The Application of 5G Network Technology in the Innovative Development of Physical Education

ZhiAng Wang

Sports College, Pingdingshan University, Pingdingshan, Henan 467000, China

Correspondence should be addressed to ZhiAng Wang; 2010037@qhnu.edu.cn

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The rapid development of information technology is changing people’s work, learning, and lifestyle and bringing new development space to education. Physical education is an important component of the university education system. The goal of physical education is to increase the physical fitness of the students and promote their advancement. In the context of the recent evolution of the social economy, the fifth-generation (5G) network technology is increasingly being deployed in many fields which may assist students to actively partake in physical education and promote successful physical education development. This study proposes an innovative framework based on 5G network technology for the development of physical education. The Internet of Things (IoT) technology is used to achieve long-term data collecting and real-time data monitoring, and a unique cuckoo search firefly optimization algorithm (CSFOA) is presented to improve data transmission efficiency. The performance of the system is assessed in terms of accuracy, energy efficiency, security level, error rate, and student satisfaction, respectively. Results confirm that the proposed system has certain practical effects and has the potential to optimize the process of physical education development.

1. Introduction

Students in elementary and secondary schools benefit from acquiring a range of personal and social skills, such as peer connection, social competency, leadership qualities, and problem-solving ability. Students who acquire these personal and social abilities will not only be better learners but they will also have an easier transition to adulthood [1]. Physical education and sports participation can aid in the development of these personal and social skills in children. Physical education’s role in raising children for the demands and challenges of everyday life is gaining popularity. With the advancement of civilization and material standards, most people’s knowledge of physical education and fitness has increased, and they are paying more and more attention to sports, not only in sports contests but also in sports in everyday life [2].

Through the rational and successful educational program, a physical education organization’s goal is to develop a logical and scientific system of knowledge in students’ curricula. Blood flow to the brain increases as a result of physical exercise. It improves brain function, memory, thinking, and cognitive abilities in children, all of which are crucial for their growth. Physical education strives to develop physically, psychologically, cognitively, and socially integrated and productive individuals via natural total-body exercises, which are mostly done during playtime [3]. Physical education has a long history and was developed to fulfill the demands of the community at the time. In the mid-1980s, physical education was still a strong system, and there were multiple conversations on physical exercise, as well as theoretical explanations of exercise techniques and applications [4]. Individuals are becoming more interested in physical activity. When studying, students should not only concentrate on the material contained in books but also learn how to exercise their bodies and engage in physical activities. Sports are extremely vital in everyone’s life to grow morally, academically, medically, as well as physically and cognitively [5].

The widespread use of 5G Internet and wireless communication technologies has resulted in a huge volume of physical education data being stored on the network [6]. The
information is processed using the advanced processing abilities of sensors and computers, and the analysis findings are acquired by comparing with information stored in databases, resulting in more intelligent sports information. In colleges, intelligent sports refer to classes that include the 5G and IoT. It connects to the intelligent terminal using IoT technology to detect the students’ sports situation through sensors and analyzes the data to completely comprehend the athletes’ sports requirements. RFID technology, wireless network technology, sensor technology, human intelligence technology, and cloud computing technology are the primary technologies involved in the 5G and IoT. We can acquire reliable information, reliably transfer it, and access all elements of an athlete’s information using these tools [7].

In this study, a novel framework for innovative development of physical education is proposed based on 5G technology integrated with real-time IoT monitoring of the physical education data. The Internet of Things (IoT) technology is used to achieve long-term data collecting and real-time data monitoring, and a unique cuckoo search firefly optimization algorithm (CSFOA) is presented to improve data transmission efficiency. The proposed model outperformed other state-of-the-art physical education models in terms of performance.

The rest of the manuscript is organized as follows. Section 2 analyzes the related literary works. In Section 3, a detailed description of the proposed method is presented and the CSFOA is described. Section 4 analyzes and compares the performance of the proposed work with the conventional methods. And, finally, Section 5 concludes the overall manuscript.

