

Original Research Article

## Application of Internet of Things in Sports Rehabilitation for Young People

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**Abstract:** Based on the background of sports rehabilitation training, this paper applies Internet of things technology to the sports rehabilitation of teenagers. By developing sensory sensors to monitor sensor terminal nodes, according to the needs of physiological parameters monitoring during rehabilitation training, the parameters of the monitoring system including ECG signal, EMG signal, exercise posture and body temperature were established based on the Internet of things technology. The experimental results show that the system can monitor the changes of the target user's vital signs in real time and provide feedback. These physiological data can be analyzed to help physicians develop effective rehabilitation training programs. To evaluate the recovery of sports ability and training participation, so as to improve the training efficiency and achieve the rehabilitation effect.

**Keywords:** sensor; Internet of things; sports rehabilitation

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### 1. Introduction

The traditional exercise rehabilitation for teenagers is before and after the exercise rehabilitation training for teenagers, rehabilitation physicians use measuring instruments to assess patients' active and passive range of motion and muscle strength recovery based on clinical experience. Throughout the program, the program relied too heavily on the medical expertise and experience of physicians, and throughout the implementation of the youth sports rehabilitation program, there is no accurate and valid data to reflect the fitness of adolescents for sports programs in real time. Therefore, it is urgent to use the exercise rehabilitation training equipment to monitor the patients' body data in real time and reflect the recovery degree of limb motor function accurately and objectively. Internet of things (Iot) technology is a kind of technology which realizes the intercommunication between objects through internet and wireless communication technology. Through various sensors, actuators and network communication devices, it makes objects have the ability of "Perception" and "Interaction", thus realizing the real-time monitoring and intelligent control of the state of objects. The system can analyze these physiological data while monitoring in real time, so that doctors can make effective rehabilitation training programs, accurately evaluate the recovery of sports ability and training participation, and thus improve the training efficiency, achieve the goal of rehabilitation.

### 2. The design of motion rehabilitation system based on Iot

#### 2.1. The selection of Iot wireless network

According to the actual demand, many factors should be considered in the selection of Iot wireless network, this includes network coverage, Data transfer rate, power consumption, security and cost. Here are three common

IoT wireless network technologies.

(1) . WiFi solution: WiFi technology into, can access the public network alone, the cost is relatively low. It is suitable for IoT products that do not require significant power consumption and are not widely deployed.

(2) . Bluetooth solution: suitable for power consumption requirements, and direct interaction with mobile phone IoT products, suitable for the deployment of Bluetooth sensor networks.

(3) . Zigbee scheme: ZigBee technology is relatively mature, the power consumption of the whole system is relatively well controlled. Suitable for possible large-scale deployment of power-sensitive products, such as sensors, wireless switches, smart sockets. Zigbee alone can not access the public network, the need for a gateway to achieve this requirement.

In addition, for remote applications, Lo-RaWan, LTE-M, or NB-IOT are the best options. Lora is a good solution for a local-level medium network that does not require location-based services or NSA-level security. Users can choose the appropriate scheme according to their actual needs and circumstances. The selection of the best wireless network scheme needs to be combined with the actual situation.

## **2.2. Functional design of the exercise rehabilitation system**

The Internet of things plays an important role in the exercise rehabilitation of adolescents by enabling real-time monitoring of their exercise status and body data through a variety of sensors and intelligent devices, so as to provide scientific basis for sports rehabilitation. The following is the functional design of an exercise rehabilitation system.

### **2.2.1. Physical condition monitoring**

Using wearable devices or sensors, real-time monitoring of the physical status of adolescents, including heart rate, blood pressure, body temperature, movement trajectory, and so on. The data will be collected, transmitted and processed through Internet of things technology.

#### **2.2.1.1. Heart rate monitoring**

Heart rate monitoring is an important indicator for assessing cardiac function and exercise intensity. By monitoring the patient's heart rate in real time, we can know the heart's ability to pump blood and the physiological reaction during exercise, and provide accurate guidance for the coach or doctor.

#### **2.2.1.2. Blood pressure monitoring**

Blood pressure monitoring is an important means of assessing the blood circulation and cardiovascular system. By continuously monitoring patients' blood pressure, potential cardiovascular problems can be detected in time and corresponding measures can be taken.

