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Smartphone App for Heart Rate Monitoring and Its Impact on Education Toward Industry 4.0

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Abstract. This paper presents the development of Smartphone app for monitoring the heart rate, which used as a tool for life-based learning. The app featured life-based experiments for undergraduates' students through do-it-by-your-self activities. This app was developed with Firebase to create a heart rate monitoring system interface as well as a framework for life-based experiments. Also, this app had video features as learning resources. We used an experimental method to evaluate the proposed system of learning. The subjects were 30 undergraduate students who were separated into two groups. Based on our survey, student learning outcomes increased by 35% compared to conventional experiments.

Keywords: heart rate monitoring, industrial 4.0, life-based learning, smart apps

INTRODUCTION

In the last decade, the number of smartphone or tablet users in the world grew exponentially [1]. This provides a great opportunity in the use of smartphones and tablets as a medium for health monitoring, given the importance of monitoring health conditions that are user-friendly and free. A critical parameter in managing human health is the heart rate [2]. By monitoring heart rate activity, one can see firsthand how daily activities affect health [3], especially for urban communities who are busy with business activities and do not have much time to do physical exercise.

The rapid growth of the elderly and sufferers of chronic diseases made many research projects and prototypes to develop to monitor specific health parameters [4]. [5] developed a portable heart rate measurement system with two Arduinos (one ethernet shield installed) and an XBee shield that lacks ease of use due to its large dimensions. The measurement results are displayed on the 2x16 LCD, which provides a less friendly interface. Authors [6] used the dragon12 microcontroller and AD8232 signal conditioning connected with the electrode pads and Bluetooth module HC-06. The measurement results have been displayed on a smartphone but cannot be used on mobile because of the large size of the microcontroller. The system that we developed provides a high level of mobility with small device dimensions and a friendly interface for all ages.

In developing technology, humans are one of the constant factors that researchers and practitioners must pay attention to. It does not mean that people, social conditions, and culture remain stagnant because it also evolves with the surrounding environment. So, to improve the skills and life situations of people, it requires the right tools and abilities in the field of technology, including the use of appropriate technology and how technology is valued in the scheme of human life. In Life-Based Design Services (LBSD), processes and results from cognitive science that were studied and focused on developing tools are needed. Learning this science usually uses Problem-Based Learning (PBL), and later, students will be guided to map the methods on Life-Based Learning [7]. Problem-based learning (PBL) is a learning technique, in which a person independently searches for information needed to solve problem situations so that he can learn new knowledge, skills, conduct research and develop creative skills. It offers a way to shape and develop competencies to improve the quality of education, quality conditions and results [8]. As long as technological developments continue, the educational perspective is as critical as the technology perspective [9]. The use of PBL methods was

known since the era of education 2.0 but was limited to how students can solve the existing problems. Since the development of the educational era, the PBL method is not only limited to solving problems but evaluating the process used in solving complex problems [10]. So, the PBL method is still considered suitable to be applied in the era of education 4.0

We developed a smartphone app for real-time heart rate monitoring and frameworks to support the life-based experiments. The rest of this paper was organized as follow. Section 3 illustrates the system architecture, software design, and inferring the user-health condition. Section 4 explains the result of the monitoring system. Section 5 presents conclusions and future work.

Related Works

There were several references used to support this research, about smart app developed and education 4.0.

Table 1 Related Reference of Smart App Development in Education 4.0

Reference	Problem	Method	Result
[11]	Implementation of education 4.0	Analysis and evaluation of the knowledge industry 4.0	Lowest knowledge about the implementation of industry 4.0 concepts
[12]	How to improve skills to education 4.0	Analysis application of educational tools in education 4.0	Develop students analytical skill and higher-order thinking skills
[13]	Monitoring heart rate	Development of smartphone app for heart rate monitoring	Structured system for collecting health data and real-time monitoring is achieved
[14]	Application required for data acquisition and visualization of biopotentials	Development of mobile apps for data acquisition and visualization of biopotentials	Biopotential data can be wirelessly transferred from the PPG device via a Bluetooth or WiFi module to a beaconing smart device is pursued

Author [11] analyzed and evaluated student's knowledge about industry 4.0 through education 4.0, the result showed that students have insufficient knowledge about industry 4.0 and the institutes did not know how to implement the concept of industry 4.0. The institutes also had inadequate knowledge about things that were required to support education 4.0.

