Implementation of Internet of Public Fitness Equipment for Health Physical Fitness Improvement

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Abstract: - In this paper, an IoT architecture for public fitness equipment, internet of public fitness equipment, with software and hardware is proposed and implemented. We utilize reed switch and MCU with WiFi module to implement IoT hardware on public fitness equipment. Furthermore, we also implement web service, database and user interface which provide thorough individual exercise prescription and monitor service. From the experimental results, all the participants' physical fitness does improve significantly. It shows that our internet of public fitness equipment can significantly improve body health by providing an efficient exercise way.

Key-Words: - Internet of Things, Public fitness equipment, Health related physical fitness

Published: February 24, 2020.

1 Introduction

In the nowadays society, less exercising easily leads us to obesity. There are more than one reasons well-known by us generation, the changes of our lifestyle and the social structure, which appears to be sedentary lifestyle more than active lifestyle for most of the population currently. Wakabayashi et al. and Warburton et al. denote that obesity is associated to chronic diseases, such as hypertension and type 2 diabetes, are all indicated with Body Mass Index. Which is why, workout and periodic inspection are crucial to preventing diseases, according to the World Health Organizat [1][2]. Hence, enhancing lifestyle by improving their regular exercise and promoting the consciousness of health self-management for all the communities as well as prospering the health industry have become the priorities all over the world. Moreover and more gyms and activity centers located, proving that we human have new concepts on workout and managing a healthy body. Furthermore, from the Cohen et al., having more fitness equipment at public spaces really do attract more users and have a huge effect on local exercising [3]. As the analysis of Taipei Departm ent of Sports, 73. 4% of the respondents over 15 years old are the most usual users using community park and school facilities; as for the elders over 60, reaching still 74.89% respondents make good use of public activity spaces [4]. From the data mentioned, we are more convinced of increasing public fitness equipment motivates the participation among residents and will benefit their mental and physical health.

Literally, public fitness equipment is the exercising facilities in public places. The equipment such as Air Walker or tools providing workout functions are all the ones referred. They have all in common of having simple structure and functions for us to understand easily. Meanwhile, even from the analyses show that, the in-house professional fitness equipment as well as the public fitness equipment affect similarly on workout. By using public fitness equipment, we can improve health related physical fitness [5]. The greatest advantage of expanding public fitness equipment in the neighborhood is providing the facilities to the public. Regardless to the fact, the large amount of equipment will cause problems when facing maintenance. Yet, comparing to the in-house gym which contains professions and the appropriate instruction provided, the public fitness equipment will bring non-effect to body or even worse, sport injury, if we didn't notice the condition of the equipment or understand well of the guide without professional leading. With the rapid development of the technology, not only the basic construction but microprocessor will support when realizing the IoT device idea. The intention of this research is to
conduct on IoT device with microprocessor and WiFi module, offering users the exercise prescription and keep the m updated with the IoT device which named internet of public fitness equipment proposed in this research. The final purpose is to take advantage of the device to improve health related physical fitness of the public.

The rest of this paper is as follows. Next Section, we will discuss some relevant works. Section III describes us implemented internet of public fitness equipment and how the exercise prescription for health related physical fitness works. Section IV and V show our experimental results and conclusion, respectively.

2 Review of Relevant Works
In this section, we are going to discuss the effect of public fitness equipment and related researches of health care combining IoT. Warburton et al. indicates that with regular exercising. The authors denote that regular exercising can effectively prevent chronic diseases of all ages and extend human lifespan [6]. These features allow us to admit that public fitness equipment plays a crucial role in supporting our society and bring public health to our lives. Nguyen et al. takes the public fitness equipment from neighbor park as sedentary Hispanic women exercising tools. After experimenting for 6 weeks, Nguyen et al. saw significant effect on losing weight of respondents [7]. Additionally, Wang et al. analyzes the usefulness of public fitness equipment from the aspect of sports biomechanics [8]. In this research which compares the gait of air walker, elliptical trainer and treadmill, we can discover that air walker and in-house trainer have the exercise intensity in common, users may obtain the same effect for themselves. Lok et al. sorts out the characteristics of public fitness equipment from many associated researches. They say that most of the researches do consider public fitness equipment benefit to public health. Apart from that, public fitness equipment in communities have some more characteristics such as “social connectedness”, “affordable”, “support”, and “design and promotion” [9]. Santamara et al. use Arduino as the core, surrounding by Bluetooth communication interface to implement the wearable IoT device [10]. Via message queueing telemetry transport (MQTT), recording and examining users’ condition and abnormal behavior during exercise, which will be uploaded to the cloud database, enables us to improve the disadvantages of inaccurate and non-instant from traditional record methods.

From the literature reviews above, it is obvious that public fitness equipment and in-house fitness equipment have lots in common. The two shows remarkable effect on keeping good health and exercise behavior, they can even offer adequate social support; yet, without the defect of cannot record and analyze immediately. Thanks to the open source and thorough network infrastructure nowadays, we can practice IoT hardware and software through open source and send/monitor the exercise prescription to our users. Namely, reaching the goals of regular exercise by using internet of public fitness equipments. In the next section, we are going to illustrate the internet of public fitness equipment architecture, the methods using Arduino to realize internet of public fitness equipment, and the design of pilot study.

