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IoT In Sports for Injury Health Monitoring

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A B S T R A C T

With the rapid development in the application of technology in various aspects of daily life, the field of sports is not exception. The application of IoT in this domain is immense. IoT devices like sensors are embedded in devices like smart watches, hats, shirts, etc to track large amounts of real time data regarding the sportspersons' health. This data can be used to track and monitor this person's health and also perform predictive analysis to identify any potential health risks or injuries. These aspects have been explored in this survey paper.

Keywords: IoT , health monitoring, sports

Introduction

Athletes constantly push boundaries in the ever-changing sports world in an effort to achieve optimum performance. The Internet of Things (IoT), a technology paradigm with great relevance for injury health monitoring in sports, is at the centre of this endeavour. This essay highlights the importance of IoT in the modern sports arena by examining its critical role in improving athlete well-being and preventing injuries. The sports sector has seen a significant shift in the use of IoT for injury health monitoring in recent years. With real-time insights into physiological markers, the incorporation of IoT devices into athletes' training and competition regimens has proven to be a game-changer. The ability of IoT to detect possible health problems and injury hazards early on is one of the main reasons it is relevant to sports. IoT devices with sophisticated algorithms are able to detect variations from baseline health through the continuous monitoring of vital parameters like body temperature, heart rate, and movement patterns. This allows for preemptive action to reduce risks. An individualised approach to athlete care is made possible by IoT. Smart technologies and wearable sensors collect individual athlete data, enabling customised training regimens. This individualised approach guarantees that athletes receive interventions that are in line with their unique physiological responses and biomechanics, lowering the risk of injuries linked to generic training regimens.

Literature Survey

In [1] Hao Zhen et al. use an IoT based Wearable Intelligent Health Monitoring System for tracking the health of an athlete. It collects heart rate, temperature using appropriate sensors. This is done using compact wearable devices and microprocessors. The proposed solution has an Accuracy(93.6%), response time ratio(95.4%),sensitivity ratio(97.5%) Performance ratio (91.3%) and Prediction Ratio (96.8%) This is helpful in preventing injuries or accidents during training or even during the matches.

In [2], Yunping Xia et al. begin with an explanation of the various parts of any IoT system. It explains various methods to obtain brain signals be it Fully(EEG), partially or Non invasive.This is followed by extraction of time and frequency domain features to interpret the signals. CSP is a spatial filtering algorithm for multi-channel EEG data which can be used to analyze airspace characteristics of injury medical system. Infrared photoelectric sensor technology is used for information collection and optimization. With the example of finger joint injury, the performance before and after optimization is explained.

In [3], Najib A. Kofahi et al. proposes a IoT-Sport Health system that is primarily deployed based on MMA teaching sport. It contains 8 main force sensors that are used to measure the force of the kick, Another second set of sensors are used to monitor body temperature The smart system uses Arduino which is an electronic board used for IoT systems, for connecting sensors together and comes with a programming platform for coding. The Arduino platform is embedded in the jacket of sport people and hence data from the sensors on the chest guard are sent to a mobile application for analysis and visualization.

In [4] Xingdong Wu et al. have proposed an IoT-enabled real-time smart healthcare system using deep learning algorithms for athletes. For this study, we have considered Sanda athletes as our case study, and our results are obtained based on the health status of these athletes. Our proposed system captures various vital signs of Sanda athletes and remotely transmits them for further analysis. The physicians use the extracted information to diagnose the diseases, analyze the conditions of athletes, and suggest proper medications. The performance of the proposed system is evaluated, and it is believed an effective tool in the healthcare monitoring system.

In [5] Jihua Liu et al. provide a secure and trusted interactive environment for IoT. A multisensor data fusion algorithm is proposed for evaluation of sports injuries. The built system takes the embedded esp8266wifi module as the hardware processing core and uses body temperature sensor, blood pressure sensor, EMG sensor, and pulse sensor to form wearable devices. By wearing wearable devices, four human physiological parameters such as body temperature, blood pressure, electromyography, and pulse can be collected. In the process of decision level fusion, different weights are set for the focal elements causing information conflict, and the optimized D-S evidence theory algorithm is used. Thus, according to the data detected by multisensor, the injury risk of user motion state is evaluated.