Author [12] explained that the goal of the research was so that students can develop analytical skills and other higher-order thinking skills for the industrial revolution 4.0. Education 4.0 through educational tools can develop skills of the students, analysis skills and ability to evaluate from learning on educational tools.

Author [13] developed a smartphone application for heart rate monitoring, and the result showed that application collected the health data and showed heart rate in real-time monitoring for medical needs.

Author [14] developed a mobile app for wireless sensor data acquisition and visualization of biopotentials that could be wirelessly transferred from the PPG device via a Bluetooth or WiFi module to a beaconing smart device that was pursued medical needs

These references show the progress of the development in digital technology in the health sector using a smartphone as the monitoring and controlling systems. In this research, digital technology was developed for education 4.0 purposes, using a smartphone as a monitoring system.

METHODS

System Architecture

In wearable devices, the size and length of time of use hold the vital part. Therefore, we designed the devices as small as possible with a low level of power consumption with MAX30105 and ESP12 sensors as microcontrollers. The system architecture, as shown in Figure 1.

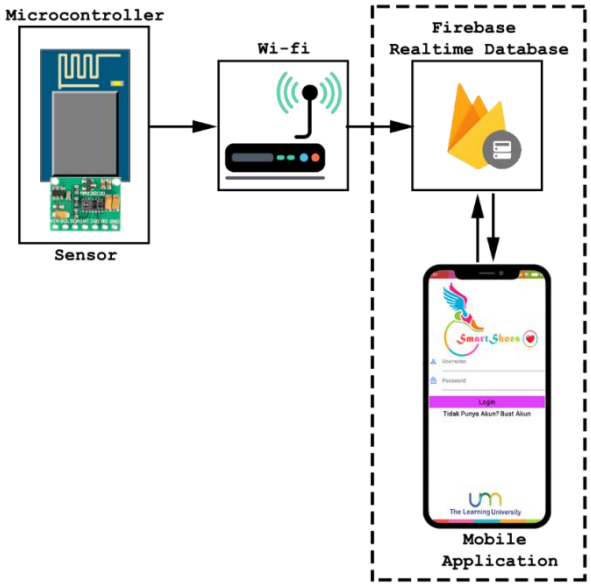

Fig. 1. System Architecture

The system was developed using Firebase, which has several features such as authentication, storage, real-time database and others [15]. This project used the firebase authentication feature and the real-time database feature as the application backend. When the database received new data, Firebase conducted data transactions to smartphone applications so that data on smartphone application was always up to date every second.

Software Design

The smartphone application was created using the flutter SDK developed by Google. The application was designed to display parameters related to human health such as BPM, SPO2 and body temperature, which were displayed on different pages. These three parameters were used to analyze the user's body health. We provided a page of analysis that offers conclusions from the results of measuring these three parameters regarding the user's health condition, based on reliable sources.

User Health Analysis

According to [16], the normal resting heart rate condition for most of us is 60-100 beats per minute (bpm), for athletes or people who are more active having resting heart rates as low as 40 beats per minute (bpm) as implemented in Table 2 as a standard health condition for users to determine whether normal or abnormal.

Table 2. Heart Rate [17]

Status	BPM
Rest/Normal	60-100
Sleeping	40-50
Athlete	40

Life-Based Learning Framework

A framework for life-based experiment consists of (1) design, (2) data acquisition, (3) video, (4) real-time report. The aimed of this framework was to encourage the students to learn the IoT system as a whole person not only to become a worker of Industry 4.0.

RESULTS AND DISCUSSIONS

Real-Time Heart Rate Monitoring

Figure 2 shows the BpM monitoring page on the smartphone application. The bottom tab is provided to change to another parameter monitoring page. The application provided 30 data (1 data taken every 5 seconds) which was updated in real-time.

