fundamental aspect of financial management. Regularly review and update the FICS to adapt to changing regulations and to address any issues or weaknesses that emerge during compliance monitoring.

By following these steps, Colleges can construct a Financial Internal Control System that enhances compliance with regulations, reducing the risk of penalties and reputational damage while promoting responsible financial stewardship.

3.4 INCREASE DONOR AND STAKEHOLDER TRUST

Constructing a Financial Internal Control System (FICS) in universities to increase the trust of donors and stakeholders involves the followings.

Ensure that the institution maintains a high level of transparency in its financial reporting. Provide donors and stakeholders with easily accessible, clear, and comprehensive financial statements. Develop and enforce financial policies that demonstrate a commitment to responsible financial stewardship. These policies should outline the institution's fiscal responsibility and adherence to best practices. Create a strong organizational structure with clearly defined roles and responsibilities for financial management. Implement mechanisms for accountability and oversight, such as a finance committee or board of trustees. Ensure that the institution complies with all relevant laws and regulations governing financial management. Regularly audit and review financial processes to confirm adherence to these standards. Engage with donors and stakeholders to understand their expectations and concerns regarding the use of funds. Seek their input and feedback to build trust. Communicate with donors and stakeholders regularly to keep them informed about the institution's financial performance, achievements, and challenges. Address concerns and provide updates on how funds are utilized. Promote a culture of ethical behavior and financial responsibility among staff and stakeholders. This includes safeguarding against conflicts of interest and financial misconduct. Showcase the impact of financial contributions by sharing success stories and demonstrating how donations are making a difference within the institution and among its beneficiaries. Clearly demonstrate how donated funds are allocated and utilized. This can be done through detailed budgeting, earmarking donations for specific projects, and providing regular updates on the progress of these initiatives. Conduct regular, independent financial audits and share the results with donors and stakeholders to demonstrate the institution's commitment to transparency and accountability.

By constructing a robust FICS and implementing these measures, universities can foster trust among donors and stakeholders, ensuring that their financial contributions are used efficiently and responsibly to support the institution's mission and goals. This trust is essential for sustaining relationships and attracting future support.

4. CONCLUSION

In conclusion, the construction of a Financial Internal Control System (FICS) within universities is not merely a matter of financial protocol; it is an indispensable pillar that upholds the institution's fiscal health, reputation, and sustainability. The importance of a well-structured FICS cannot be overstated.

By implementing a comprehensive FICS, universities can ensure responsible financial stewardship, transparent reporting, and compliance with regulations, all of which are paramount for earning and maintaining the trust of donors, stakeholders, and the public. This trust is fundamental to securing the financial resources necessary for academic and research excellence, infrastructural development, and student support.

Moreover, an effective FICS safeguards against financial irregularities, fraud, and mismanagement, providing a solid foundation for long-term financial stability. It fosters a culture of accountability, ethics, and responsibility among staff and stakeholders, which is essential in preserving the institution's reputation and achieving its mission.

In a world where the fiscal landscapes of higher education are increasingly complex and subject to scrutiny, a robust FICS is not an option but a fundamental requirement. Its construction is a commitment to sound financial practices, responsible resource allocation, and a dedication to the ideals of higher education. As universities continue to evolve, the significance of a well-constructed FICS remains undeniably essential for their continued success and the realization of their academic and societal objectives.

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Navigating Remote Work Stress and Performance: Coping Mechanisms among College Teachers

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Abstract: This study investigates the strategies college teachers employ to manage stress and sustain performance in the context of remote work. The shift to remote teaching, accelerated by global events, has significantly altered the educational landscape, introducing unique stressors for educators. The abstract explores the coping mechanisms utilized by college teachers and the impact of stress on their overall performance. The literature review emphasizes the psychological effects of prolonged remote work, highlighting stressors specific to this environment. Various coping strategies, such as resilience-building techniques and institutional support, are examined. The study also delves into the correlation between stress levels and performance, including its influence on academic engagement and teaching quality. Methodologically, a mixed-methods approach involving surveys, interviews, and case studies was used to collect data. The findings suggest that while college teachers face multifaceted stressors, they employ diverse coping mechanisms to navigate these challenges. However, the impact of stress on their performance remains significant. The study concludes by proposing the need for enhanced institutional support and interventions to aid educators in managing stress and sustaining performance while working remotely. Understanding these dynamics is crucial for the development of effective support systems within the educational sector.

