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Analysis of the prospective application of artificial intelligence in swimming

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Abstract. Swimming has consistently maintained its status as a highly favored athletic pursuit for a span of one hundred years. In contemporary times, the burgeoning field of artificial intelligence (AI) has exhibited notable advancements, resulting in significant impacts across all domains. Examples of industries include finance, the service industry, and engineering. Furthermore, it has been implemented in various other sports previously. Presently, a predominant focus of scholarly inquiry is in the exploration of artificial intelligence (AI) applications within the realm of team sports, including disciplines such as basketball, volleyball, and rugby. Nevertheless, swimming shares certain characteristics with the aforementioned sports. In order to enhance the advancement of the swimming domain through the utilization of artificial intelligence (AI) technology, this essay will examine the feasibility of implementing certain AI applications that have been employed to support other sports, and will also introduce several AI technologies that have the potential to make distinctive contributions to the field of swimming.

Keywords: Artificial Intelligence, Sport, Swimming, Neural Networks, Pattern Recognition.

1. Introduction

In a general sense, artificial intelligence (AI) is predicated on the concept of replicating human behaviors and skills, including cognition and learning. The subject matter pertains to the advancement of intelligent agents or computers capable of acquiring, simulating, and utilizing information, analytical abilities, and professional competence to proficiently address intricate problem-solving tasks [1]. The principal aim of artificial intelligence (AI) is to develop and design systems that possess the ability to emulate human intelligence, with the purpose of offering support and solutions across a wide range of problem-solving fields.

The discipline of sports biomechanics allows for the collection of a diverse set of variables pertaining to human motion. However, in order to effectively analyze this data, it is imperative to incorporate principles from the field of information science. Hence, the integration of biomechanics and information science is crucial for the purpose of comprehending the biomechanical implications of the findings and utilizing information processing technologies to analyze the data. Our foremost objective is to optimize the utilization of AI platforms for conducting thorough assessments of athletes' training advancements. The process of monitoring information in swimming enables the precise replication of an athlete's technical motions at every level. Therefore, the establishment of a training guiding system based on big data emerges as a pivotal objective. The effective processing system for motion information necessitates

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technological assistance in the form of data pretreatment, feature extraction, classification decision-making, and information fusion.

Currently, artificial intelligence approaches have predominantly been employed in abstract and specialized domains. However, there is a limited body of research on the practical applications of artificial intelligence (AI), particularly in the context of swimming. In the realm of swimming, particularly in the context of competitive swimming, the significance and urgency of quantification and intellectualization have increased [1]. These factors play a crucial role in various aspects such as aiding in the development of training regimens, reducing the risk of injuries, and arranging events. Therefore, it is imperative to allocate greater emphasis towards the utilization of artificial intelligence (AI) in the field of swimming, as this has the potential to significantly enhance the progress of the swimming business.

The objective of this study is to examine prospective avenues for the implementation of artificial intelligence (AI) in the domain of swimming. This analysis is grounded in an exploration of existing AI applications in various sports disciplines, as well as an assessment of prevalent AI technology. This paper discusses recent studies that demonstrate the utilization of artificial intelligence (AI) in the context of intelligent wearable devices, swimming scheduling systems employing AI technology, and life-saving monitoring systems [2]. This paper will utilize the third option as a case study, demonstrating its functionality and potential constraints. The potential resolutions will also be elucidated.The purpose of this work is to identify prospective applications of artificial intelligence in the subject of swimming, with the aim of inspiring future research in this area. Additionally, the findings of this study may have implications for the application of artificial intelligence in other domains.

2. Swimming chatbot

The concept of the swimming chatbot was conceived based on KAI, a foundational technology utilized by the Sacramento Kings of the National Basketball Association (NBA), in conjunction with ChatGPT. The KAI chatbot functions within the Facebook Messenger platform, offering timely responses to requests from fans. It provides many types of information, including as the historical background of the franchise, up-to-date team statistics, facts about the team roster, and specific information about the Golden 1 Center, which serves as the home venue for the Sacramento Kings [3]. Ryan Montoya, the Chief Technology Officer of Kings, has declared his dedication to utilizing technology in order to improve the fan experience. However, specific details on user numbers and strategic objectives for the chatbot are currently undisclosed. According to assertions put up by the franchise, Golden 1 Center is regarded as the arena with the highest level of technological advancement and sustainability globally.ChatGPT is an AI language model tool that has been developed by OpenAI and is characterized by its exceptional capabilities. The framework employed is the Generative Pre-trained Transformer (GPT). This highly potent instrument facilitates interaction with machines and operates as a language model chatbot. The system's notable capacity to participate in organic conversational discourse enables it to deliver responses that resemble those of a human [4]. ChatGPT utilizes advanced methodologies in natural language processing (NLP) to comprehensively comprehend and provide intelligent responses to user inquiries. The system has been specifically engineered to engage in interactions with individuals in a manner that is both natural and intuitive. ChatGPT possesses a comprehensive training regimen that encompasses a wide range of textual data. As a result, it is capable of furnishing information on a multitude of subjects, responding to inquiries, offering suggestions, and participating in informal dialogues. Furthermore, its proficiency and pertinence are consistently enhanced by ongoing refinement. The latest iteration of ChatGPT is GPT-4, which signifies OpenAI's state-of-the-art artificial intelligence technology. In contrast to its predecessor, GPT-3.x, GPT-4 demonstrates a wider scope of general knowledge and improved capabilities in problem-solving. Indeed, GPT-4 demonstrates a substantial improvement in AI technology, as it exhibits an approximate accuracy that is approximately 500 times greater than that of GPT-3.x.