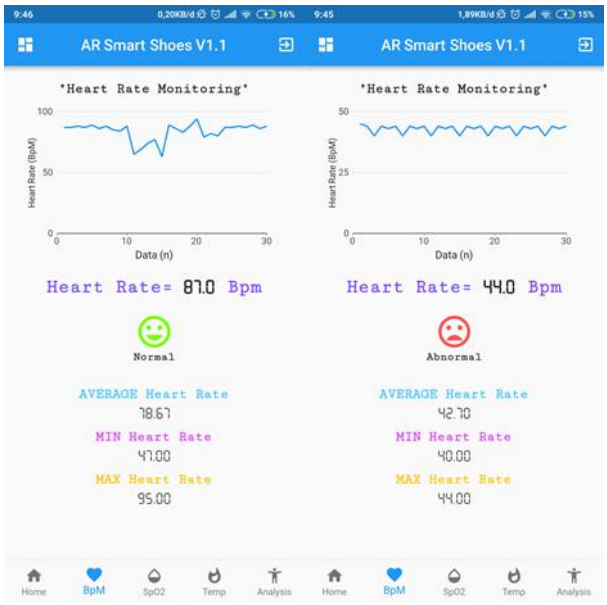

Fig 2. BPM result

Minimum and maximum Bpm values of 30 data are displayed to give users an idea of the activity of the heart.

Impact on Education

A survey on undergraduate students at the Department of Electrical Engineering, Universitas Negeri Malang was held on last October 2018. Several items were used to measure the student's enhancement through life-based learning compare to the traditional experiment, namely: interest and grade. Fig. 3 shows the videos to help the students to learn how to design the system. The video was divided into four parts, namely, preparation, design, test, and experiment.

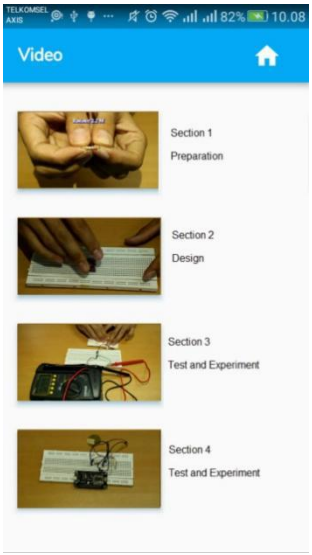

Fig 3. Education Video

Fig 4 life-based experiment

Fig 4 shows the activities of a student while doing a life-based experiment. They collaborated, learned in a group, and conducted a discussion on the next design. Fig 5 shows the results of our survey that show a gradual increase from 73 to 78. Also, the interest of the student could improve to 6.

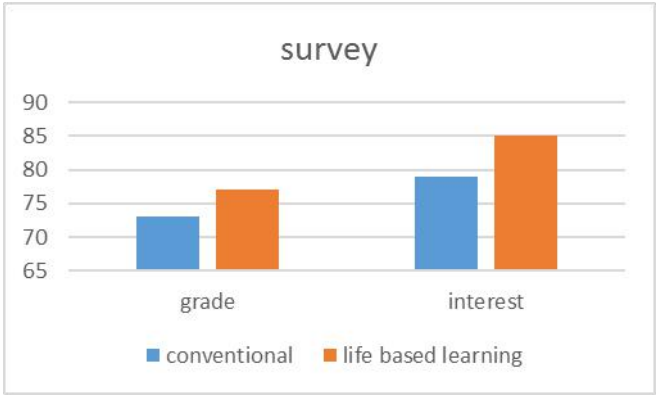

Fig 5. Survey result

CONCLUSION

Smartphone apps for remote heart rate monitoring were developed successfully. The user heart rate was monitored and displayed on the smartphone. Besides, life-based experiment using this app was proven successful. There was a margin of about 4% for both items, grade, and interest.

For now, this research placed the sensor on the index finger to measure heart rate, SpO2, and temperature. The next project would implement the hardware on the shoes (named it AR smart shoes). Besides, we would improve the data acquisition for calculating heart rate as developed in [18].

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