Keywords: Remote work; College teachers; Stress management; Performance; Coping strategies

1. INTRODUCTION

The educational landscape has undergone a transformative shift with the rapid adoption of remote work, driven primarily by global events necessitating the restructuring of traditional teaching environments. This transition has notably impacted college teachers, compelling them to adapt their instructional methodologies to virtual platforms. The abrupt pivot towards remote instruction has introduced a myriad of challenges and stressors unique to this new work paradigm, significantly altering the professional landscape for educators.

Understanding the stressors and challenges faced by college teachers in the remote work setting is of paramount importance. The mental, emotional, and professional well-being of educators significantly influences their ability to deliver quality education to students. Exploring the coping mechanisms and strategies employed by teachers to manage stress within this context is vital not only for their individual welfare but also for sustaining a high standard of education.

This study aims to investigate the coping mechanisms utilized by college teachers to manage stress while working remotely. It seeks to identify the specific stressors prevalent in the remote teaching environment and explore how educators cope with these challenges. By delving into the strategies employed, the study intends to comprehend the relationship between stress management and the performance of college teachers in this remote work scenario. Ultimately, the research endeavors to contribute valuable insights towards developing support systems and interventions to aid educators in effectively managing stress and maintaining their performance levels in a remote work setting.

2. LITERATURE REVIEW

The shift to remote work has significantly influenced the stress levels experienced by college teachers. Research indicates that the sudden adaptation to virtual teaching platforms, increased workload, blurred boundaries between professional and personal life, and the lack of direct interaction with students have contributed to heightened stress levels among educators. Studies have emphasized the need to understand these stressors to effectively address their impact on teacher well-being.

Various coping strategies and models have been proposed to assist college teachers in managing stress while working remotely. These include resilience-building techniques, mindfulness practices, time management strategies, fostering a supportive virtual community, and establishing clear boundaries between work and personal life. Additionally, models such as the Transactional Model of Stress and Coping have been explored in understanding how teachers adapt and cope with the stressors associated with remote work.

Numerous factors influence the performance and productivity of college teachers in a remote work environment. These encompass technological proficiency, access to resources, work-life balance, the availability of institutional support, and the adaptability of teaching methodologies to online platforms. Understanding these factors is crucial in enhancing the effectiveness of remote teaching and sustaining educators' performance levels.

The prolonged exposure to remote work environments has significant psychological implications for educators. It has led to feelings of isolation, increased levels of burnout,

challenges in maintaining motivation and engagement, and concerns about job security. The psychological impact of remote work on college teachers warrants a deeper exploration to mitigate its adverse effects and support their mental health and well-being.

This review of the existing literature illuminates the multifaceted impact of remote work on college teachers, addressing stress levels, coping mechanisms, performance factors, and the psychological implications of prolonged remote work in the educational sector. Understanding these dimensions is crucial for designing effective interventions and support systems for educators in remote work settings.

3. UNDERSTANDING STRESS AMONG COLLEGE TEACHERS IN REMOTE WORK SETTINGS

3.1 ANALYSIS OF STRESSORS SPECIFIC TO REMOTE WORK ENVIRONMENTS FOR COLLEGE EDUCATORS

Remote work environments present unique stressors for college educators, including but not limited to the challenges of adapting to online teaching methodologies, technological issues, increased workload due to the demands of virtual platforms, the absence of face-to-face interactions with students, blurred boundaries between professional and personal life, and the pressure to continuously innovate teaching strategies in an online format. Understanding and delineating these stressors are crucial in addressing the challenges faced by teachers in remote settings.

