# Health Monitoring System for Elderly Patients

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**Abstract.** Indonesia experienced an increase in the number of elderly people from 18 million people (7.56%) in 2010 to 25.9 million people (9.7%) in 2019, and is expected to continue to increase where in 2035 to 48.2 million people (15,77%). On the other hand, this increase in age is accompanied by complexity of problems faced by the elderly. This happens because the increase in age entails a decline in various functions of the human body, which puts the elderly wiatigher risk factors for various degenerative diseases. The reduction of many community-based services and the social distancing restrictions thatng the COVID-19 pandemic are some of the primary reasons for using health technology to provide remote monitoring for the elderly. This study proposed the system that naa LansiaCnaansiaCare that was designedis signs such as heart rate, blood pressure, oxygen saturation and temperature. This system using a wearable device (smart banuses a Data Acquisition Device (DAD). Once the data is retrieved, it is sent to the cloud system and displayed on the mobile application (family and elderly people) and dashboard (doctors and medical staff). Medical sensors are used to collect vital sign data from patients and to collect physiological data from patients. The last stage is making the interface design for the application. This mobile application for the elderly is made by paying attention to every aspect of the user interface that is in accordance with the needs of thebyeatures needed by the elderly so that their health conditions can always be monitored by the elderly themselves, their families, and medical staff.

**Keywords:** elderly · health monitoring system

## 1 Introduction

One sign of successful national development is an increase in the life expectancy of a country [1]. This is also reflected in the increasing number of elderly people. We are entering the ageing population period, where there is an increase in life expectancy


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followed by an increase in the number of elderly people. Indonesia experienced an increase in the number of elderly people from 18 million people (7.56%) in 2010, to 25.9 million people (9.7%) in 2019, and is expected to continue to increase where in 2035 to 48.2 million people (15,77%) [2]. On the other hand, this increase in age is accompanied by a complexity of problems faced by the elderly. This happens because the increase in age entails a decline in various functions of the human body, which puts the elderly with higher risk factors for various degenerative diseases. Furthermore, health care costs increase as the world's elderly population ages.

Health care costs increase as the world's elderly population ages, and the demand for better outcomes in the management of chronic diseases in the elderly makes e-health an effective technological solution in the current era [3]. E-health provides potentially cost-effective remote support for self-management of chronic disease, as well as convenience and flexibility of access, and individualized feedback [4].

The development of e-health shows promising intervention results for the prevention and treatment of chronic diseases in the elderly, including web-based communication [5], mobile phone apps [6], and smartwatch or wrist monitoring devices [7].

The global pandemic of Corona Virus Disease 2019 (COVID-19) has significantly changed Indonesian outpatient services [8]. Since the epidemic was declared on March 11, 2020 - January 17, 2022, there have been 4,271,649 positive cases of Covid19 and 144,170 deaths [9]. 76% of countries reported a decrease in outpatient treatment. The most frequently mentioned factor was the cancellation of selective services (66%) [10]. Other factors mentioned were the relocation of staff to provide COVID-19 relief supplies, the inability to use services due to the closure of medical facilities or services, and supply chain difficulties.

Elderly patients with chronic disease who need regular treatment discontinue treatment due to reluctance to visit medical facilities. The reduction of many community-based services and the social distancing restrictions that occurred during the COVID-19 pandemic are some of the primary reasons for using health technology to provide remote monitoring for the elderly [11].

As a result, health technology has become an integral part of healthcare delivery. The importance of health technology in treating chronic diseases is becoming more apparent, and therefore the development of e-health care services for the elderly should be prioritized.

LansiaCare is designed to be able to monitor vital signs such as heart rate, blood pressure, oxygen saturation and temperature. The monitoring uses a smartwatch ad a data acquisition device. This data is then transmitted using the internet network to health facilities. Processing in the system produces information that can be used by health workers to provide feedback directly to the elderly and to their immediate family.

Previous studies have reported that long-term monitoring of daily vital signs helps detect changing patient conditions for medical diagnosis. This is very beneficial for people with chronic disease[12]. People with chronic disease are continuously monitored for vital signs. Vital signs include measurements of body temperature, respiratory rate, pulse, blood pressure, and blood oxygen saturation [13]. Advances in information and communication technology have greatly helped remote monitoring. However, little is known on the development of symptoms and signs remote monitoring for elderly with chronic illness. Therefore, we aimed to develop a monitoring system for elderly.

