Methods for Assessing the Effectiveness of the Internet of Things (IoT) Applications for Physical Education

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Abstract. With the development of health management, more and more wearable devices are used in physical education. In order to improve the quality of sports training, wearable technology related to Internet of Things (IoT) has broad application prospects. These technologies may improve personal health management, achieve the goals of health campaigns, and make better health. Although IoT applications in sports have been reviewed, applications in the field of health monitoring still need to be summarized. This research focuses on the application of the IoT and wearable technologies related to physical exercise of university students and the types of data they collect. This article also analyzes the existing views of the existing areas of IoT/wearable applications, as well as new application areas. The result is to provide technical support for the design and development of physical education solutions. It can also improve the effect of physical training and improve the health and well-being of university students.

Keywords: Internet of Things · IoT · Physical Education

1 Introduction

Due to improvements in Internet of things and network technology, more and more technologies such as wearable devices and integrated it is used in the field of sports training [3, 6]. University Students' sports training needs more Internet of things technology supports, including physical activities monitoring, physiological data monitoring, sports effect evaluation, especially if teachers want to get the better sports training effect. Therefore, the evaluation of the physical education teaching effect needs more Internet of things technology supports, such as a wearable smart bracelet to detect the whole training process of students [5, 7, 11]. Device performance and financial constraints may limit the applications of IoT technologies.

IoT may change the future of physical training; they can reduce the pressure on teachers to evaluate the effects of sports, and allow students to receive the exercise monitoring of the Internet of Things technology to provide better physical education teaching effects and reduce evaluation costs, so as to scientifically and rationally treat students' mark [2, 4, 7, 11]. The emergence of wearable technology based on the IoT has

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provided help for personal health monitoring. These technologies have recently attracted widespread attention and can provide a variety of solutions to health monitoring and health care. They also have the potential to improve the evaluation of personal exercise effects, and facilitate fitness and body shaping through exercise [3, 5].

We found that the IoT includes sensing devices and technologies. The concept of the Internet of Things is to link objects to the Internet, and its functions are realized through the interconnection of these objects and the services on the Internet [8, 9]. IoT technologies are described as: communication, convergence, connectivity, aggregation, computing and content [7, 10]. The most important elements of IoT devices include intelligence, connectivity, perception, expression, energy and security [8]. IoT technologies also connect physical and virtual objects, enabling them to exchange and combine the data, developing a wide range of solutions to people [9].

Physical activity and physiological data need to be monitored by wearable devices, and wearable devices are part of the IoT system [4, 11]. Those devices are embedded with sensors and analytic algorithms that enabled them to track, analyze and guide users' behavior, vital signs or movement [3–5]. The applications of IoT/wearable technology for physical activities have been investigated by different researchers before. However, most studies were discrete focusing on a single area of applications or one type of IoT/wearable device [1, 3–7, 10, 11]. Therefore, the lack of a comprehensive study of networking applications for physical activity and physiological data is the main challenge in this field.

Davis proposed Technology Acceptance Model (TAM) when he used the theory of rational behavior to study user acceptance of information systems [4]. TAM has two main determinants: 'perceived usefulness' and 'perceived ease of use'. This preliminary study aims to understand and improve the measurement of IoT technology through TAM and text data mining. It tries to use the technology acceptance model to study the case report on the IoT applications.

The purpose of this study is to understand and determine the measurement standards or IoT measurement applications used by the evaluation team, and check the consistency of IoT used in motion monitoring reports. Future research will apply these methods of health risk management and other related content.

2 Methods

2.1 Data Source

The research design aims to summarize the main points about IoT/wearable technologies and applications in physical activity and physiological data. Then, we selected 100 valuable comments from top five IoT online shops' (from Taobao and Jingdong) using reports on IoT devices as the basis of the data analysis. The keywords are 'IoT', and 'physiological data', or 'physical activities'.