3.2 IDENTIFYING THE PSYCHOLOGICAL, SOCIAL, AND PROFESSIONAL IMPACT OF STRESS ON TEACHERS

The stress experienced by college teachers in remote work settings has profound impacts on their psychological, social, and professional well-being. Psychological impacts encompass increased levels of anxiety, feelings of isolation, burnout, and challenges in maintaining motivation and engagement. Socially, it affects their interactions with colleagues and students, leading to a sense of disconnection. Professionally, it influences the quality of teaching, productivity, and overall job satisfaction. Understanding the multi-dimensional impacts of stress is essential in developing targeted interventions.

3.3 CASE STUDIES OR INTERVIEWS HIGHLIGHTING INDIVIDUAL EXPERIENCES WITH STRESS AND COPING MECHANISMS

Conducting case studies or interviews with college teachers can provide invaluable insights into their individual experiences with stress and the coping mechanisms they employ. These personal accounts can shed light on the diverse range of stressors encountered in remote work environments, as well as the efficacy of various coping strategies. By examining these real-life experiences, the study aims to offer a nuanced understanding of the challenges faced by educators and the effectiveness of different coping mechanisms in managing stress.

This section seeks to delve deeper into the specifics of stress in remote work settings for college teachers, examining stressors, its impacts across various domains, and providing a qualitative exploration through case studies or interviews to elucidate personal experiences and coping mechanisms utilized by educators.

4. COPING MECHANISMS FOR STRESS MANAGEMENT

4.1 EXAMINING VARIOUS COPING STRATEGIES USED BY COLLEGE TEACHERS

College teachers employ a diverse array of coping strategies to manage stress in remote work settings. These strategies encompass time management techniques, adopting flexible work schedules, maintaining clear boundaries between work and personal life, practicing mindfulness and relaxation techniques, seeking social support networks, employing adaptive teaching methods, and enhancing communication channels with students and colleagues. Understanding the efficacy of these varied strategies is essential for educators to navigate the challenges of remote work effectively.

4.2 RESILIENCE-BUILDING TECHNIQUES AND THEIR EFFECTIVENESS IN MANAGING STRESS

Resilience-building techniques play a pivotal role in enabling college teachers to manage stress in a remote work environment. These techniques involve developing emotional intelligence, fostering adaptability, embracing change, cultivating a positive mindset, and enhancing problem-solving skills. Assessing the effectiveness of these resilience-building techniques in bolstering teachers' ability to navigate stress and adversity is vital in enhancing their overall well-being and job performance.

4.3 THE ROLE OF INSTITUTIONAL SUPPORT AND SELF-CARE

Institutional support and self-care practices significantly contribute to stress reduction among college teachers. Support from educational institutions through training programs, mental health resources, technology assistance, and administrative guidance can significantly alleviate the stress burden on educators. Equally important are self-care practices involving physical exercise, maintaining a healthy work-life balance, setting personal boundaries, and engaging in hobbies or activities that promote relaxation. Analyzing the impact of institutional support and individual self-care practices on reducing stress is crucial for designing comprehensive support systems.

This section aims to explore the diverse coping strategies used by college teachers, focusing on resilience-building techniques, institutional support, and self-care practices as pivotal components in managing stress in remote work environments. Understanding the effectiveness of these strategies is essential in developing tailored interventions to

support educators in navigating the challenges of remote teaching.

5. IMPACT OF STRESS ON PERFORMANCE AND ACADEMIC ENGAGEMENT

5.1 RELATIONSHIP BETWEEN STRESS LEVELS AND PERFORMANCE AMONG COLLEGE EDUCATORS

The level of stress experienced by college educators has a substantial impact on their overall performance. Studies indicate a direct correlation between heightened stress levels and decreased job performance, affecting the quality of teaching, lesson planning, assessment, and the ability to engage with students effectively. Understanding this relationship is pivotal in addressing the impediments caused by stress and in fostering an environment that supports educators' performance.