#### **2.2.1.3. Exercise monitoring**

Exercise monitoring can help patients understand their activity levels and daily energy expenditure. By wearing sensors or using a mobile app to record movement data, users can rationalize their training and eating schedules.

#### **2.2.1.4. Body composition analysis**

Body composition analysis is to assess the patient's physical condition and health status by measuring body fat rate, muscle mass, water and other indicators. The results of the analysis can provide a basis for coaches and doctors to make diet plans and rehabilitation programs.

#### **2.2.1.5. Evaluation of fatigue**

Evaluation is an effective method to understand the degree of physical fatigue of patients. By collecting multiple physiological data, the system can comprehensively analyze patients' fatigue status and provide appropriate suggestions to help patients arrange training and rest.

#### **2.2.1.6. Muscle strength testing**

Muscle strength testing is an important means of assessing muscle function in patients. By testing patients' muscle strength and endurance, coaches and doctors can learn about patients' muscle conditions and make training plans accordingly.

### **2.3. Movement data recording and Analysis**

Movement Data Recording and analysis is a key functional module in the movement rehabilitation system. By recording and analyzing the user's motion data, we can better understand the user's motion state and the progress of rehabilitation, so as to provide them with more scientific and effective guidance of motion rehabilitation.

#### **2.3.1. Recording of movement data**

First, in a way that combines wearable devices such as smart wristbands and smartwatches with mobile applications to capture the user's movement data in real time. While wearable devices monitor basic data such as a user's steps, heart rate, and sleep, mobile applications can track a user's movements, duration, and type of activity. Secondly, data storage: the collected motion data is stored in the cloud server for subsequent data analysis and processing. At the same time, users can also view historical movement data in the mobile application, to understand their movement habits and progress.

#### **2.3.2. Movement data analysis**

First, basic data analysis: statistical analysis of basic data such as a user's steps, duration of movement, and calorie consumption, generating various charts and reports, to help users understand their movement status and progress.

Secondly, the movement pattern recognition: through analyzing the user's movement track and movement type, to identify the user's movement patterns and habits, so as to provide them with more personalized sports rehabilitation guidance. For example, gait analysis can be used to assess a user's lower-extremity joint health and develop a rehabilitation program.

In addition, trend prediction: Based on historical motion data, machine learning algorithm is used to predict the user's future movement trend and health status. For example, based on the user's recent sports data, to predict the future whether there is a risk of sports injury, so as to take appropriate preventive measures in advance. Through the design of movement data record and analysis function, the movement rehabilitation system can better understand the user's movement state and the progress of rehabilitation, and provide them with more scientific and effective guidance of movement rehabilitation.

At the same time, this feature also helps to improve user alignment the cognition and understanding of sports, cultivate their sports habits, promote their physical and mental health and all-round development.

#### **2.3.3. The exercise rehabilitation guidance**

Based on the physical condition and exercise data of the Adolescents, and the system provides them with individualized exercise rehabilitation guidance, including adjustment of exercise intensity, action correction, fatigue recovery, etc. The instructions will be presented to teenagers via mobile apps or smart devices.

### **2.3.3.1. Development of training programmes**

Based on the user's physical condition and rehabilitation goals, the system can develop personalized training plan. The plan may include training items, intensity, frequency and time to meet the different needs of users.

### **2.3.3.2. Training methods recommended**

According to the user's physical condition and exercise ability, the system can recommend appropriate training methods, such as strength training, aerobic exercise, flexibility training. At the same time, the system can also provide relevant training skills and notes to help users better training.

### **2.3.3.3. Progress tracking**

The system can track the user's training progress and record the training data so as to understand the user's training status and rehabilitation progress. Based on the tracking results, the system can adjust the training plan to ensure that users can better achieve the rehabilitation goals.

### **2.3.3.4. Health monitoring**

The system can monitor the physical condition of the user in real time, such as heart rate, blood pressure, fatigue degree and so on, in order to detect potential health problems in time. Based on the monitoring results, the system can provide corresponding recommendations and warnings to ensure the safety and health of users.