3 Proposed Internet of Public Fitness Equipment
In this section, we will introduce hardware, software and user interface architecture of our proposed internet of public fitness equipment. In this paper, we select Air Walker as our implementation public fitness equipment which is one of the most popular equipment in parks. We take reed switches as the position sensor monitoring user’s gait on the Air Walker and use reed switches to calculate users’ step length and step frequency each time. Then, the exercise processes are recorded on the database. Accordingly, hardware structure should contain enough General purpose input/output interface as well as the one with external communication.
In this paper, we choose the device - D1 mini, based on ESP8266 and is able to open up Microcontroller unit by using Arduino. This is a low power consumption 8-bits MCU. Its characteristic is that the communication interface has already been built-in Wifi. We can upload users’ exercise processes from public fitness equipment to cloud through the well-built Wifi infrastructure. Also, due to that ESP8266 has standard Wifi interface inside, we can practice the HTML packet directly. Shortly, exercise processes will be delivered by the methods of HTML form. The greatest advantage is that by using TCP to deliver HTML, we can provide the communication of higher quality.

Software block handles sending and restoring of information. We built a web service inside the software, PHP, in our server for public fitness equipment to read exercise processes delivered through the internet HTML package over the web service and store the into database. In the meantime, software interface offers the API (application interface) to send messages, in order to communicate with user interface.

User interface block represents the communication, which means delivering exercise processes and sport exercise from their personal trainer to user. In order to solve the problem of heterogeneity OS, we use chatting software to build up chatbox. Exercise prescription designed by personal trainer and user’s exercise processes are both sent on communication software. In this paper, we install user interface into Line - the most frequently used application in Taiwan nowadays.

3.2 Pilot study
The exercise prescription for user given by fitness coach and observe the effect. We choose Air Walker as our public fitness equipment training example (as can be seen in Fig. 2). And install three magnetic switch sensors on air walk to calculate the usage time and frequency as our exercise history. The procedure of the system is showed on Fig. 3. In the pilot study, we recruit some participants, and named them userA, userB and userC. Besides, we recruit one private coach with R.O.C health fitness instructor level-2 license as a participant. Private coach is responsible for designing the exercise prescription applied on public fitness equipment for each user individually.

It is important that exercise prescription designed by the private coach is delivered via internet to the software square in Fig. 1. Software not only stores the exercise prescription in database but do send through chatting software, Line messenger API to the system users. Fig. 4 is the Line screenshot from the end-user. After receiving exercise prescription, user starts to working on their exercise prescription in the fixed period. Exercise history will be sent to software square over the internet of public fitness equipment we proposed.
In the exercise process we delivered to users, in addition to the basic information of public fitness equipment, the system has done calculation of calorie consumption as well, providing the reference for private coaches and users. As Fig. 5 shows that private coaches can receive the three users' exercise history on their mobile phones.

Private coaches will also adjust the exercise prescription according to the processes afterwards, offering the most instant and effective exercise prescription for users.

### 4 Experimental Results

In this section, we show the experimental results of our pilot study. We recruited 3 participants whose ages are between 24-27, female. They fully understand the risk of our experiments and the right of participants, especially they can quit the experiment anytime without any considering. The duration of the pilot study is from January 28th, 2019 to March 28, 2019, totally 60 days. Participants had a pre-test, day-20 test and post-test. Testing items are standing broad jump, 1 minute sit-ups, the sit and reach test and 800m jogging, they are tested for power, muscular endurance, flexibility and cardiovascular fitness, respectively. From these experimental results, we can obtain the efficiency of our proposed internet of public fitness equipment.

In the power test (see Fig. 6), the power of participant A on the twentieth day slightly increases but decreases on the sixtieth day, the value was even lower than the first day. The power of participant B has no improvement on the twentieth day, but then a slight increase on the sixtieth day. Participant C turns out to be the one increases noticeably. We can see that on both twentieth and sixtieth day, there’re obvious increases.

Fig. 7 shows the experimental result of muscular endurance test. From this figure, we can obtain that participant A has no improvement, and little improvement for participant B and C compare to the first test on the twentieth day. On the sixtieth day, post-test, there’re noticeable improvement for all. We can tell that subject C has the most noticeable increase on muscular endurance. In the flexibility test (see Fig. 8), we can see that participant A and B improve less than C on the twentieth day. Then on the sixtieth day, they do have some improvement compare to the first test. Participant C increases the most.
Finally, we show the experimental result of cardiovascular fitness test which shown in Fig. 9. All our participants, A, B and C, do make significant improvement on both twentieth and sixtieth day, compare to the first test. Among them, A increases the most dramatically.

From these figures, we can obtain that, on the sixtieth day, participants show great improvement on all test, only participant A has a decrease in the power test. Among all the participants, A shows greatest improvement during the cardiovascular fitness test, the most noticeable increase for C on power and muscular endurance test. Compared with A and C, B has the slightest improvement on all tests. The only exercise prescription given is the exercise time, instead of the stepping frequency, may be the factor influences our experimental results.

5 Conclusion
In this paper, we proposed and implemented an internet of public fitness equipment which connects public fitness equipment with each other. Instructor sends exercise prescription remotely to user over IoT. Apparently, the result shows that for women with irregular exercise habit, their flexibility, power, muscular endurance, and cardiovascular fitness increase dramatically based on the value. After receiving the exercise history, the private coach can give personal exercise prescription any time, anywhere. The private coach has no limited to the environment. Owing to that our internet of public fitness equipment and Air Walk have no intensity to adjust, designing exercise prescription integrating with other sports is necessary to achieve effective training performances. From this paper, not only government can manage the public fitness equipment easily, but also for citizens who cannot utilize our proposed internet of public fitness equipment to improve their health physical fitness.

Acknowledgement
This research is supported by Ministry of Science and Technology, Taiwan, R.O.C. The project number is 107-2410-H-845-026.

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