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Wearable Basketball Dribbling Gesture Detection Method

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Abstract: *This utility model reveals a wearable gesture-detection system for basketball dribbling that consists of a motion-sensing glove and a gesture-detection terminal. The gesture detection terminal comprises a Bluetooth signal receiver, the main Arduino controller, buttons, a power source, and a display screen. This technique provides a practical and valuable supplemental tool for basketball training and performance improvement by precisely capturing gesture movements during dribbling. Athletes can track and evaluate their dribbling motions in real time using the motion-sensing glove and terminal, leading to more accurate technique correction and progress. Basketball players will have improved training and performance opportunities thanks to this wearable, which will actively advance the sport.*

Keywords: *Wearable Basketball, Gesture Detection, Motion-sensing Glove, Training Enhancement, Real-time Monitoring*

1. Introduction

Basketball, a popular sport, has a fundamental ability known as dribbling. Dribbling includes controlling the ball with the fingers rather than the palm. The palm stays open during the dribbling process, and the fingers bend downward according to the height of the ball, which is helped by bending the palm joints. Furthermore, good dribbling requires strong bending of the fingers while preserving the stability of the other two joints and synchronizing the strength of all the fingers. Many novices, however, fail to master the precise finger movements necessary for efficient dribbling. Incorrect finger joint movements are typical, resulting in awkward dribbling or sometimes hitting the ball with the palm. In this context, the ongoing growth of electronic technology provides a possibility to address this issue.

This breakthrough presents a unique wearable basketball dribbling gesture-detecting technique and device. Using advanced sensors and processing technologies, it seeks to record finger joint motions while dribbling in real time and give feedback and ideas via data analysis. The technology can determine if a player's finger motions during dribbling are exact, assisting beginners in correcting incorrect finger joint actions and improving the precision and fluidity of their dribbling skills. In essence, this idea tries to build a unique basketball dribbling gesture-detecting technique and system using contemporary electrical technology. Athletes may obtain real-time insights about the status of their finger joints during dribbling using wearable sensors and processors, improving their abilities, increasing training outcomes, and pushing the growth of basketball skill training.

Specifically, the primary issue addressed by this method is the requirement for exact and real-time evaluation of dribbling activities in order to improve players' proficiency. In answer to this problem, the study's thesis focuses on creating and applying a programmable motion-sensing glove. This wearable device records the nuances of dribbling movements in less than 10 seconds as participants don the glove and initiate dribbling actions. A painstakingly developed linkage system converts the glove's sliding resistance into electrical signals representing finger movements. These signals are then wirelessly transferred to a computer for Bluetooth processing.

The convergence of Arduino technology is also critical in this strategy, quickly processing the temporal data of finger motions and angular velocities. This analysis culminates in graphical representations shown on a screen, providing a detailed depiction of dribbling motions. This study bridges the gap between traditional basketball training and the possibility of real-time, data-driven dribbling skill modification by seamlessly integrating wearable technologies, motion monitoring, and data processing. Finally, this system can potentially change how athletes approach basketball skill

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development, ushering in a new era of informed and optimal training paradigms.

2. Literature Review

Wearable technology has attracted substantial attention in numerous sports applications in recent years, with the goal of improving athlete performance and training. As a highly dynamic sport, basketball has witnessed a surge in interest in the development of wearable gadgets that can precisely detect and analyze players' dribbling movements. This literature review examines present research on wearable basketball dribbling gesture recognition technologies, emphasizing their technological breakthroughs, benefits, limitations, and potential implications for athlete training and performance development.

Diverse methodologies have been investigated by researchers in order to develop wearable devices for basketball dribbling gesture detection. Hoelzemann et al. developed a wearable sensor-based system that tracks hand movements during dribbling and provides real-time player tactics feedback [1]. Trigueiros et al. expanded on this notion by incorporating machine learning algorithms for gesture detection, gaining more accuracy in distinguishing different dribbling patterns [2]. Wearable gesture detection technologies provide numerous benefits for athletic training. Players can receive insights into their dribbling techniques with real-time monitoring and feedback, allowing quick adjustments and improvements. According to Gundersen et al., this fast feedback loop can speed the learning process and improve muscle memory, enhancing dribbling skills.

Furthermore, because of their portability and simplicity, these wearables allow athletes to engage in individualized training sessions outside of typical practice environments [3]. Despite their promising uses, wearable basketball dribbling gesture recognition technologies have some drawbacks. Because of the complexities of hand posture and motion, Pernigoni et al. stressed the difficulty of accurately identifying sophisticated dribbling actions such as crossovers and spin moves [4]. Furthermore, battery life and comfort limitations in wearable devices continue to be issues that limit lengthy usage during training sessions.

The development of wearable basketball dribbling motion detection systems offers excellent promise for sports training and performance enhancement in the future. Researchers are looking at how augmented reality (AR) and virtual reality (VR) interfaces might be used to provide more immersive and engaging training experiences. Furthermore, advances in downsizing and energy-efficient sensor technologies are expected to overcome present device size and battery life restrictions, improving these wearables' overall usefulness and practicality. Finally, wearable basketball dribbling gesture detection systems represent a significant advancement in sports technology. These methods provide real-time feedback, customized training possibilities, and seamless interaction with sports analytics, all of which contribute to improved athlete performance and the refinement of essential abilities. While issues such as gesture complexity recognition and device comfort remain, continued research and innovation are ready to address these deficiencies, paving the way for an exciting new era of basketball training and comprehensive player development.