2. Related Works

The mobile Internet and the IoT are intrinsically linked in future 5G application scenarios. To fulfill the rapidly growing requirements of the mobile Internet and the IoT, the cellular network offers a wide range of access options. Using 5G IoT technology, several scholars have performed relevant investigations on the construction of different physical education indicators. Casey et al. [8] presented a model-based approach (MBP) for physical education and examined the actual and complex issues that come when attempting to achieve, engage with, plan for, and implement a broader, multimodal concept of MBP. Parker et al. [9] reviewed the evidence for self-determination theory in the context of school physical education. They analyzed data from 265 noteworthy articles discovered in extensive research using a multilevel structural equation modeling technique. As expected by the hypothesis, autonomous motivation was positively related to desired results and negatively associated with undesirable outcomes. Both beneficial and detrimental results were somewhat linked with intrinsic management. External regulation and motivation both had negative associations with adaptive results but favorable associations with undesirable outcomes. According to results, the teachers had a greater influence on school experiences of autonomy and competence. Renshaw and Chow [10] proposed a Constraint-Led Approach (CLA), which has arisen as a feasible educational alternative for athletics and physical education teachers and professors. The rise of a CLA to teaching and coaching has coincided with a shift in the current culture, with several researchers adopting intricacies and a more environmentally focused initiative. To construct a physical education system based on machine learning and IoT, Wang and Du [11] used IoT and machine learning to detect athletic training qualities and predict actions, as well as to manage physical education and training information. This research improved the hidden layer mapping and optimization strategies over time to improve prediction performance, addressing various flaws in the original extreme learning machine. Furthermore, this study used IoT to gather data over a long period of time, and once the data has been processed to a particular level, an extreme learning machine is used to determine the status of sports training. The application of virtual reality technology (VRT) in physical education was examined by Gui [12]. They studied 2 groups of freshmen, one of which served as the control group and the other as the experimental group. The control class used VRT to teach aerobics based on current physical education instructions, whereas the experimental group used VRT to teach aerobics based on traditional physical education instructions. Zhao [13] explored the existing challenges in the assessment of physical education instruction in universities and colleges and examined the relevant enhanced procedures. Based on the multiple intelligence theory, build an assessment index system of physical education from all-around factors, i.e., teaching step, teaching and learning step, and managing step, to upgrade the assessment index system of physical education teaching in universities and colleges. A complete fuzzy evaluation method of physical education teaching was presented. The reliability of this method was illustrated in the case analysis section as an effort to successfully assess physical education training. Zeng [14] conducted an in-depth evaluation of the overall assessment of PE teaching impacts in colleges from the perspectives of instructors’ teaching skills and students’ learning impact, combining the hidden Markov model and data mining. This study looked at how data mining technologies and the hidden Markov model may be used to measure physical education instruction quality in universities, and it proposed a mathematical model for evaluating physical education. According to Zhu [15], the application of computer multimedia technology has significant support and relevance for the execution of physical educational reforms. We should make clear the benefits of computer multimedia teaching in the modernization and advancement of physical education in universities and colleges, empirically construct a group of related work application principles, and give full play to its gains, proving more academic value, in linked teaching activities. Physical education is a vital part of the national health program. Improving the science and performance of higher education requires promoting the technological and updated development of physical education curricula in colleges and universities. As a result, 5G must be included in physical education development.
3. Proposed Work

The IoT and 5G technologies have advanced rapidly, particularly in terms of data processing, such as data mining and analysis, which may be applied to a wide range of applications, from face recognition to aircraft carrier production [16]. Through some data gathering devices, it can produce, estimate, capture, and deliver physical education information. In this study, 5G-based physical education teaching method is presented. The schematic representation of the proposed method is depicted in Figure 1.

3.1. Dataset Preprocessing and Normalization. The dataset for physical education is obtained from various universities and colleges. The incoming data are raw and generally contain duplicate packets and incomplete information [17]. It is essential to clean and preprocess the raw data to remove repetitive and duplicate instances as well as incomplete information [18]. Because the datasets for physical education are large, sample size reduction approaches must be used. Since there are so many features in this database, feature extraction tools are required to eliminate those that are not important. During the preprocessing phase, the database was normalized in the range of 0 and 1. The z-score method is used as the first step of the normalization as given in

\[
Z = \frac{R - \alpha}{\omega},
\]

where \(\alpha\) denotes the mean of the data and \(\omega\) indicates the standard deviation. And \(Z\) is expressed as

\[
Z = \frac{R - \bar{R}}{SD},
\]

where \(\bar{R}\) denotes the mean of the sample and SD denotes the standard deviation of the samples.

The random sample is in the form of

\[
Z_k = \beta_0 + \beta_1 R_k + \epsilon_k,
\]

where \(\epsilon_k\) denotes the errors that are dependent on \(\omega^2\). Following that, the errors must not rely on each other, as provided below.

\[
r_k \sim \sqrt{W} \frac{r}{\sqrt{r^2 + \omega - 1}},
\]

where \(r\) represents a random variable.

Next, the standard deviation is computed to obtain the normalized movements of the variable.