5.2 EVALUATION OF THE EFFECTIVENESS OF COPING MECHANISMS ON PRODUCTIVITY AND TEACHING QUALITY

Assessing the effectiveness of coping mechanisms used by college teachers in managing stress is crucial in understanding their impact on productivity and teaching quality. Various coping strategies, such as time management techniques, resilience-building practices, and social support networks, play a vital role in maintaining productivity and ensuring the delivery of high-quality education. Analyzing the effectiveness of these coping mechanisms provides insights into their influence on the educators' performance and instructional efficacy.

5.3 STUDENT ENGAGEMENT AND LEARNING OUTCOMES INFLUENCED BY TEACHERS' STRESS LEVELS

The stress levels of college teachers directly influence student engagement and learning outcomes. Research suggests that educators experiencing high levels of stress may struggle to effectively engage and support their students. This, in turn, can impact the learning environment, student motivation, and academic outcomes. Understanding the impact of teachers' stress on student engagement and learning outcomes is crucial for ensuring a supportive and conducive educational environment.

This section aims to analyze the significant impact of stress on the performance of college educators, evaluating the relationship between stress levels and performance, assessing the effectiveness of coping mechanisms on productivity and teaching quality, and understanding how teachers' stress levels influence student engagement and academic outcomes. These insights are crucial in developing strategies to support both educators and students in remote work settings.

6. SUPPORT SYSTEMS AND INTERVENTIONS

6.1 ANALYSIS OF INSTITUTIONAL SUPPORT SYSTEMS FOR REMOTE COLLEGE TEACHERS

The examination of existing institutional support systems for remote college teachers is crucial in understanding the level of assistance available to educators. This analysis involves assessing the provision of technological resources, mental health services, professional development opportunities, administrative support, and the overall infrastructure aimed at aiding educators in their transition to and maintenance of remote teaching environments. Understanding the strengths and limitations of current support systems is fundamental in identifying areas for improvement.

6.2 RECOMMENDATIONS FOR ENHANCING SUPPORT STRUCTURES AND RESOURCES

Drawing from the analysis, recommendations for enhancing support structures and resources are proposed. This includes suggestions for improving technological infrastructure, offering tailored professional development opportunities, establishing accessible mental health and counseling services, providing administrative guidance and support, and fostering a collaborative and inclusive work environment. These recommendations aim to address the identified gaps in the existing support systems for remote college teachers.

6.3 PROPOSAL FOR TRAINING PROGRAMS AND INTERVENTIONS TO AID IN STRESS MANAGEMENT

Developing specific training programs and interventions designed to aid in stress management is crucial for supporting remote college teachers. Proposals in this section outline strategies such as stress management workshops, resilience-building programs, mental health awareness training, and workshops focusing on coping strategies specifically tailored to the challenges of remote teaching. These interventions aim to equip educators with the necessary tools and techniques to effectively manage stress and enhance their overall well-being in a remote work setting.

This section aims to analyze the current institutional support available for remote college teachers, provide recommendations for improvement in support structures and resources, and propose training programs and interventions specifically designed to aid in stress management. These proposals intend to contribute to the development of more comprehensive and effective support systems for educators in remote work environments.

7. CONCLUSION

The landscape of education has undergone a radical transformation with the swift transition to remote work, impacting college teachers in multifaceted ways. This study has delved into the intricate dynamics of stress, coping mechanisms, and the consequent impact on performance among educators operating in remote environments.

Examining the stressors specific to remote work settings has highlighted the challenges faced by teachers, including the adaptation to virtual teaching, increased workload, and the blurred boundaries between personal and professional life. Understanding these stressors is imperative to provide targeted support.