## 2 Literature Review and Related Work

Various studies are being conducted by many researchers to monitor the health of patients. One of the most important health monitoring solutions is the Internet of Things (IoT) application. It is used to monitor and regularly track the patient's health. These applications can significantly reduce the number of patients visiting hospitals to monitor their health.

These IoT applications offer different levels of accuracy and options, especially in the area of remote monitoring, due to their different software and hardware implementations.

Narasimha Rao used sensors connected to Adriano's microcontrollers to design a model primarily focused on remote health monitoring. The cloud was used to process and analyze the data collected from the entire system [14]. Rapin et al. proposed a work where a wearable sensor was designed for frequency-multiplexed EIT [15]. The architecture was designed for the proposed system and was based n-cooperative sensors which minimized the need for cabling. A low-cost motion sensor was designed by Javier Hernandez that measured the opportunistic heart rate assessments [16].

Jassas et al. designing integration between cloud environment and health monitoring system. Human body temperature monitoring using a Raspberry pi motherboard connected to a cloud-based system. Sensors connected to the Raspberry Pi record the temperature of the human body, and these readings are sent using the Wireless Sensor Network (WSN). This will send the record to a cloud-based website where you can monitor your data.[17].

Yusuf et al. developed a system that allows patients to report their health based on the level of pain they were feeling at the time. Visible health includes input values for pain levels based on body part, temperature, and heart rate. The system will notify the doctor of further contact and advise the patient to check their health at the clinic. The system allows patients to request a health check online and easily see the treatments for their doctor's illness [18].

Karajah et al. created a health station system for monitoring vital signs called "heart monitor" that can measure a patient's heart rate and body temperature and record them in a cloud service. Medical staff can then access cloud services in real time to monitor patient health anytime, anywhere [19].

Parihar et al. developed consisting of a heart rate sensor controlled by a microcontroller, a body temperature sensor, and measurements displayed on an LCD monitor. This approach uses the wireless system "nRF24L01" to send the measurement data from the remote site, the data will be displayed on the receiving side [20].

Our monitoring system measures heart rate, oxygen saturation, blood pressure and body temperature have the potential to monitor these values from anywhere via an internet connection.

## 3 Method

We developed monitoring system for elderly patients. The system created in this monitoring is shown in Fig. 1.

This study began with a selection of wearables to obtain data on oxygen saturation, blood pressure temperature and heart rate. Once the data is retrieved, it is sent to the cloud system and displayed on the mobile application (family and elderly people) and dashboard (doctors and medical staff). Medical sensors are used to collect vital sign data from patients and to collect physiological data from patients.

### 3.1 Data Acquisition

The vital signs monitored by this tool are oxygen saturation, heart rate, and blood pressure.

*Oxygen Saturation* is the ratio between the amount of hemoglobin bound to oxygen compared to the total hemoglobin (whether bound or not bound by oxygen). The higher the oxygen saturation value, the more effective it is to bind oxygen and distribute it throughout the body.

*Heart rate* describes how fast the heart beats. Variations in heart rate can describe a person's activity as well as can be an indicator for doctors to find out the disease.

*Blood pressure* is the pressure exerted by the blood flowing against the blood vessels. Blood pressure is indicated by a maximum peak pressure called systolic and a minimum peak pressure called diastolic.

The wearable medical sensor that has been used to collect raw oxygen saturation (SpO2), heart rate (HR), and blood pressure (BP) data is the photoplethysmography (PPG) sensor. PPG is a non-invasive optical technique for measuring changes in blood volume based on changes in the intensity of light transmitted or reflected through human organs. The principle of PPG sensor displayed in Fig. 2.

Photopretismography using a light source consisting of an LED (light emitting diode) and a PD (photodetector) to detect the presence of changes in blood volume in a blood vessel. The data is sent using the Bluetooth TXRX module and is displayed in the mobile application on a regular instance basis.