The below expression is utilized to estimate the moment scale deviation.

\[
MS = \frac{\lambda_{ms}}{\Omega_{ms}},
\]

where \(ms\) is the moment scale.

\[
\lambda_{ms} = E(R - \alpha)^{MS}.
\]

Here, \(R\) indicates a random variable and \(E\) denotes the expected value.

\[
\Omega_{ms} = \left(\sqrt{E(R - \alpha)^{MS}}\right)^2,
\]

\[
r_w = \frac{ms}{\bar{R}}.
\]

Here, \(r_w\) represents the coefficient of the variance.

By adjusting all of the variables to 0 or 1, the feature scaling method is terminated. This process is known as the unison-based normalizing method. The normalized is computed as shown in

\[
R' = \frac{(r - r_{\text{min}})}{(r_{\text{max}} - r_{\text{min}})}.
\]

After the data has been normalized, it can be saved, and the range and irregularity of the data may be preserved. The purpose of this phase is to minimize or eliminate data delays. The normalized information could then be fed into the future stages as an input.

3.2. Cuckoo Search Firefly Optimization Algorithm. The method employed in this study was constructed by combining the cuckoo search and firefly algorithm, two biologically inspired algorithms. The cuckoo search (CS) is a novel optimization metaheuristic algorithm that is scientifically inspired by cuckoos’ behavior when hunting for nests to lay eggs in. The cuckoo search method is a biologically inspired algorithm that is commonly used in engineering and industry to solve exceedingly complicated optimization issues. There are several publications in the literature that employed this method in its original form, as well as other refinements or hybridizations with other algorithms.

The firefly technique is a biologically inspired optimization technique that emulates the flashing light of a firefly. The cuckoo search firefly optimization method, or cuckoo search firefly optimization algorithm, is a hybrid algorithm that combines the cuckoo search (CS) algorithm and the firefly algorithm (FA). The Lévy flight mechanism is used in both algorithms for the development of new solutions. The key difference between these two algorithms is that the CS approach has a mechanism for eliminating a “bad” nest, which indicates a risk that the program would leave the better path while looking for an optimum solution at some time. It may prolong the time it takes to identify the best solution. The proposed hybrid algorithm depends on the CS algorithm, which incorporates a portion of the FA algorithm. The steps are given Algorithm 1.

3.3. IoT-Based Real-Time Monitoring System. The IoT is one of the most investigated communities in the public sector and industry. Even though many standard Internet interactions
between a limited number of individuals and equipment are facilitated, in this situation, numerous "things" linked to the Internet are connected without computational intelligence or human involvement [19]. Applications for the Internet of Things: the use of the Internet and wireless communication technologies is incorporated into real-time physical education broadcast support and the creation of a functional network. Things have recently become an important aspect of the physical education field’s output. In the physical education sector, a combination of sensor and microcontroller is to be placed, to evaluate and send sensor data to the IoT cloud, and then proceeds to a student. We will also incorporate IoT capabilities into the physical education system for students to better care for them and increase quality and service.

The IoT in physical education may collect data at any time and from any location. It can save and assist the data of thousands of pupils who are controlled by computers. Many sensor components have been made more portable, enabling students to wear devices while being supervised. Physical education monitoring technology is attached to the kids, allowing the instructor to keep an eye on them at all times. The role of students is to assist Internet access via the Internet, allowing physical education to take the appropriate action at the appropriate time for assessment.

The majority of underdeveloped nations have inadequate physical education facilities. It is then determined that connection with the portable device is physically capable of communication for physical education. Students now have access to more affordable mobile communication devices. Student care in the physical education sector is becoming more reliable. Students’ data may be examined and recorded in real time, and teachers can supervise them using a mobile computer.

### 4. Performance Analysis

The performance of the proposed system is analyzed using the MATLAB simulation tool. We also compared the proposed methodology with the existing approaches for physical education. We evaluated the system in terms of accuracy, energy efficiency, error rate, security level, and student satisfaction.

#### 4.1. Accuracy

This metric denotes the effectiveness of the 5G-based physical education system. Figure 2 shows the comparative analysis of the accuracy of the existing and the proposed methods. We compared the proposed physical education system with that of Casey et al. [8], Kang et al. [18], Wang et al.
The proposed system obtained the highest accuracy of 98% as compared to other models.

4.2. Energy Efficiency. Energy efficiency is perhaps the most important element. Physical education offers numerous advantages in schools, including increased student physical health and academic progress. Figure 3 shows the comparative analysis of energy efficiency for the existing and the proposed methods. The proposed physical education was compared with that of Casey et al. [8], Kang et al. [18], Wang et al. [3], and Wen [20], respectively. The highest energy efficiency of 93% was shown by the proposed system.