In [6] , Prosenjit Kumar Ghosh et al. explain the following : Ubiquity of Wearable and IoT Devices: Wearable and IoT technologies are pervasive, connecting real-time devices to virtual cloud networks across various industries. Healthcare Applications: IoT-enabled consumer products, particularly wearable health devices, play a vital role in health monitoring, facilitating data exchange with physicians for better treatment guidance. Athlete Health Monitoring: Wearable IoT devices are extensively used in sports to monitor athlete health, collecting and storing performance data for the detection of adverse health issues during training or gameplay. Risk Reduction and Injury Prevention: Continuous health monitoring with wearable IoT devices during active game time and off-days significantly reduces sports-related risks, stress, and injuries, even preventing life-threatening accidents. IoT-Based Stress Index Framework: The research introduces an IoT-based framework for real-time athlete health monitoring, aiming to develop a stress index as an indicator for long-term analysis of physiological parameters.

In [7], Afzaal Hussain et a. aim at developing a Fog Computing Paradigm in IOT to overcome issues like latency, mobility , real time data manipulation,etc. This is to be used i healthcare with examples like WSN, RFID, etc. It can be used in IoT based smart workouts and automatic exercise recognition. There were a total of 4 athletes, comprised of young males between the ages of 25 and 40. On a given day, each athlete performed all the exercises scheduled in the workout of that day targeting a single muscle group. Each exercise was performed 3 times (3 sets). The sets for an exercise were performed with a small resting period .The data was collected by a commercially available device called Zephyr Bio Harness 3 (BH3). LSTM is used.

In [8] Changfeng Ning et al. propose a system that is mainly composed of sensors, smart phones and cloud servers to prevent sports injuries of students. PNF stretching method uses the theoretical knowledge of neuromuscular facilitation, which is a very good treatment method. Sensors detect various movement parameters and physiological indicators of the body and transmit these data to the smartphone. As a bridge, smart phones transmit data from sensor hardware devices to cloud servers through Bluetooth and mobile communication network. On the cloud server, this data can be stored.

In [9], João Passos et al. provide a systematic review of electronic databases (WOS, CCC, DIIDW, KJD, MEDLINE, RSCI, SCIELO, IEEEXplore, PubMed, SPORTDiscus, Cochrane and Web of Science) was undertaken according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. From the 280 studies initially identified, 20 were fully examined in terms of hardware and software and their applicability for fitness assessment Results have shown that wearable and IoT technologies have been used in sports not only for fitness assessment but also for monitoring the athlete's internal and external workloads, employing physiological status monitoring and activity recognition and tracking techniques

In [10] Jiang Yi et al. established the kinematics theoretical model of human lower limb and conducted the kinematics analysis of human body. By using the dynamic attitude analysis system, combined with the human body mark points, the position data of human body mark points in the process of standing up, sitting up, walking, stepping up, and squatting were collected. Combined with the movement mechanism of human lower limbs, the characteristics of human motion state transition are analyzed, and the perceptual algorithm for judging human motion intention is studied, so as to determine the wearer's current posture, standing intention while sitting, walking intention while standing, moving intention, and stopping intention during walking. The results show that the angle of the hip joint changes regularly between 0° and 37° and the angle of the knee joint changes regularly between 0° and 70°during the standing process, which is consistent with the angle change trajectory collected by the dynamic attitude analysis system

In [11] Inam Ullah Khan et al. propose "AntHocNet" which is a Quality Of Experience based hybrid algorithm for flying networks which has both reactive and proactive components. AntHocNet is a novel algorithm consists of five main steps which are as follows:

(i) Initial solution

(ii) Making decision in a centralized way

(iii) Pheromone concentration

(iv) Reinforcement learning or pheromone update

(v) Pheromone evaporation

Pheromone is a watery liquid that will have a high concentration if the number of ants on that trail increases. Also, the process of reinforcement is incorporated that it allows ants to learn from the surrounding environment. Else, if the ants' moment will be very low on the specific path, then pheromone evaporation occurs.

In [12] Jian Dng et al. describe about the IoT and its application in intelligent sports health management systems, the first aspect is data collection: a large number of actual and reliable data are the basis for the construction of the suggested model. For example wearable devices have been widely used in sports activities. The most common are smart bracelets, mobile phones, etc. Such devices can collect a user's daily energy intake and output and data such as the user's heart rate and exercise Feature selection is a kind of big data analysis technology that selects d most representative features from n features of the sample. Feature selection is used for data dimensionality reduction. The selected features are also the most representative, so we can analyze the main factors affecting user health through feature selection to provide more targeted scientific and logical representations.