The key shared characteristic observed in both conversation models is the utilization of pre-training techniques. In the domain of artificial intelligence (AI), the term "pre-training" pertains to the initial

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stage of model training. During this phase, a substantial dataset is employed to gather general features or representations. During this phase, the model is exposed to a substantial quantity of unlabeled data, which allows it to effectively capture the underlying patterns and structures present within the data. Simultaneously, two occurrences embrace the concept of transfer learning. Transfer learning is a fundamental principle within the field of machine learning, wherein the utilization of previously acquired information and experience from performing one specific job is employed to enhance the performance of a distinct yet interconnected activity. Transfer learning enables the application of previously acquired knowledge from one domain to another, hence obviating the need to commence problem-solving endeavors from the ground up for each distinct task. Transfer learning is a concept rooted in the notion that models that have been trained on extensive datasets for a specific task have gained features that can be applied to other similar tasks in a generalizable manner. By leveraging pre-trained models as an initial foundation, one can effectively reduce the time, computational resources, and training data necessary for constructing proficient models.

The process of transfer learning generally consists of two main stages: pre-training and fine-tuning. During the initial training phase, a model undergoes training using a substantial dataset with the objective of accomplishing a certain job, such as the classification of images. The initial training phase facilitates the acquisition of general features by the model, which are applicable to a wide range of images. Subsequently, during the fine-tuning phase, the pre-existing model undergoes adaptation or refinement by utilizing a reduced dataset that is tailored to the precise objective of the work at hand. This procedure facilitates the acquisition of task-specific knowledge by the model while preserving the knowledge acquired during the pre-training phase. The design of the Swimming chatbot would incorporate state-of-the-art artificial intelligence techniques and be developed to respond to inquiries pertaining to the fundamentals of swimming exercise, build customized training plans, and enhance ways for proficient movement and physical fitness based on specialized inputs. The rationale behind the inclusion of these functionalities in the chatbot is rooted in the constraints faced by many novice individuals upon their entry into society, namely the scarcity of both time and financial resources to engage in an extensive swimming training program. The utilization of the Swimming chatbot enables individuals to engage in self-correction of swimming movements and self-directed training.

While imperfections are present in this chatbot. Initially, it is important to note that while users theoretically have the ability to obtain solutions by posing inquiries to the chatbot, a significant portion of them have difficulties in effectively articulating their problems just through textual means. In this scenario, it is possible for the responses to questions to be lacking in accuracy. The potential resolution of this challenge may arise with the development of a sophisticated artificial intelligence methodology that possesses the capability to effectively process video-based data [5].

3. Movement monitor

Swimming is widely acknowledged as a complex exercise, necessitating the acquisition of precise movement techniques by swimmers at all skill levels, a viewpoint held by other experts [6]. The utilization of AI technology has the potential to be employed in the monitoring of motions within the context of digitization and quantification. This application can provide a more dependable foundation and point of reference for swimmers and coaches, enabling them to optimize the entirety of the motion process. Consequently, this can successfully enhance their skills and ensure their overall improvement [6]. Currently, artificial intelligence (AI) has found utility in the domain of diving, an aquatic sport. The Chinese national diving team has incorporated 3D+AI technology into their everyday training regimen to enhance the effectiveness and relevance of their workouts. The process involves capturing the complete trajectory of an individual's dive and transforming it into a three-dimensional virtual representation. In the present study, the process of disassembling and categorizing a comprehensive motion will be undertaken utilizing artificial intelligence methodologies, such as Convolutional Neural Network and Markov Decision Process, among others. The parameters of each section of the motion will also be indicated. Given the fast-paced nature of diving as a sport, with a mere two-second duration from the initiation of the leap to entering the pool, and the inherent complexity of movements executed

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in mid-air, the utilization of three-dimensional (3D) technology in conjunction with artificial intelligence (AI) holds potential to aid coaches and athletes in analyzing the intricate nuances of motion. This technological integration can facilitate the identification of areas requiring refinement, enabling athletes to rectify their movements and ultimately enhance their overall athletic performance.