The coping strategies and resilience-building techniques employed by college teachers have emerged as pivotal tools in managing stress. From time management to fostering social support networks, these strategies play a vital role in sustaining productivity and quality teaching. The analysis has underscored the significance of institutional support and individual self-care practices in mitigating stress levels.

Stress among educators has shown a direct correlation with performance. High stress levels impact teaching quality, productivity, and student engagement, underscoring the need for comprehensive support systems.

The evaluation of existing institutional support systems has revealed areas for improvement. Recommendations focusing on enhanced resources, infrastructure, and training interventions have been proposed to empower educators in managing stress and adapting to remote work environments effectively.

In conclusion, this study emphasizes the urgent need for tailored interventions and comprehensive support structures for college teachers in remote work settings. By understanding and addressing the stressors and challenges specific to this environment, educational institutions can foster an environment conducive to educators' well-being and, by extension, optimal learning outcomes for students. Enhancing the support systems for teachers is fundamental in navigating the complexities of remote work and ensuring a sustainable, fulfilling educational experience for both educators and learners.

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The Impact of Technology on Music Education

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Abstract: The integration of technology in music education has fundamentally transformed the landscape of teaching and learning within the realm of music. This abstract explores the multifaceted impact of technology on music education, encompassing its historical evolution, present applications, and future implications. The historical perspective reveals a transition from traditional methods to an era where technological advancements have become integral to pedagogy. Various tools such as software applications for composition, recording, and production, alongside digital platforms for collaboration and learning, have redefined how music is taught and learned. The rise of online and blended learning has not only expanded accessibility but also enhanced inclusivity within music education. This abstract delves into the innovative approaches and emerging trends, shedding light on the potential of AI, virtual reality, and augmented reality in music instruction. While technology offers immense opportunities, it also presents challenges such as access disparities and ethical considerations. By reviewing empirical studies and research findings, this abstract emphasizes the overall positive impact of technology on student engagement, performance, and the pedagogical landscape. Recommendations for educators and policymakers are outlined, underscoring the necessity of embracing technology while considering its challenges in ensuring a robust, inclusive, and effective music education system.

Keywords: Technological Integration ; Music Pedagogy ; Online Learning ; Inclusivity ; Educational Innovation

1. INTRODUCTION

Music education holds a unique position in nurturing cognitive, emotional, and social development, fostering creativity, and enriching cultural understanding. Its importance transcends mere musical skill acquisition; it serves as a gateway to comprehensive learning experiences. In the contemporary educational landscape, technology has emerged as a catalyst for transformative pedagogical practices. The integration of technology in music education has revolutionized how students engage with music, expanding avenues for learning and creativity.

This article aims to explore the profound impact of technology on music education. It begins by delving into the historical evolution of music education, tracing its traditional roots to the current era where technological advancements have become pivotal in teaching methods. The chapter structure encompasses an analysis of various technological tools employed in music education, the role of technology in enhancing inclusivity and accessibility, and the emergence of online learning in the music sphere. Furthermore, it will explore innovative approaches and forecast potential future trends. By evaluating empirical research, this article seeks to underscore the positive outcomes and challenges stemming from the integration of technology in music education.

In delineating the significance of technology in music education, this article aims to present an insightful framework for educators, policymakers, and stakeholders, navigating the dynamic relationship between technology and music pedagogy in the modern era.

2. EVOLUTION OF MUSIC EDUCATION

Music education, deeply intertwined with human history, has served as a cornerstone in cultural expression, societal development, and personal enrichment. Its historical perspective illuminates a journey of pedagogical transformation, where traditional methods intertwined with the contemporary, laying the foundation for the dynamic landscape observed today.

Traditionally, music education relied heavily on in-person instruction, mentorship, and direct engagement between teachers and students. These methods, though valuable, were often limited by geographical constraints and the availability of resources. Students learned through oral transmission, notation, and direct practice, embodying a more intimate and personalized approach to learning.