2.2 Piloting Text Data Mining Method

The Internet of Things (IoT) using reports is text data that can be used for qualitative content analysis to identify IoT application metrics. We have developed an automated

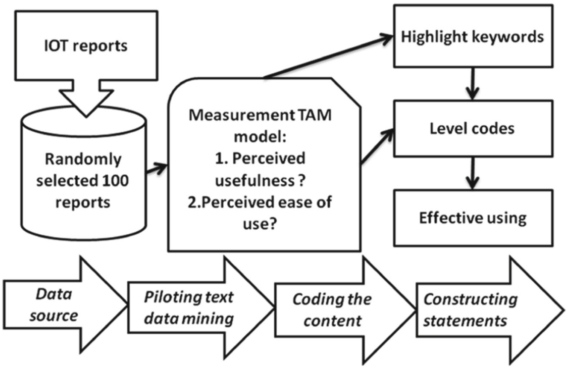

Fig. 1. Four-step analysis method for measurement.

tool to extract part of the IoT application content from the reports. We then performed 'automated keyword search' and 'manual content reading', and mapped the content recorded in 100 random using reports (Fig. 1).

In order to establish analysis standards, we randomly selected five IoT using reports for analysis. These reports are used to extract relevant content from IoT applications. We use each sentence as the unit of analysis to determine the relationship between the expectations described in the statement and the application of the Internet of Things.

The third author uses qualitative analysis to analyze one report. She read each sentence carefully to make sure that she understood the meaning of the sentence. For sentences with multiple meanings, she need to divide the sentence into several sub-sentence. In order to ensure the consistency of the structure between the sentence and the sub-sentence, each sub-sentence is determined to have only one meaning.

For example, a sentence in the report mention that 'users use IoT because they can effectively obtain physiological data'. This sentence was divided into: 'users feel IoT is useful', 'users feel IoT is easy to use', and 'users need physiological data obtained by IoT'.

After that, all the authors analyze the qualitative text data together to make sure that the extracted statements are valid. They need to compare the original sentence with the extracted statement to determine the consistency. For the inconsistencies and key points, the authors need to reach a consensus to generate a unified measurements.

In order to ensure the reliability of the data, we conducted reliability tests. The first and second authors continue to perform the same tasks from the remaining case reports. The research results are summarized and input into an excel spreadsheet, and each sentence has a unique ID.

Finally, the results of the study showed that the agreement was only 82%. The difference lies in the number of clauses and how to clause. The authors finally reached a consensus after discussion, and the 5 sentences were successfully sent into 13 sub-sentences.

2.3 Coding the Content

For the first-level code, we shortened the sentence while retaining the meaning. In a typical example, the clause is simplified to 'the user expresses that their physical activity is appropriate'.

The second-level code is established on the premise that the first-level code is simplified, and the method of establishment is the same as that of the first-level code. However, the secondary code is built around three main themes: proper monitoring, proper use, and other proper IoT applications.

2.4 Constructing Statements

The sub-sentences were constructed into four IoT applications measurement statements under the three themes: Five items in protection, nine items in using and 15 items in IoT applications. The five items in the process were related to 13 IoT applications of IoT for physiological data and physical activities.

We use 100 reports randomly selected before for use in the mapping process. Figure 1 describes the semantic mapping process. We have developed a keyword search list for two main metrics. We also use an automatic program that can automatically search for keywords, extract surrounding information and export the information to a text document or excel spreadsheet.

For example, the IoT application part of the case report contains the keyword "physical activity". Then, we manually read the selected content to check whether the sentence can be semantically mapped to the sentence we intend to map. If any statement is mapped, it is recorded as '1'; otherwise, it is recorded as '0'.

After the mapping process, we analyzed the matching percentage of each sentence to ensure that the evaluation team used consistent measurements.

3 Result

3.1 IoT Applications

WE found the Internet of things smart wearable bracelet can be used to monitor physiological data (blood pressure, heart rate, ECG and Spo2). It can also be used for physical activities monitoring (positioning, electronic fence, and trajectory monitoring). Valuable products come from Xiaomi, Huawei and customized manufacturers and RFID, NFC, GPS, sensors, infrared and wearable technologies are used.

Two main determinants of Technology Acceptance Model (TAM) were identified from 100 reports. Two themes (monitoring of physiological data and monitoring of physical activities) were finally grouped into four categories: useless or usefulness and perceived ease of use and overall hard use (Table 1).