3. Operational Procedure

The suggested approach for recognizing basketball dribbling movements consists of a sequence of connected processes that balance wearable technology with advanced processing. The full method of employing this system is outlined in the following operational procedure and Figure 1.

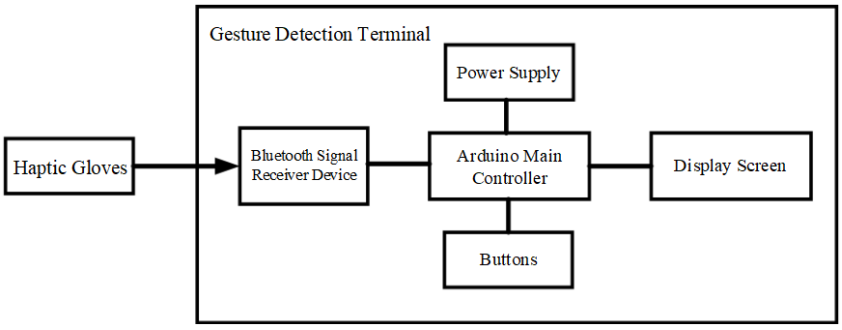

Figure 1: Main Controller Program Flow

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1) Participant Preparation and Wearable Configuration: The basketball player begins by donning the motion-sensing glove, especially the "Open Source Motion-Sensing Glove" produced by Shenzhen Huanyu Technologies Co., Ltd. This wearable glove, known for its precision and accuracy, allows real-time monitoring of hand motions during dribbling.

2) Data Transmission through Bluetooth: The motion-sensing glove conveys hand motion information through Bluetooth. This wireless transmission guarantees that the user's finger motions are correctly caught and relayed for further analysis.

3) Reception of Bluetooth Signals and Data Acquisition: The Bluetooth signal receiver interface at the gesture detection terminal, connected with an Arduino main controller or a similar microcontroller board, awaits the incoming hand motion data from the motion-sensing glove. The system's architecture smoothly combines the acquired data, laying the groundwork for further analysis.

4) Beginning Data Analysis: After successfully receiving the gathered hand motion data, the following step is to hit the corresponding button on the gesture detection terminal. This operation instructs the central controller to analyze the received hand motion data. Deciphering the various finger movements that comprise basketball dribbling gestures is essential at this level.

5) Analyzed Results Processing and Display: The primary controller processes the data and methodically interprets and decodes the complicated array of hand motions gathered during dribbling. When the analysis is finished, the results are shown clearly on the integrated display screen. This dynamic display gives users instant feedback on the quality and accuracy of their dribbling methods.

6) Adjustable Detection Timeframe: Adjusting the detection timeframe can accommodate individual preferences and training requirements. The default setting of 10 seconds allows you enough time to collect and evaluate a wide range of dribbling movements.

7) Results Presentation in Real Time: The real-time presentation of the evaluated data on the display screen is the climax of this complicated procedure. Athletes can quickly see the complexities of their hand gestures, allowing for exact technique evaluation and skill enhancement.

This operational process is a comprehensive way to identify basketball dribbling movements. The combination of wearable technology, a motion-sensing glove, an Arduino main controller, and a display screen results in a dynamic system that allows sportsmen to get insights into their dribbling methods. This technique dramatically increases the possibility for informed training, which leads to increased basketball abilities and performance.

4. Methodology of Implementation

The "Open Source Motion-Sensing Glove" created by Shenzhen Huanyu Technologies Co., Ltd. is fundamental to the implementation. This glove is a vital link between the athlete's physical movements and the following data analysis. As seen in Figure 2, this motion-sensing glove provides real-time communication by utilizing the power of Bluetooth connectivity, transferring precise finger joint motion data and complete hand joint motion data. These data streams form the foundation for future assessment and feedback procedures. Through a dual-pronged technique, the motion-sensing glove catches the intricacies of movement. The finger joint motion data includes the subtle angles created at each finger's junction with the hand. This extensive data collection provides a multidimensional view of the interaction between hand and finger motions.

Furthermore, as shown in Figure 3, the hand joint data records the spatial angles of the wrist along the X, Y, and Z axes. This three-dimensional perspective offers a comprehensive view of the athlete's hand posture throughout dribbling. This entire data-collecting procedure moves at an astounding rate of 20 frames per second, delivering an unrivaled degree of accuracy and precision. Bluetooth technology is used to transfer data from the motion-sensing glove to the gesture-detection terminal. Each data frame sets off on a wireless voyage, navigating the complex network of connections to its destination in the terminal. The Bluetooth signal receiver in the terminal functions as a vigilant element, consistently prepared to receive and process incoming data frames in real time.