### **2.3.4. Social interaction**

Social interaction is an important function of sports rehabilitation system, which can help users establish social relationship during the rehabilitation process, increase the fun and motivation of sports, and also provide support and encouragement among users, promote better rehabilitation effects. The following are the specific social interaction functions

#### **2.3.4.1. Community functions**

Sports rehabilitation system can establish a community function, so that users can share their own rehabilitation process, sports results and experience, increase communication and interaction with other users. At the same time, the community can also provide relevant rehabilitation knowledge and skills to help users better carry out rehabilitation training.

#### **2.3.4.2. Challenges and competitions**

The system can set up challenge and competition functions to motivate users to actively participate in rehabilitation training, and to compete with other users. These challenges and contests can be set with different levels of difficulty and rewards to suit the needs and interests of different users.

#### **2.3.4.3. Online communication and guidance**

The system can set up online communication and guidance function, so that users can communicate with other users or professionals at any time and consultation. This can help users to solve problems and confusion encountered during the rehabilitation process, providing more personalized and professional guidance.

Through the realization of the social interaction function mentioned above, the sports rehabilitation system can not only provide personalized guidance and suggestions for rehabilitation training, but also increase users' sociability and participation, improve their rehabilitation and quality of life. At the same time, the system contributes to the cohesion and vitality of the community and provides more comprehensive and accessible services for the health management and social interaction of older persons.

### **2.3.5. Remote monitoring and early warning**

The system has remote monitoring function, parents or doctors can use the mobile phone APP or computer

terminal real-time view the physical status of adolescents and sports data. When the body appears abnormal situation, the system will automatically alert, in order to take timely measures.

#### **2.3.5.1. Real-time monitoring of patient status**

The exercise rehabilitation system has the function of monitoring the patient's condition in real time. It can collect the patient's physiological data, such as heart rate, blood pressure, respiration, and movement data, through wearable devices or sensors, such as the number of steps, amount of exercise, etc. . The data can be transmitted in real time to the back end of the system for analysis and evaluation by doctors and rehabilitators.

#### **2.3.5.2. Recording and analysis of motion data**

The system can record the patient's movement data, including the movement type, the length, the intensity and so on, and carries on the personalized analysis and the appraisal according to the patient's actual situation. By analyzing the movement data, doctors and rehabilitators can better understand patients' exercise habits and progress in rehabilitation, and make more accurate rehabilitation plans.

#### **2.3.5.3. Rehabilitation effect assessment report**

The system can generate personalized evaluation report of rehabilitation effect according to patients' rehabilitation plan and actual exercise situation. The content of the report can include the progress of rehabilitation, the changing trend of movement data, the changing trend of physiological data, etc.

#### **2.3.5.4. Remote expert consultation and guidance**

For patients who need professional guidance and counseling, the system can provide remote expert counseling and guidance functions. Through the system, patients can communicate with professional doctors or rehabilitators online, consult relevant questions and get professional guidance and advice. This kind of long-distance consultation method is convenient and quick, can satisfy the patient's actual demand.

#### **2.3.6. Privacy protection**

With the increasing awareness of health information and privacy protection, the design of privacy protection function of sports rehabilitation system becomes more and more important. The following is a detailed design of the privacy protection function of the sports rehabilitation system.

##### **2.3.6.1. Encryption of user data**

In order to ensure the security of user data, the system should adopt advanced encryption algorithm to store and process user's personal information, physiological data, motion data and other sensitive data. This encryption technique ensures that even if the data is intercepted during transmission, it can not be illegally obtained and cracked.

##### **2.3.6.2. Access control**

The system should establish strict access control mechanism and set different data access rights for different user roles. Only authorized users have access to the relevant data, and access logs should be kept for all users to facilitate tracking and auditing. This effectively prevents unauthorized access and data leakage.

##### **2.3.6.3. Data backup and recovery**

In order to prevent data loss, the system should establish a sound data backup and recovery mechanism. Back up all data on a regular basis and store it in a safe and secure location. When the data is damaged or lost due to unexpected circumstances, the system can recover the data quickly to ensure the normal operation of the system and the security of user data.

In short, through the above functional design, the Internet of things can play an important role in the exercise

and rehabilitation of young people to help scientific exercise and rehabilitation training, improve physical fitness and health levels. It will also help parents and doctors to better manage and supervise adolescents.