<table>
<thead>
<tr>
<th></th>
<th>Model-based approach (8)</th>
<th>Virtual reality (18)</th>
<th>IoT-DPARS (3)</th>
<th>Artificial intelligence (19)</th>
<th>5G+Cuckoo search firefly optimization (proposed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy (%)</td>
<td>20</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>120</td>
</tr>
</tbody>
</table>

**Algorithm 1:** Cuckoo search firefly optimization algorithm.

```plaintext
No steps
1 Procedure FF (Nbr_iter: number of iterations)
2 Beginning
3 Generate an initial population of fireflies \( x_i \) (\( i = 1, \ldots, n \))
4 Find the intensities of light \( I_i \) at \( x_i \) via \( f(x_i) \)
5 while (\( t < \text{Nbr}_{\text{iter}} \)) do
6 for \( i = 1 \) to \( n/\)all fireflies
7 for \( j = 1 \) to \( n/\)all fireflies
8 if (\( I_j > I_i \)) then
9 Attractiveness \( \beta_{i,j} \) varies according to the distance \( r_{i,j} \)
10 Move firefly \( i \) to \( j \) with attractiveness \( \beta_{i,j} \)
11 Otherwise, move \( I \) randomly
12 end if
13 Evaluate the new solution
14 Update intensity \( I_i \)
15 Check if \( i \) firefly is the best
16 End \( j \), end \( i \)
17 Find the best firefly according to objective
18 \( t++ \)
19 Fact
20 Creation of an initial population of host nests
21 while the stopping criterion is not satisfied, repeat
22 Generate a cuckoo by Levy flight and evaluate its cost function
23 Randomly select a nest among the host nests, if
24 Replace with this new solution
25 End for
26 A fraction of the worst nests is dropped and others are generated instead, and make a selection
27 Identify the best solution
28 End while
29 End procedure
```

**Figure 2:** Comparison of accuracy (%) for the existing and proposed method.
This confirms that the proposed 5G+cuckoo search firefly optimization is more efficient as compared to other models.

4.3. Security Level. As 5G, data, and IoT threats merge, new and potentially more dangerous security risks emerge. To avoid any vulnerability in the educational system, physical education data must be secured. The level of security of the proposed system is analyzed and contrasted with the traditional approaches. Figure 4 shows the comparative analysis of the security level of the proposed system and the conventional approaches. We compared the security level of the proposed system with the security of the systems developed by Casey et al. [8], Kang et al. [18], Wang et al. [3], and Wen [20], respectively. The proposed system showed the highest security level of 86% as compared to the security levels of the system proposed by Casey et al. [8], Kang et al. [18], Wang et al. [3], and Wen [20] which are 88%, 89%, 91%, and 92%, respectively. This shows that the proposed system is more secure than other models.

4.4. Error Rate. According to the complexity of the curriculum materials and the complexity of the curriculum content of error rate, as shown in Figure 5, students can grasp and acquire the information taught in depth.

Figure 6 shows the comparative analysis of the error rate for the existing and the proposed methods. The proposed model showed the lowest error rate of 6% as compared to the other models.

4.5. Student Satisfaction. The performance of the students is analyzed, and the metric of student satisfaction is compared with the existing methods. Figure 7 shows the comparison of student satisfaction of the proposed method and the traditional approaches. With the proposed physical education system, the student showed the highest satisfaction of 97% as compared to the satisfaction levels of models developed by Casey et al. [8], Kang et al. [18], Wang et al. [3], and Wen [20], respectively.

5. Conclusions

The rapid development of IoT and 5G and network intelligence is altering students’ learning and lifestyles and bringing new development space to education. In this study, a
A novel framework based on 5G network technology with IoT monitoring is proposed for the innovative development of physical education. The quality of the physical education curriculum determines the implementation role that will shape and accomplish physical education results. The Internet of Things (IoT) technology was used to achieve long-
term data collecting and real-time data monitoring, and a unique cuckoo search firefly optimization algorithm (CSFOA) is presented to improve data transmission efficiency. Content standards, evaluation assistance, and sustainability are used to shape the development of innovative physical education programs. Different talents that students must master are mentioned as prerequisites. The proposed model was compared with existing models in terms of accuracy, energy efficiency, error rate, security level, and student satisfaction. The proposed model has the highest accuracy of 98%, 92%, 86%, 6%, and 97%, respectively. The proposed 5G framework for physical education is an effective approach for the development of physical education.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The author declares that there are no conflicts of interest.

References


