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Low-cost Physiological Parameter Development using Internet of Things Based for Monitoring Health Elderly

Bedjo Utomo[1]*, Triwiyanto Triwiyanto[1], Sari Luthfiyah[1], Wuri Ratna Hidayani[2], Lukman Handoko[3]

[1]Department of Medical Electronics Technology, Health Polytechnic, Ministry of Health Surabaya, Surabaya, East Java, Indonesia; [2]Department of Public Health, STIKes Respati Tasikmalaya, Singaparna, Indonesia; [3]Head of the Fire and Safety Work Laboratory, Shipbuilding Institute, Polytechnic Surabaya, Surabaya, Indonesia

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***Correspondence:** Bedjo Utomo, Department of Medical Electronics Technology, Health Polytechnic Ministry of Health Surabaya, Surabaya, East Java, Indonesia. E-mail: bedjoutomo123@gmail.com
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Abstract

BACKGROUND: In today's digital era, the development of technology and information is so fast not only in the world of medicine and medical equipment but also in the model of health services so that many e-services are found, such as Alodokter and Halodoc. As well Internet of Things (IoT)-based technology IoT makes the method that can be used for remote services easy to reach and low cost, this is very significant in helping home care services in the elderly.

AIM: The goal of this research is to develop the design of telehealthcare based on IoT, especially the vital signs of monitoring for the early detection of diseases in the elderly through health-care services.

METHODS: This type of research is experimental with the design of equipment design using IoT based with parameters of a biomedical temperature sensor, heart rate, and SpO_2 sensor for monitoring health elderly integrated into smartphone applications through programming Arduino ESP 32 microcontroller as a transmitter.

RESULTS: The results of this study consist of two stages, including first determining the accuracy value of biomedical sensor data results by measuring the error factor, namely, for beats per minute sensor, data have a deviation error of 1.6 and SpO_2 deviation error of 0.25 and temperature deviation error of 0.16 with a confidence level of 0.05% and second comparing parameter values to standard values using *t*-test tests with $p > 0.05$ results means that there is no significant difference between parameter values and standard values.

CONCLUSION: The results of this study can be concluded that the physiological parameters, such as spo2, bpm and body temperature can be used for health monitoring in the elderly, and it is hoped that the results of this research design can be used for early detection of the elderly for routine health checks using a smartphone application

Introduction

Health monitoring is needed to determine physiological conditions and health risks. Every change in the value of biomedical parameters, such as oximetry levels, heart rate, and temperature, can be predicted for the occurrence of disease, this can be assisted with the help of current technology and information devices [1]. The development of medical information technology and the development of nutritional science. Standards of health parameters, such as any physiological changes in the body, can be easily identified and easily resolved with the provision of drugs and nutritional food so that it is very helpful to increase the level of human life expectancy, especially the elderly which has an impact on activities of daily life [2]. Elderly growth is predicted to increase rapidly in the future, especially in the developing countries, such as in Indonesia as a developing country will experience an explosion in the number of elderly people, based on estimates 2010–2035 age groups 0–14 years and 15–49 will decrease, while the age group of 50–64 years and 65+ will continue to grow.

According to the 1999 BKKBN report in Probosuseno, (2007) in 1995, the benchmark for the elderly at 7% in each region jumped, such as Yogyakarta (12.5%), East Java (9.46%), Bali (8.93%), Central Java (8.8%), and West Sumatra (7.98%), these data are used to estimate the increase in the number of elderly people in the next few years. The increasing number of elderly people in Indonesia certainly needs serious attention from the government social services and health services related to the aging process. The elderly need special attention in health, independence, care, and respect [3].

The main problems faced by the elderly in general include aspects: Physical, health, mental, and social. Approaching the aging process, the problems faced by the elderly make the elderly need services from various parties. Therefore, comprehensive treatment is needed as an effort to improve social welfare for the elderly [4].