#### **2.4. node design of exercise rehabilitation system**

Internet of things (Iot) is widely used in the sports rehabilitation of teenagers. Through various node designs, it can realize all-round and accurate sports rehabilitation services. The following is the node design of a sports rehabilitation system.

##### **2.4.1. Sensor Nodes**

These nodes can be integrated in clothing, insoles or sports equipment for real-time monitoring of the movement of adolescents. For example, accelerometers and gyroscopes can be used to detect the severity of movements, changes in direction and posture, while EMG sensors can assess muscle activity and fatigue.

##### **2.4.2. Data transfer nodes**

These nodes are responsible for the real-time transmission of data from the sensor nodes to the cloud or local servers for storage and analysis. Transmission nodes are usually Low-power electronics to ensure long-term continuous monitoring.

##### **2.4.3. Processing and analysis node**

This node runs on a cloud or local server and is responsible for receiving and processing data from various sensor nodes. Through the analysis of these data, we can get the movement pattern, physical fitness status, recovery progress and other information. In addition, machine learning algorithm can also be used to mine data in depth, providing personalized training advice and rehabilitation guidance for adolescents.

### **3. Results and discussion on the application of Internet of things in sports rehabilitation of teenagers**

#### **3.1. Application profile**

Internet of things technology is increasingly used in the field of sports rehabilitation for young people, providing personalized training and rehabilitation programmes for young people through real-time monitoring, data analysis and feedback mechanisms. The purpose of this study was to explore the application of the Internet of things (Iot) in the rehabilitation of young people, including technology development, rehabilitation evaluation, safety analysis, patient satisfaction, cost–benefit analysis and future development.

#### **3.2. Technology development**

In recent years, the application of Internet of things technology in the field of sports rehabilitation has made a series of progress. The development of new sensor technology, wireless communication technology and cloud computing technology make real-time monitoring, data transmission and processing possible. By combining these techniques with rehabilitation medicine, a comprehensive and accurate sports rehabilitation service can be realized. However, the continuous updating and development of technology is essential to enhance the application of the Internet of things in sports rehabilitation for young people.

#### **3.3. Rehabilitation effect assessment**

Through the contrast experiment and application practice, we found that the Internet of things technology has a significant effect in the exercise rehabilitation of adolescents. The use of sensors and data analysis

techniques allows for real-time monitoring and evaluation of movement patterns and physiological parameters in adolescents. By comparing the data before and after rehabilitation, we can objectively evaluate the effect of rehabilitation training. At the same time, Iot technology can also provide personalized training advice and rehabilitation guidance according to the individual differences and rehabilitation needs of adolescents, and further improve the rehabilitation effect.

### **3.4. Security analysis**

In the process of sports rehabilitation for teenagers, safety is very important. The application of iot technology shows good performance in security. On the one hand, through real-time monitoring of physical parameters and movement status of adolescents, potential security risks can be detected and prevented in a timely manner; on the other hand, IOT technology can provide intelligent alert and feedback mechanisms, to help adolescents and doctors adjust training programs and rehabilitation programs in a timely manner to ensure that the rehabilitation process is safe and controllable.

### **3.5. The development direction of the application of Internet of things in sports rehabilitation for young people**

The application of Internet of things (Iot) in the sports rehabilitation of teenagers will be more intelligent, personalized and efficient. First, the use of artificial intelligence techniques and machine learning algorithms can further improve the accuracy and efficiency of data processing and analysis; second, through in-depth research into the physiological characteristics and rehabilitation needs of adolescents, it can provide more personalized training and rehabilitation programs, and finally, combined with virtual reality, augmented reality and other technologies, it can build a more intelligent sports rehabilitation system, to improve the effect and quality of sports rehabilitation for adolescents.

## **4. Conclusion**

The application of Internet of Things Technology in sports rehabilitation of adolescents has significant advantages and potentials. Through the advantages of real-time monitoring, personalized rehabilitation plan and intelligent decision-making, the rehabilitation effect can be effectively improved, the cost of rehabilitation can be reduced, and the rehabilitation efficiency and satisfaction of athletes can be improved. With the development of Internet of things (Iot) technology, the application of Iot in sports rehabilitation will be more extensive and in-depth in the future, and it is expected to become an important force to promote the development of sports rehabilitation.

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