Diving and swimming exhibit commonalities in terms of technique and physical requirements. Both activities require individuals to maintain a streamlined body stance in order to reduce drag, while also placing emphasis on breath control throughout execution. Rhythm and coordination are essential elements in aquatic sports, as swimmers must synchronize their strokes, kicks, and breathing patterns, while divers must coordinate their motions with precision for optimal performance. When considering the physical requirements, it is essential to note that both diving and swimming place a significant emphasis on cardiovascular endurance. However, it is important to highlight that diving requires short but intense bursts of energy during aerial movements. Muscular strength and power are essential factors for propulsion, although flexibility and range of motion also contribute significantly to this process. The comprehension of these common characteristics strengthens our understanding of the interrelatedness among different water-based activities, emphasizing the significance of skill mastery and attaining ideal physical condition to achieve exceptional performance.

Given the significant overlap in characteristics between diving and swimming, it is plausible to employ similar methodologies for monitoring swimming movements. The crucial component of the monitoring system involves the identification and detection of swimmers' strength data. When the fuzzy minimum-maximum neural network is utilized for pattern classification, the outcome is characterized by increased flexibility and generality in comparison to conventional classification methods that do not incorporate artificial intelligence techniques. Furthermore, each pattern will be accompanied with assigned qualities, so offering precise movement data to coaches and swimmers alike.

One limitation of the movement monitor is its lack of user-friendliness for novices and amateurs, as the output it provides may be too raw and difficult to comprehend for individuals without professional expertise in the field. The incorporation of a comprehensive judicial system encompassing all patterns of movement shows potential as a viable avenue for advancement. However, given the current state of artificial intelligence, its implementation may be momentarily unfeasible.

4. Life-saving monitor system of swimming

It has been established that sports such as basketball and rugby carry a significant risk of injury and accidents [7-8]. Swimming, in fact, is a sport that carries inherent risks and has the potential to lead to serious accidents, such as near-drowning incidents [9]. However, there are currently existing monitoring systems that utilize AI technology, such as neural networks and convolutional neural networks. One example of a life-saving monitoring system has been identified [10]. The intelligent monitoring system designed to prevent loss of life has attracted significant attention from several nations, prompting certain jurisdictions to enforce the compulsory installation of life-saving equipment in swimming facilities. The present system employs waterproof cameras strategically positioned within the pool to capture pertinent images and data, facilitating wireless alerts for incidents of drowning, while also offering video footage, photographs, and digital data for the purposes of competitive events and training activities. The cameras in place have the capability to identify and determine the whereabouts of anyone within the pool area. In the event that an individual remains submerged in the pool for an extended duration, the system will identify this as indicative of drowning and then activate alarms to alert nearby lifeguards. The hardware utilized in this system consists of several components, including a central control host, video capture card, on-site touch monitor screen, wireless launch and alarm device, drowning accident video and storage system, intelligent life-saving software set alongside auxiliary competition training software, paging vibration device, cable, and embedded parts. The system's hardware is centered around a high-performance computer that is designed to be completely waterproof. Additionally, the hardware incorporates various audio-visual prompts that are capable of providing specific guidance in situations of peril.

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Nevertheless, the inherent constraints of this life-preserving monitoring system are apparent. The recognition accuracy of the system may be influenced by various circumstances, including the quality of water and the presence of bubbles generated by swimmers. Furthermore, the system's efficacy is diminished as it solely provides alerts once an individual is already in the midst of drowning and has descended to the depths, hence exacerbating the severity of the drowning situation. These limitations could be addressed through the implementation of ongoing training for the recognition component of individuals utilizing low-resolution photographs of swimming individuals, with the aim of identifying swimmers under conditions characterized by significant amounts of interference. Furthermore, the monitoring system has the capability to identify instances of drowning by employing a method of distinguishing between individuals engaged in regular swimming activities and those who are drowning, based on visual analysis of images.

5. Conclusion

The paper initially presented the concept of artificial intelligence (AI) and subsequently elucidated the significance of AI technology in the context of swimming. It proceeded to evaluate prior studies pertaining to AI in swimming and conducted an analysis of potential applications of AI in terms of swimming chatbots, movement monitoring, and life-saving monitoring systems. This analysis was conducted by considering prevailing AI techniques and previous applications in other sports. The functions, limitations, and potential solutions of these applications were also examined. It has been observed that contemporary advanced artificial intelligence systems continue to fall short in meeting all the necessary criteria within the domain of swimming. When the availability of sources and the scope of investigation are restricted, the outcome is likely to exhibit a decline in alignment with reality. The integration of additional research, refinements, and technological progress facilitates the implementation of an advanced coaching system that offers timely evaluation and feedback resources for both professional and amateur athletes, as well as coaches. This would provide significant benefits for both inexperienced swimmers and experienced those with expertise in swimming in pools.

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