Efforts to improve the social welfare of the elderly according to Government Regulation Number 43 of 2004 are a series of activities carried out in a coordinated manner between the government and the community to empower the elderly so that the elderly can still carry out

their social functions and play an active role naturally in the life of society, nation, and state. Efforts to improve the social welfare of the elderly can be carried out through the form of health services for the elderly, one of which is home care services. As in the Regulation of the Minister of Health Number 29 of 2014 concerning clinics which state that health services can be carried out both promotively, preventively, curatively, and rehabilitation, therefore, elderly activities are carried out in the form of outpatient, inpatient, 1-day care, and/or home care [5].

Home care services aim to increase, maintain, or maximize the level of independence and minimize the consequences of illness [6]. Along with the development of technology and information, the role of telemedicine is an alternative to be developed further. To support the plan for the development of the Surabaya Ministry of Health Poltekkes institution, especially in the field of health technology, it is necessary to make continuous and innovative development efforts, one of which is prevention, promotive, and rehabilitative efforts. One important factor is the change in behavior patterns that lead to a good value system carried out in the form of services and health service technology, therefore, the role of telemedicine, in this case, is very helpful in overcoming services, such as equitable service, wide coverage, reducing services. referrals, providing fast access, easy access to expert doctors, patients staying close at home, and cost and time efficient so that this is very helpful in services in the form of home care [7].

Several research applications on telemedicine have been carried out, such as telehealth, telenursing, smart care, and smart home. However, there are still obstacles, especially in the problem of providing technology and information systems and managing service management which has not been accommodated. Therefore, a research study is needed that will combine information technology and e-Health through applications and health-care information systems.

Ahmad *et al*. (2020) in his article entitled The Future of Healthcare Internet of Things (H-IoT): A survey of emerging technologies explains how important it is to develop an IoT platform in health-care services which is defined as the H-IoT [5], which is a basic technology that allows including communication systems between sensing nodes and processors; and processing algorithms to produce output from data collected by sensors and currently allows technology to be supported by several new technologies, such as the use of artificial intelligence (AI) in H-IoT systems at every hardware and software level [8].

Dimitrov (2016) in his article entitled Medical IoT (M-IoT) and Big Data in Health care explained the M-IoT which integrates telemedicine and telehealth service systems to collect all patient data that can be used to analyze patients in critical condition [9]. Sharma and Tripathi (2020) in his article entitled Performance of IoT-Based Healthcare Secure Services and Its Importance: Issues and Challenges which explains the analysis of the development of IoT-based health care and future challenges regarding data security issues [10].

Learning from the descriptions of several research articles, the development of IoT-based designs for several cases in the field still needs to be considered, especially in cases of care and counseling for the elderly [11]. Tynes (2019) in her research on Diffusion of Telehealth: Analyzes several Telehealth applications (Teleradiology, Teledermatology, Telepathology, Telepsychology, and Remote Monitoring) on the relative aspects of advantage, compatibility, complexity, and observational capability shows that remarkable progress so that forms of innovation and development of telehealth can be considered for health services and several applications using biomedical sensors have also been developed for health services, as have been done in Kumar. (2017) research on IoT-based health-care design that uses multiple sensors for widely accessible health care, such as measuring blood glucose, temperature body, heart rate, and ECG [12].

Researchers, Depolli *et al*. (2016), are known to have developed a PCARD platform for smartphone-based real-time ECG monitoring equipped with data storage which aims to introduce information and communication systems in health services to improve health management independently at affordable costs and efficiency [8], [13]. Furthermore, the results of a study entitled: IoT and Smart Homes for Elderly Healthcare: An End-User Perspective by Debajyoti Pal *et al.* (2018) have shown an increase in behavior toward the IoT-based homecare service perspective to increase the life expectancy of the elderly. The survey results showed that 82.4% of technology anxiety, costs, and social influences had no effect on behavioral intentions for smart home use [14].