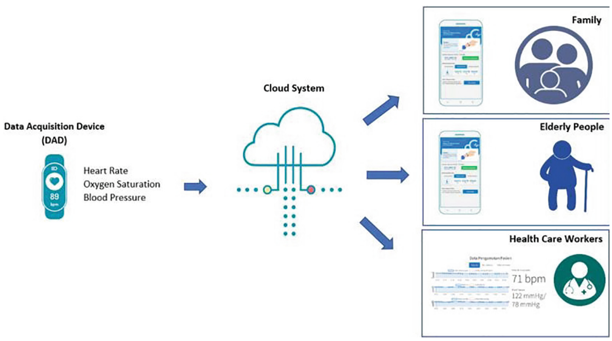



**Fig. 1.** The Design of Elderly Patients Monitoring System

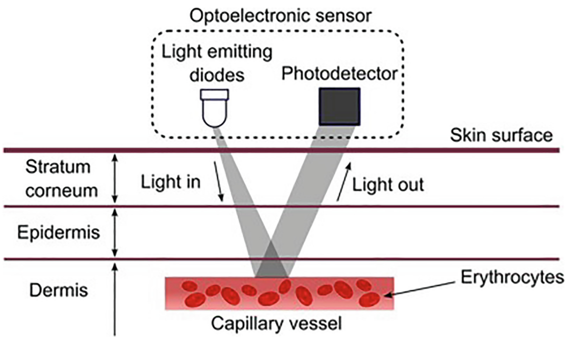



**Fig. 2.** The Principle of PPG Sensor [21]

### 3.2 Cloud System

Based on the proposed architecture, the health monitoring system can monitor and determine the patient's physiological status through real-time communication between the end user and the web services of the cloud computing platform. Cloud systems were chosen as data storage because they enable computerization processes, application execution, and the storage and processing of virtual data using the internet network connected to the server. All data and information can be recalled at any time as long as you are connected to the internet. Cloud storage systems also work online, making it easier to retrieve data. A ubiquitous healthcare system built according to the proposed framework can support four core processes further analyzed in this section.

**Data Collection**: For healthcare servicing, physical data are mainly collected from smart watch.

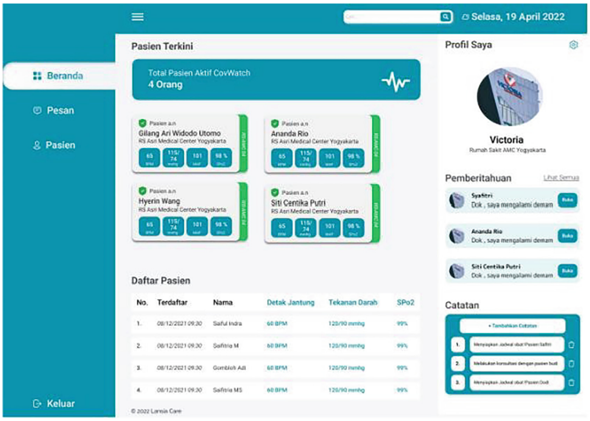
**Tenant Data Storage.** Health data are stored in the tenant database. The databases are isolated from each other.

Data on the cloud system will be displayed on the dashboard (doctors and medical staff), mobile application (patient and family). Data that appear on the dashboard are monitored patient data and vital data (oxygen saturation, blood pressure, and heart rate). Figure 3 present dashboard for doctor and medical staff.

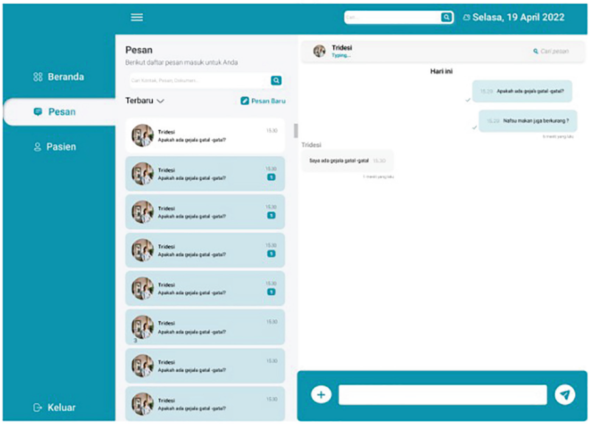
### 3.3 User Interface Design

The user interface (UI) is defined as a visual part of a computer application or operating system. Where users monitor software, applications, or hardware devices. It shows how commands are passed to a program or computer, and how information is displayed on the screen. A well-designed user interface provides a user-friendly design and Users can easily interact with the software or hardware. The GUI contains common graphical controls such as menus, toolbars, windows, buttons, icons, and other controls that enable this. For those who want to use the software and hardware without completely relearning the user interface. It also provides a consistent user experience across multiple programs.