The monitoring of physiological data expressed are 'useless monitoring for physiological data' which occurs to all 57 using reports, 'none or incorrect usefulness' (13 reports), and 'ease of use' (16 reports) and 'none or incorrect of use' (6 reports). The monitoring of physical activities expressed are 'useless monitoring for physical activities' (23 reports), 'none or incorrect usefulness' (15 reports), and 'ease of use' (54

Table 1. IoT for physical activities.

No	Knowledge for motion monitoring		
	TAM Model	*Physiological data (%)*	*Physical activities (%)*
1	Usefulness	57%	23%
2	None or incorrect usefulness	13%	15%
3	Ease of use	16%	54%
4	Fail in ease of use	6%	4%

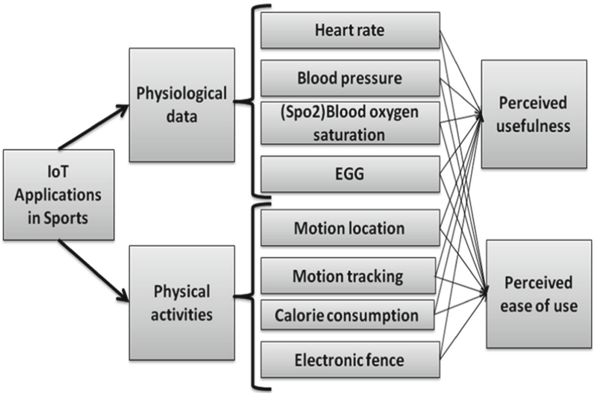

Fig. 2. IoT Applications in motion monitoring.

reports) and 'none or incorrect of use' (4 reports). The remaining reports are IoT applications of effectiveness. They are 'none or incorrect use' to administer physiological data (6 reports) and 'unmonitored activities' (4 reports).

3.2 Knowledge of IoT Applications

Figure 2 shows the results of data mapping and knowledge mining. We found that as long as the information exchange of objects is ensured, and through effective data transmission and communication means, the communication focus could be avoided. All report show that the most effective use depends on a stable network link. Knowledge mining shows that the accepted IoT devices have: usefulness, simplicity and practicality. The evaluation of the effect of IoT use shows that the difference in effect depends on familiarity with the functions of the IoT device.

4 Discussion

Our research found that the IoT using reports lacks a comprehensive quality assessment, especially the evaluation of the structure and process of physical activities and the application of the IoT. The advantage of our research method is to determine the content of the IoT. The bottleneck of the research is to improve the semantic matching ability of the mapping method between sentence and the sub-sentence.

The IoT case is an important element for experts to review. Due to the insufficient measurement of physical activity process, monitoring of physiological data, and IoT network structure, only limited knowledge can be obtained. The changing is the major focus of physical activity monitoring. We found that not all reports use the usefulness of measuring physiological data.

The mapping results show that it is difficult to find the corresponding measurement indicators in the using reports released by IoT online stores. The measurement of IoT applications is limited to statements of physical activity and physiological data. The advantage of this measurement is that it can provide suggestions for the use of IoT applications, while reducing the possibility of incorrect use.

The limitation of the research is the lack of IoT experts to review the results in order to expand the scale of data. Future research will involve experts in the Internet of Things and text analysis to verify the research results and our research methods.

5 Conclusion

This preliminary study tested the research methods of large-scale research aimed at improving the measurement of motion monitoring in IoT technology. We analyzed the 100 IoT using reports released by online shops from January 1, 2021 to March 25, 2021. We found that communication stability is the main requirement of IoT technologies. The most frequently reported metrics in the IoT summary reports describe the communication between things, the data obtained by regular review. The IoT systems ensure that the data onto students are correctly analyzed and the correct methods are used to handle IoT applications.

We recommend that IoT using reports also use objective measurements of IoT applications, rather than just users who claim to be IoT applications measurements. This preliminary study confirmed that our research methods can be used to perform qualitative data analysis on the officially released IoT using report. In order to better use the IoT technologies in the sports field, we need to understand and improve the measurement of the usefulness of the IoT.

The effectiveness of semantic matching between usage reports and standard measurements depends on the improvement of our analysis methods. These reports and standard measurements are extracted from related IoT technologies from the bottom up. Further research will automatically or semi-automatically extract the IoT online using reports.

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