The advent of technological advancements marked a significant turning point in music pedagogy. The transition from handwritten scores to printed sheet music was one of the initial technological shifts, allowing for wider distribution and access. Recording technology further revolutionized the landscape, enabling the preservation of musical performances and expanding the repertoire available for educational purposes.

Key milestones in the integration of technology into music education emerged with the advent of electronic instruments and the introduction of early software applications for music composition and practice. The evolution of personal computers and the subsequent development of music-specific software significantly broadened the horizons of music education. These technological advancements not only enhanced music creation

and analysis but also paved the way for innovative teaching methodologies, enriching the learning experience for students.

As technology continued to evolve, digital platforms and online resources became catalysts for the democratization of music education. They transcended the limitations of traditional classroom settings, fostering inclusivity and accessibility. The subsequent sections of this chapter will explore in depth the impact of these technological shifts on pedagogical approaches in music education, illuminating the transformative power of technology in shaping the way music is taught and learned.

3. TECHNOLOGY TOOLS IN MUSIC EDUCATION

The infusion of technology into music education has given rise to a diverse array of tools and platforms, revolutionizing the ways in which music is taught, learned, and created. This chapter embarks on an exploration of the various technological tools that have significantly altered the landscape of music education, ranging from software applications to digital platforms, and examines their profound impact on student engagement and learning outcomes.

Software applications designed for composition, recording, and production have emerged as fundamental instruments in the modern music classroom. These tools offer students and educators a wide range of possibilities, from basic music notation software to advanced digital audio workstations (DAWs). They facilitate not only the creation of music but also its analysis, enhancing students' understanding of music theory, structure, and composition.

Digital platforms dedicated to music learning and collaboration have further broadened the horizons of music education. Online platforms, ranging from interactive music theory tutorials to virtual ensemble practice spaces, offer students the opportunity for collaborative learning, irrespective of geographical boundaries. These platforms facilitate peer interaction, feedback, and the sharing of resources, fostering a sense of community among students and educators alike.

The impact of these technological tools on student engagement and learning outcomes has been profound. Students, through access to these tools, have demonstrated increased motivation, as technology often provides a more interactive and personalized learning experience. Moreover, these tools cater to diverse learning styles, enabling students to learn at their own pace and in their preferred mode. The ability to practice, compose, and collaborate in a digital environment has enhanced creativity and critical thinking skills while offering immediate feedback, thereby improving learning outcomes.

The subsequent sections of this chapter will delve deeper into specific examples of software applications and digital platforms, showcasing their functionalities, benefits, and their role in transforming the landscape of music education. The analysis will focus on empirical evidence and case studies that highlight the effectiveness of these technological tools in enhancing student engagement and advancing learning outcomes in music education.

4. ACCESS AND INCLUSIVITY IN MUSIC EDUCATION

Technology has played a pivotal role in democratizing access to music education, ushering in an era where geographical barriers and resource limitations no longer pose insurmountable obstacles. This chapter examines how technology serves as a catalyst for enhancing access to music education and its role in fostering inclusivity within this sphere.

The traditional model of music education often presented challenges in terms of accessibility, particularly for individuals in remote areas or those with limited resources. Technology, however, has been a transformative force, offering solutions to these impediments. Online platforms and digital tools have expanded the reach of music education, allowing students to access a wide array of resources, tutorials, and virtual classrooms regardless of their physical location. This shift has not only broadened the horizons of learning but also facilitated access to expert guidance and diverse musical experiences for students who might have otherwise been isolated from such opportunities.

Furthermore, technology has been instrumental in making music education more inclusive. It has provided avenues for students with disabilities or limitations to participate fully in music learning. Adaptive technologies and specialized software have empowered individuals with diverse needs to engage with music in ways that were previously challenging or impossible. This inclusive approach has significantly broadened the scope of music education, allowing a wider spectrum of learners to actively participate and contribute to the musical landscape.