In the design for the elderly, we need to consider the influence of age in the design. Basically, as we get older, our level of limitations, and illnesses increases. Interface design needs to take into account poor eyesight, loss of motor skills and cognition.




(a)




(b)

**Fig. 3.** (a) Dashboard of Patient Data (b) Dashboard of Doctor Data

Interface design for the patient have several components that need attention are shown in the Fig. 4.

**Color,** Older people have lower contrast. This capacity reduction applies to different color ranges, especially in the blue-green range. Therefore, when creating the user interface in this study, proper color contrast was used to improve and make vision clearer for older users. Use appropriate contrasting colors between the text and the background or between the foreground and the background, and use similar colors close together. On the other hand, it is very important to know that the contrast of colors with each other is made more or less visible than the individual colors themselves. These are simple three rules for making effective color choices [22].

**Font** is a vital component in UI design because they have a direct influence on vision, mood, and strength. Fonts are defined as characters that are displayed or printed in a certain shape and size [23]. Making fonts must consider the type and size. Using

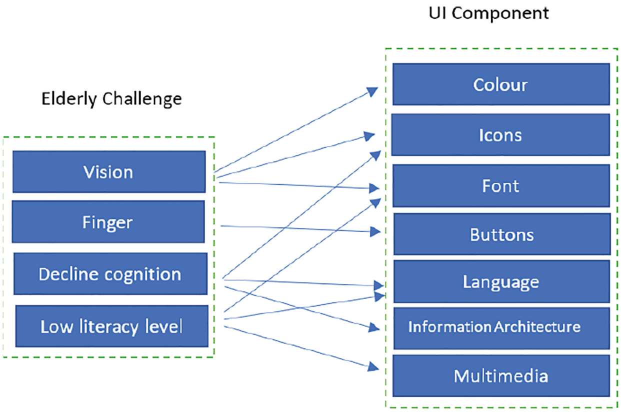



**Fig. 4.** Elderly challenges and User Interface Components

common and large fonts helps users avoid confusion regarding the text displayed on the screen. Using this font will positively affect learning and usage.

**Icons** play an important role in UI design and reveal information about functionality without use words. When the meaning of an icon is familiar to the user, the context in question can be identified quickly, perhaps faster than through reading a text message or label. In addition, icon size reflects positively on parents' visual cognition. Previous studies have found that there is difficulty in recognizing certain icons in different situations. For this reason, the icon itself and its size should be considered during UI design design.

**Button,** adopting large UI elements design in UI design, especially buttons, will solve problems associated with "fat fingers" and tremors. Large buttons provide sufficient space for the elderly to press the target button correctly without errors. Normal or small sized buttons cause parents to make a lot of mistakes forcing them to start over. This time and cause many users to abandon application or system use.

**Language** is an important part of the interaction and communication between the user and the UI interface and has a direct influence on the usability of any UI. Using proper and common words makes it easier for seniors to understand and use UI content.

**Information architecture** consists of buttons, icons, and layouts. With age, vision decreases. Therefore, to cultivate their environment, the elderly needs higher attention. In addition, application content must be clear and easy to find and simple designed to improve the learning ability of the elderly in using the system.

**Multimedia**, many elderly people have difficulty reading and writing, so they cannot use the system properly or optimally. The use of multimedia in user interface design enhances memory through action, sight and hearing. A shared user interface with video and audio sources will provide a comfortable, communicative and simple environment for users, especially parents.

## 4 Results and Discussion

The results of the design produce an interface design, taking into account the limitations of the elderly. The UI design of the "Lansia Care" mobile application consists of 3 pages, namely Home, Circle, and chat. Each page has a different function, but they are interrelated and complementary to support the performance of the application (Fig. 5).