In [13], Quantao He et al. use the data that comes from a middle school in Beijing in the third quarter of 2020. In this article, 100 athletes were randomly selected from a high school, and 70 of them met the requirements of this study after screening.there are 31 women and 39 men, and a total of 70 high school track and field athletes participated in the survey. Among the 70 track and field athletes, 18 were under 60 kg. Among them, 14 were female and 4 were male, accounting for 25.7% of the total; 34 were in the range of 60–70 kg. Among them, 12 were women and 22 were men, accounting for 48.6% of the total. both in terms of speed and accuracy, from the overall perspective, the computational and Internet of Things (IoT) based research method for common sports injuries of track and field athletes proposed in this article is higher than the multi-level model method, with speed being about 10% faster than the multi-level model method, and accuracy being 18% higher than the multilevel model method.

In [14] Syed Karimunnisa et al. propose a system where sensors are connected around the stadium to metric other conditions like ground temperature and others. This layer is a perception devices layer. CoAP (Constrained Application protocol) is utilized in the sensor devices in order to interconnect with the gateway. The second block is the Network layer and its central function is to gather the information from the perception devices and forward that data to the cloud. In the IoT cricket system, ZigBee technology is used is to collect the data from the perception devices and transmits that data to the Internet. There are 2 classifications of Cloud computing in the ESI's M2M standards. One part is for routing, security, and registration and the other part is for network applications.

Here the proposed methodology consists of three layers.

They are :

1) First layer is a perception.

2) Second layer is a network.

3) Third layer is a application layer in cloud

In [15], Peng Sun et al. consider 60 athletes in Hebei Province who were selected randomly, including 30 men and 30 women. Then, a series of training and recovery were carried out. The 60 athletes were observed, and the status quo of the injury of the posterior thigh muscle group and its prevention and recovery were analyzed.

Flexibility training: before the formal training, the subjects complete 5-10 minutes of warm-up by jogging and then complete a series of training after that

Sprint training: the subjects wore tight clothes and trousers, pasted reflective markers on their bodies, and determined the placement of electrodes for biceps femoris, semitendinosus and semimembranosus muscles on both sides according to the anatomical markers on the body surface and the freehand examination.

Isokinetic strength training: after the sprint training, the subjects keep the original body surface marker points unchanged, first complete the static standing calibration to collect the three-dimensional coordinates of all marker points, because the seat will block the waist points during isokinetic strength training, so remove the waist points after the calibration.

Strength training: during the formal training, the athletes stand on the pedal with their feet fully in contact with the pedal.

Proposed System

This is a proposed architecture for monitoring athlete health. It starts of with mounting devices for real time data collection related to health parameters of the sportsperson. This involves sensor to track heartrate, to track amount of sweat , to track position of muscles and joints. This data is then sent to an iot hub like a raspberry pi which is an edge device used for processing data at a fast speed. The processed data is fed to deep learning programs that use it for quantitative predictive analysis of the different health parameters. These values are compared against a set threshold to evaluate health of the athlete. If beyond the threshold, the athlete is alerted through an app connected to this raspberry pi via an API. In this way the app should be set such that real time data of his health is fetched at a rate of time of his choice on the app created. Rehabilitation and injury prevention programs can also be advocated through this app from real industry experts.

Conclusion

Notwithstanding the encouraging uses, the survey highlights some important issues. Obstacles that necessitate careful thought and strategic planning include data privacy concerns, sensor dependability, initial implementation costs, ethical considerations, and technical difficulties. In order to fully utilise IoT in sports, it will be essential to overcome these issues as the technology becomes more and more prevalent. Sports organisations can benefit from the long-term health insights obtained from historical data. Long-term training plans and injury prevention techniques are guided by evidence-based solutions for sustained athlete health made possible by predictive models built on accumulated data. This all-encompassing strategy for athlete well-being fits nicely with the changing requirements of sports science, establishing IoT as a pillar for further developments in the area. The report concludes by highlighting the revolutionary potential of IoT for injury health monitoring in sports. To ensure prudent and successful adoption in the sports industry, we must find a balance between utilising the advantages of IoT and resolving its problems as we traverse this evolving landscape. The survey's findings open up new avenues for investigation and development, promoting a more integrated, data-driven, and athlete-focused approach to sports technology.

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