Case studies provide vivid illustrations of technology's impact on breaking barriers in music learning. These examples demonstrate how technology has empowered individuals from various backgrounds, abilities, and circumstances to engage in music education. Whether through virtual learning environments, adaptive instruments, or online collaborative platforms, these case studies showcase how technology has not only facilitated access but also fostered an inclusive environment where all learners can thrive.

The subsequent sections of this chapter will delve deeper into specific case studies and examples that illustrate the profound impact of technology in enhancing access and inclusivity in music education. Through these case studies, we aim to highlight the transformative power of technology in breaking down barriers and creating a more inclusive space for diverse learners in the realm of music education.

5. BLENDED LEARNING AND ONLINE MUSIC EDUCATION

The proliferation of online education has significantly transformed the landscape of music instruction, giving rise to new paradigms in teaching and learning. This chapter examines the rise of online music education, explores the advantages and challenges of blended learning in the context of music education, and evaluates the effectiveness of online platforms in teaching various aspects of music.

The rise of online music education has been a pivotal development, offering unprecedented accessibility and flexibility. Advancements in technology have facilitated the creation of virtual classrooms and online platforms dedicated

to music education. These platforms provide access to a wealth of resources, including video tutorials, interactive lessons, and live sessions with instructors, enabling students to engage with music theory, instrument lessons, and ensemble practices from virtually anywhere with an internet connection.

Blended learning, combining both traditional face-to-face instruction and online components, has emerged as a popular and effective approach in music education. This method offers the advantages of flexibility, personalized learning, and access to a vast array of resources. However, it also presents challenges such as maintaining student engagement, ensuring quality interactions between teachers and students, and balancing the integration of online and offline components effectively.

Online platforms have proven to be effective in teaching various elements of music. They provide interactive modules for music theory, allowing students to learn at their own pace while receiving immediate feedback. Instrument lessons, once confined to in-person instruction, have transitioned successfully to online platforms, utilizing live streaming, pre-recorded lessons, and interactive interfaces to facilitate learning. Moreover, ensemble practices have found a place in the online sphere, where students can collaborate, rehearse, and perform together in virtual environments.

The subsequent sections of this chapter will delve deeper into the advantages, challenges, and effectiveness of blended learning in music education, focusing on the innovative ways online platforms are utilized to teach music theory, instrument lessons, and ensemble practices. Through examining specific examples and case studies, this chapter aims to illuminate the evolving landscape of music education and the efficacy of online platforms in providing a comprehensive learning experience for aspiring musicians.

6. INNOVATIVE APPROACHES AND FUTURE TRENDS

The intersection of technology and music education continues to evolve, ushering in a wave of innovative approaches that hold the potential to redefine the learning experience for aspiring musicians. This chapter explores cutting-edge technologies and their promising applications in music education, particularly focusing on AI, virtual reality (VR), augmented reality (AR), and predicts future trends with significant implications for the field.

Cutting-edge technologies, notably artificial intelligence (AI), have begun to make substantial inroads into music education. AI's applications range from personalized learning experiences to intelligent music composition and analysis tools. AI-powered platforms offer tailored learning paths, adapting to students' individual needs, styles, and paces of learning. Moreover, AI-driven music creation and analysis tools have the potential to revolutionize how music is composed, evaluated, and studied.

Virtual reality (VR) and augmented reality (AR) technologies have also begun to demonstrate their potential in reshaping music education. VR immerses students in simulated environments, offering interactive experiences such as virtual concerts, instrument simulations, and immersive music theory lessons. AR supplements the physical world with digital overlays, enabling students to interact with virtual

objects, notes, and instructional content overlaid onto the real world, enhancing their learning experiences.

The future trends in music education are poised to be shaped by the continued evolution and integration of these cutting-edge technologies. AI, VR, and AR are likely to become more deeply embedded in pedagogical practices, offering more personalized, immersive, and engaging learning experiences for students. These technologies are expected to expand accessibility, break geographical barriers, and provide innovative tools for teaching and learning music.