The visual appearance of the home page will create a first impression in the minds of the audience which will determine the decision to continue exploring the application. A website or mobile application with a good appearance will only be felt by the audience the first time it is visited (Iswandi, 2018: 106). Thus, the impression that arises during the first interaction through the home page is the key to sustaining the audience to interact with the visual communication media.

*Color*

Visualization of the concept into UI design colors is done by applying a white background and several color variations to represent the "Lansia Care" product. The color variations of the UI design consist of 3 types, namely white, gray, and black. These colors were chosen because they do not have a strong enough contrast with white as the background. Next, black is used for fonts and icons. This color choice was chosen because the elderly will find it easier to see text and icons with colors that contrast with the background.

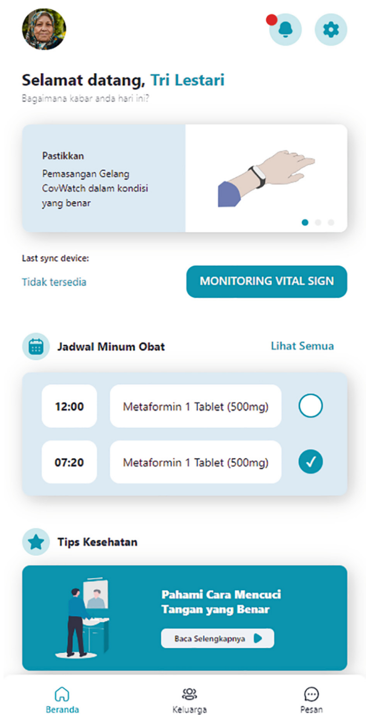



**Fig. 5.** Home Page of Lansia Care

*Font*

This user interface design uses 2 types of fonts. The font chosen are font that are easy to read, because the elderly has limited vision. The letters for each feature use the bold style, while the letters for the description use the regular style. Use bold to indicate that it is a feature, so that the eye can focus on the letter. In addition to the type and style of the font, the font size is also considered in the design of the user interface. Large font sizes are used in this UI because the elderly have difficulty appearing to read small font sizes.

*Icon*

The icon used in the user interface is an icon that symbolizes each patient's vital sign, namely oxygen saturation, temperature, blood pressure, and heart rate. This icon was chosen so that it is easier for the elderly to understand the meaning of the feature.

*Language*

Bahasa is used in this application, because not all the elderly has good skills in the use of foreign languages. This language was chosen because it is considered the most familiar to users, the words used in the application also use words that are commonly used.

Another page of this user interface is shown in the Fig. 6.

This mobile application for the elderly is made by paying attention to every aspect of the elderly's needs, the user interface design adapts to the limitations of the elderly such as poor eyesight, loss of motor skills and cognition.

In addition to paying attention to the user interface design, another thing to consider is the application features. This application has a feature to add family contacts and health facilities, besides that there is also a chat feature that makes it easy for the elderly to always connect with doctors or medical staff. The main feature of this application is that it can display reports on the patient's vital signs, so that any changes in the patient's condition can be monitored by the elderly, family and medical staff.

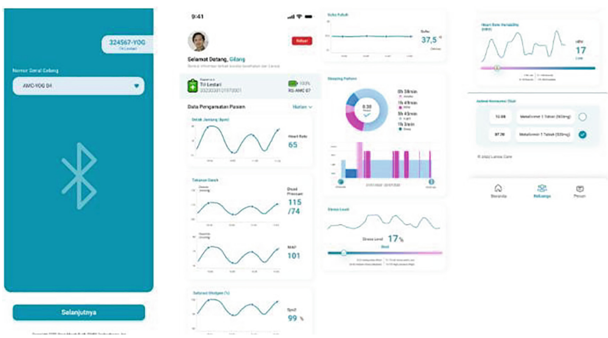



**Fig. 6.** Display Vital Sign Monitoring

## 5 Conclusion

Elderlycare is made to monitor the patient's vital signs. The patient's vital signs are taken using a smart band as a Data Acquisition Device, then this data is stored in the cloud system. This data can be used by patients, families and medical staff to find out the patient's condition in real time.

In making the user interface, there are several factors that need to be considered, considering that this application is intended for the elderly, these include colors, icons, fonts, multimedia and language. In addition, the application for the elderly also requires connected contacts and chat features to make it easier for the elderly to communicate with family or medical staff.

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