The purpose of the study is to create a health monitoring application system, especially the health of the elderly, which can be monitored by health workers in-home care services remotely and from an economic point of view it will be cost savings. In this study, we focus more on several parameters that are considered vital parameters, such as the use of biomedical sensors for monitoring (SpO_2) levels, heart rate, and temperature. By utilizing technology and communication systems, this equipment uses the ESP32 microcontroller as programming and node MCU for the wifi module which can be integrated into Blynk application as a communication facility user to user [15].

Methods

This research is an experimental study with the design of a biomedical sensor data equipment module

design consisting of oximetry data (SPO_2), heart rate (beats per minute [BPM]), and temperature with the help of the ESP 32 microcontroller program and wifi module IoT [16]. The data will be connected in real time to the Blynk application with Android by operating system. The Purpose of this study was to monitor health parameter, such as signal Oximetry SpO2, heart rate BPM, and temperture by real time with a remote system. Observations were made on the subject for 1 min to obtain continuous data from 30 biomedical parameter data, Figure 1.

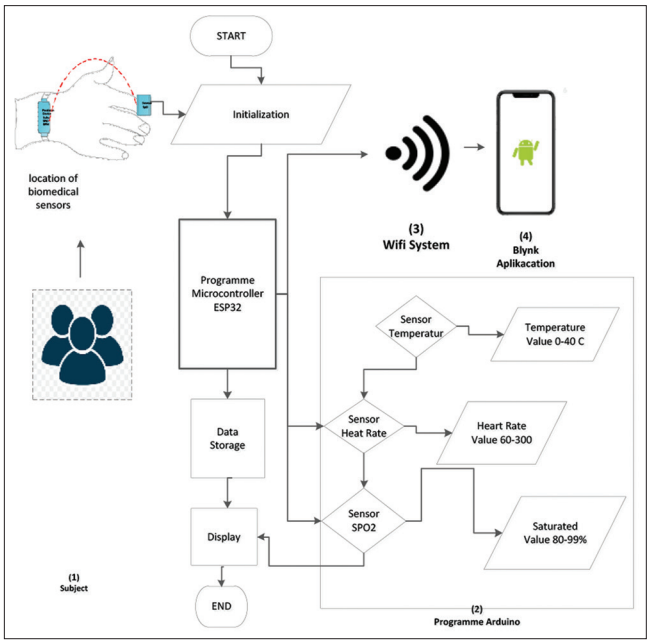

Figure 1: Design diagram and model of biomedical sensor data equipment (SpO_2, BPM, and temperature) for health monitoring

Then, a statistical test analysis is performed using the *t*-test to produce the level of difference between the module and standard equipment**.** In the context of the picture, it also shows the flow of the global module design system and the parts of the subsystems involved in the system as a whole, the linkages and interactions between the subsystems, namely, through [17]:

1. Initialize sensor data
2. ESP32 microcontroller programming
3. Data storage
4. Display.

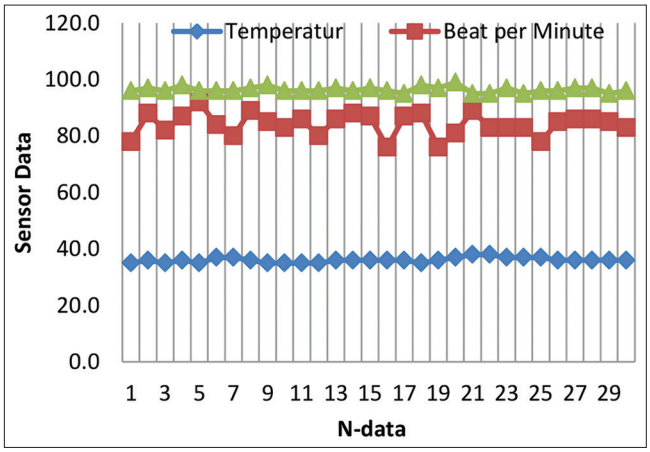

Figure 2: Biomedical data sensor on equipment module

This research focuses on designing the module using the Arduino ESP 32 microcontroller program as the basis for initializing the temperature, heart rate, and SpO2 sensors. The purpose of this study is to design a health service application system for monitoring the health of the elderly. This series of systems takes data from the index finger using the max 30100 sensor and body temperature data are taken from the wrist as well as the use of this sensor for hypoxemia detection for patients [18]. The use of a pulse sensor works like the working principle of photoplethysmography, where the optical method is relatively simple and inexpensive to detect noninvasive changes in blood volume for each heartbeat in the vascular network (Allen, 2007) [18]. The signal generated by the sensor produces a wave called photoplethysmogram.

The Wi-Fi system embedded in the Arduino ESP 32 will be connected to the internet. Furthermore, visualization of patient health data can be accessed in real time on the android application through the Blynk application making it possible to analyze medical data as patient health information [19].

Results

The results of taking subject data on module equipment taken from the subject with the sensor position in hand for 1 min (60 s) produce 30 data records, while the acquisition data can be seen in Figure 2 [20].

Figure 1 shows the trend of changes in biomedical sensor parameter data on the equipment module for 60 min. As for the parameter data of each, as follows: (a) The average temperature sensor data of 36° with an average deviation of 35 + 3.91. (b) Average heart rate sensor data of 84.1 BPM with an average deviation of 84.1 + 0.72. (c) Average oximetry sensor data: 96.4 with an average deviation of 96.4 + 0.18. The value of data transmission speed on internet network systems is 0 s so that the speed of data accuracy can be quickly conveyed to patients.

Discussion

This research was conducted to facilitate health services, especially home care services for the elderly by utilizing the development of technology and communication based on the IoT. The use of communication technology cannot be separated from the increasing use of internet media in Indonesia. Internet users in Indonesia, in July 2021, online penetration

Table 1: Analysis biomedical data sensor between module tool and manufacturer t-test: Paired two samples for means

Statistic Parameter	Oximetry module	oximetry standard	Heart rate module	Heart rate standard	Temperature	Temperature standard
Mean	96.253	98.633	82.638	83.0	36.067	36.450
Pearson correlation	–0.024		0.264		0.078	
p (T<=*t*) two tailed	1.13E-11		0.665		0.022	

reached about 70%. Popular online activities include mobile messaging and social media. The most popular social network in Indonesia is YouTube, about 94% of the online population uses the platform (statista.com). Hence, it can be said that the use of the internet has now become a basic need in everyday life, therefore, in research on designing IoT-based vital sign parameter monitoring tools must be used by the elderly, where the monitoring tool is very efficient both in terms of time and cost operational. Telehealthcare uses the Blynk application as a tool to monitor vital health sign parameters that can be seen visually on smartphones [21], [22].

In the table above, data analysis is carried out to see the difference between the parameters using the comparison module and tool using the compare paired sample *t*-test, the results are as follows.

From the results of the data analysis using Excel for Windows, the correlation value for each parameter shows that it's −0.024 for oximetry, 0.264 for BPM, and 0.078 for temperature. The correlation value is more than 0.5 indicating the higher the correlation or over wise. While seeing the significant level of difference can be seen in the p value, p > 0.05 indicates no difference or over wise, this can be shown in the oximetry parameters (p = 1,13E-11) and beat per min (0.665) as shown in Table 1 [23].

Conclusion

From the results and discussion of this study, it can be concluded that the development of information technology in the design of biomedical equipment for monitoring such as heart rate, temperature, and oximetry rate is very helpful in improving health care services. Furthermore, based on IoT technology, it is very possible to reach more and more affordable services with internet coverage that is evenly distributed throughout areas that are not covered by health facilities. Furthermore, the development of health-care designs still requires good coordination between medical/paramedical personnel and local health institutions regarding the service models.

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