This chapter will further examine the potential of AI, VR, and AR in teaching music, showcasing current applications and exploring their future trajectories. By analyzing the trends and possibilities offered by these emerging technologies, it aims to offer insights into the transformative potential of these innovations in the realm of music education, laying the groundwork for a more interactive, personalized, and immersive learning environment.

7. CHALLENGES AND CONSIDERATIONS

The integration of technology into music education brings forth a myriad of opportunities but is also accompanied by a set of challenges that demand careful consideration. This chapter identifies and discusses the challenges in implementing technology in music education, delves into ethical considerations and potential pitfalls, and proposes strategies to overcome obstacles while maximizing the benefits of technology.

Challenges in implementing technology in music education encompass various aspects. Access disparities remain a significant concern, as not all students or educational institutions have equal access to the necessary technology and resources. Additionally, resistance to change among educators or institutions, coupled with insufficient training in utilizing technology for music education, poses hurdles in effectively integrating these tools into the curriculum.

Ethical considerations in technology-assisted music education involve concerns about data privacy, digital rights management, and equitable access. Issues related to ownership of digital content, copyright, and the ethical use of technology in music creation and distribution are pivotal to address. Moreover, there is a risk of overreliance on technology, potentially diminishing the development of critical musical skills and creativity in students.

Strategies to overcome these challenges and maximize the benefits of technology in music education are crucial. Providing adequate training and professional development for educators is essential to enhance their confidence and skills in integrating technology into their teaching methods. Promoting equitable access to technology and resources, perhaps through collaboration between institutions and governmental support, is fundamental in ensuring all students have equal opportunities.

Moreover, integrating ethical education into music technology curriculum can foster responsible and respectful use of technology among students. Encouraging a balance between traditional methods and technological tools is vital to ensure students acquire both foundational musical skills and

technological proficiency without sacrificing one for the other.

This chapter will further explore these challenges, ethical considerations, and strategies through in-depth analysis and case studies. By examining these aspects, it aims to provide a comprehensive understanding of the obstacles posed by technology in music education and propose viable strategies to harness its benefits while addressing the associated challenges.

8. CONCLUSION

In the wake of the dynamic integration of technology into music education, this chapter provides a comprehensive synthesis of key findings, reflections on the overall impact of technology, recommendations for stakeholders, and closing remarks that underscore the evolving landscape of music education in the digital age.

The exploration of technology's influence on music education has unveiled a transformational journey. Throughout this analysis, several key points and findings have surfaced. Technology has democratized access, broadened opportunities, and redefined pedagogical methods in music education. Software applications, online platforms, and innovative technologies have enhanced student engagement, expanded inclusivity, and facilitated creative expression.

The overall impact of technology on music education has been profound. It has empowered educators and students with a diverse array of tools, enabling personalized learning experiences and fostering collaborative environments. Technology has not only augmented traditional teaching methods but has also created new pathways for learning, composition, and performance.

For educators, policymakers, and stakeholders, recommendations stem from a nuanced understanding of the opportunities and challenges posed by technology in music education. Encouraging professional development, promoting equitable access to technology, and integrating ethical considerations into curricula are pivotal steps. Balancing the integration of traditional methodologies with innovative tools and fostering a balance between foundational musical skills and technological proficiency is essential for a well-rounded music education.

Looking forward, future research in music education should focus on continually adapting to technological advancements, exploring the impact of AI, VR, AR, and other emerging technologies. This entails comprehensive studies that assess student outcomes, engagement, and creativity in technologically integrated music education settings.

In conclusion, the evolving landscape of music education in the digital age signifies a paradigm shift that demands a delicate balance between tradition and innovation. Technology, when integrated thoughtfully, offers an

expansive canvas for creative exploration, inclusive learning environments, and boundless opportunities. The journey ahead requires a commitment to leveraging technology's potential while preserving the essence of music education, ensuring a vibrant and comprehensive learning experience for all aspiring musicians.

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