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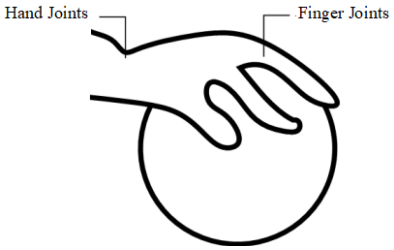

Figure 2: Information description of collection points of somatosensory gloves

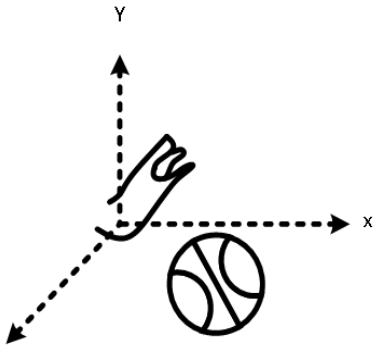

Figure 3: Description of Wrist Spatial Angle

The Arduino main controller functions as the central hub of the system, overseeing and coordinating all operations with a guiding authority. It may easily collect the inbound data frames thanks to its serial connection with the Bluetooth signal receiver. The subsequent data processing and extraction process is painstakingly carried out to get relevant insights. The assessment of angular velocities is crucial to the study. The Arduino main controller dissects the five-finger joint angles and the hand-wrist spatial angles for each data frame received. A complicated algorithm created with accuracy and understanding examines these angles. The controller efficiently estimates the angular velocity of the finger joint motions by methodically comparing the present angles with their preceding values. This estimated angular velocity is then compared to a preloaded dataset of ideal angular velocity fluctuations. This dynamic analysis concludes with a decision of whether the athlete's gestures meet the predetermined requirements.

The main control unit of the Arduino is triggered through a precisely timed cycle. Each cycle lasts 10 seconds and is initiated by pushing the corresponding switch. This signalizes the start of the complicated set of operations included within stages 8 through 13. The display panel transforms into a doorway into the system's activities throughout the detection cycle, providing real-time insights and status updates. The screen displays a clear and educational prompt prior to the detection procedure, showing that the system is ready for action. In Figure 4, the screen changes as the detection cycle progresses, indicating the current detection status in a visual language that the athlete can quickly understand. A countdown meter that ticks in sync with the detection process increases the athlete's involvement by establishing a rhythmic cadence for the assessment trip. The display panel transforms once again at the end of the detecting cycle. This time, it delivers the substance of the analysis: a definite judgment conclusion. This concise portrayal provides athletes with rapid feedback on the efficacy of their dribbling motions.

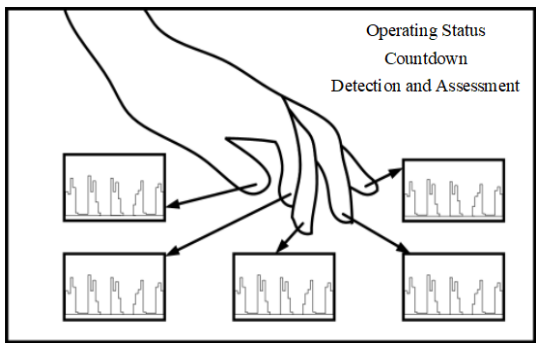

Figure 4: Description of Display Screen Presentation Method

The execution of the wearable gesture detection system amalgamates cutting-edge technology and

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practical application. This intricate interplay of motion-sensing gloves, Bluetooth connectivity, Arduino main controllers, and display panels signifies a transformative evolution in the realm of basketball training. Athletes are enabled to engage in a continual cycle of refinement, improving their dribbling methods and performance capabilities, thanks to real-time insights and dynamic feedback. This system exemplifies the marriage of cutting-edge technology with the quest for sports achievement, placing itself as a trailblazer in the evolution of basketball skill development.

5. Conclusion

In summary, the newly developed wearable gesture detection system represents a significant advancement in the fusion of cutting-edge technology and athletic training. This creative integration of Bluetooth connectivity, Arduino main controller, display screen, and motion-sensing glove offers a fresh method for improving basketball dribbling abilities.

Through real-time data transfer, athletes get insights into their finger and hand motions while dribbling. The system's careful analysis of angular velocities compared to ideal values provides athletes with helpful feedback for improving their technique. This continuous cycle of assessment and correction promises to elevate individual skill levels and overall performance standards. Additionally, the integration of wearable technology into basketball training provides a concrete connection between academic understanding and real-world application. Real-time interaction between athletes and their performance can encourage an iterative improvement approach. A dynamic and immersive training experience is also made possible by the system's user-friendly interface and rapid visual feedback.

Technology plays a pivotal role in pushing boundaries as the sport evolves. The presented technology has the potential to revolutionize basketball training methods, equipping athletes with the essential tools to master dribbling skills. Positioned as a fundamental pillar in the growth of basketball players, this technology opens avenues for personalized training routines, skill refinement, and real-time performance assessment. The wearable gesture detection technology transcends conventional training paradigms, ushering in a data-driven, targeted skill enhancement era. This juncture marks the inception of a new epoch in athletic training, where the fusion of technology and sports leads to informed analysis and rapid feedback. With its transformative capabilities, this system redefines the trajectory of sports training and empowers players to excel in their pursuits.

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