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IOT BASED MOBILE APP FOR OLD AGE PEOPLE MONITORING SYSTEM THROUGH WEARABLE SENSORS

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ABSTRACT:
Health is essential for human survival, particularly for elder people. In contrast to previous generations, the prevalence of diseases has increased in recent days, which makes health management more important. There has been a rise in the number of diagnosed cases of heart disease as well as other illnesses, highlighting the need for a continuous health monitoring system (HMS). Current HMS necessitate periodic hospital visits to track their health, which can be difficult for elderly people. The project's goal is to establish an HMS that will allow people to be monitored 24 hours a day and reduce the requirement for frequent hospital visits. Wearable sensors and IoT technology make it possible to learn about a person's health status in this way. The sensors are attached to the microcontroller and can monitor a few parameters, such as temperature, Heart Rate (HR), Blood Pressure (BP), and oxygen levels. Once the WiFi module has established a connection to the internet, the microcontroller takes the role of a server and begins transmitting data to a predetermined URL. Those parameters can be viewed on a mobile application which is linked to the same network. If the respective health parameters become abnormal, the notification about the abnormalities and the location of the person will be sent automatically to the mobile phone using the Global System for Mobile Communication (GSM) and Global Positioning System (GPS).
KEYWORDS: Sensors, Global Positioning System, Health Measures, Mobile Application, Remote Monitoring, Firebase

INTRODUCTION:

Throughout the world, people are getting older [1]. In 2019, there are 702.9 million people aged 65 and up in the world, a figure that is expected to more than double to 1548.9 million by 2050, a 120% increase. As a result, the types of illnesses for which people seek medical attention have shifted, with the majority of them being those typically associated with ageing. Dementia is the most common, ranging from mild cognitive impairment to the severe cognitive and functional impairments associated with Alzheimer, neuro disorder. The number of people affected by dementia worldwide is expected to triple, from 50 million in 2019 to 150 million in 2050 [2]. 70% of them require continuous care from someone else [3]. However, there is no effective method for reversing cognitive difficulties in the patient population at the moment. When doctors have completed and accurate data about their patients' health, they can develop tailored plans to treat their symptoms and slow the progression of their disease.

Therefore, IoT has the potential to lessen the burden on human carers and enhance the quality of clinical decision-making by providing constant, reliable, and detailed monitoring. Through the use of wearable technology, the IoT is a cutting-edge idea that enables healthcare monitoring. The IoT is a system of interconnected devices that could automatically collect data from their immediate environment, respond to it, and share that data with other nodes in the network. There has been a lot of talk in the last decade about using the IoT for things like fitness trackers, which have become more affordable thanks to the introduction of wearable gadgets with sensors. These smartwatches and bracelets can monitor a human's activity levels throughout the day without generating any major inconvenience or discomfort [3]. Smart fabrics, belts, shoes and eyewear are now on the market, adding to the list of smart devices.
The paper is structured as follows. Section 1 summarizes the need of monitoring elder people, Section 2 review recent studies and their aspects, and Section 3 discuss the suggested system by joining hands with a block diagram, and details necessary things like hardware and software requirements. Section 4 deliberates the outcomes of the suggested system, and Section 5 concludes the suggested work.

LITERATURE REVIEW:

Research into assistive technologies for the elderly is a relatively new topic, so a systematic, and comprehensive review is required to investigate both current practises and potential future directions. We provide a comprehensive literature review of IoT devices for elderly care. Targeted are existing review papers as well as case studies, and common technological and clinical factors are identified. A selection of current individual research on the use of technology in the care of the elderly conducted in recent years (2020-2023) is shown below.

The authors [4] have been developing an accelerometer-based wearable device for elderly monitoring systems. The accelerometer sends data to a service called ThingSpeak, which is an IoT platform. Patients over the age of 65 can be remotely monitored using an IoT platform as long as carers have internet access. They describe the outcomes of research carried out to assess the accuracy and reliability of the accelerometer used in the proposed arrangement. This is where accurate data collection for monitoring purposes begins. The experimental results indicate that both the sensitivity and specificity tests are effective.

In the research paper [5], the authors propose a wearable IoT HMS for keeping tabs on basic health measurements over time. The suggested system is an integrated device that can track physiological parameters like HR, respiration, and temperature. The data and preliminary forecasts are delivered via an IoT cloud framework, where specialists provide input that can be utilised for extra action, such as remote monitoring. The data and preliminary forecasts are provided via IoT, where experts provide feedback that can be used for additional action, such as remote monitoring. In the event of any critical changes, the doctor and closest contacts have been notified. Recent advances in covid necessitate prompt notification of a professional if any changes in body temperature are discovered to be below or above the normal value, or any respiratory issues with abnormal values. The sensor values are checked regularly, and a GSM module is linked to an Arduino to send out alerts. The proposed IoT-based patient HMS makes it easier for medical professionals and family members to monitor their health. The study met its primary goals of predicting the likelihood of unrecognised or untreated health effects and monitoring patients' health.

The author of this study [6] describes the steps taken during the critical design phase of developing an IoT-based HMS dashboard for elder care in the cloud. The levels of vital signs, core temperature, and oxygen saturation are all monitored. These measures could be used to track an elderly person's overall health. An accelerometer sensor is used to predict the likelihood of a fall as an added safety measure. Lastly, a real-time interface was established for integrated data monitoring and alert warnings. And the system is extendable to accommodate the increasing demand for more health-tracking devices.

The primary goal of the research presented in the paper [7] is to monitor nursing home residents around the clock. Because many nursing home residents are elderly with chronic health conditions, it is critical to constantly monitor residents' vital signs. To that end, an OpenThread-based mesh system was developed. Particle Xenon and Particle Argon served as capillary gateways and access points in the OpenThread mesh network of interconnected devices. All of the nodes continuously monitored the person's HR or beats per minute, and the data was transmitted to the cloud via a gateway. Whenever a node is not directly connected to the gateway, data is routed to other neighbouring nodes until it reaches the gateway. The data is pulled from a cloud-based database and displayed in real-time via an Android app. This programme was designed to send an alert whenever the user's HR deviates from the normal range. In addition, the app includes a medication reminder that notifies users when it is time to take their prescribed medications.

The authors of the paper [8] describe the development of a geriatric-targeted smart home-friendly wearable health monitoring device. The suggested system gives alternatives for observing a person's mental state, physical wellbeing, and locations in a home automation context. In this research, they present a stress identification model that uses sensors in a wristband to monitor physiological stress. The model is trained and tested with salivary cortisol. They simulated a data gathering and streaming setup in addition to constructing a voice-based prototype to examine the viability of integrating the suggested system into a home automation context. In addition to developing a stress prediction model, they developed a BP estimate system based on PPG inputs. Finally, in a home automation context, a voice-assisted indoor tracking method is shown and built to work in tandem with the developed framework.

The paper [9] demonstrates that all patients who require assistance, not just those who are bedridden, are regularly monitored. To effectively capture and publish real-time data related to patients, they designed, built, and deployed an energy-efficient, reliable, cost-effective, and readily available patient monitoring system. The temperature, HR, electrocardiogram, and patient position can all be tracked in real-time, making it a valuable tool for medical professionals. It's a two-way street, so it's not just healthcare experts that can help out; patients' family members can, too. The developed scheme for the patient's health will periodically and routinely check their health data. This paper also highlighted the numerous challenges that must be overcome when integrating IoT into real-time HMS.

The study [10] proposes a method for continuously monitoring the health of nursing home residents. This elderly HMS's primary goals are to record and display vital signs like HR and temperature, as well as to record and display an electrocardiogram. Simultaneously, indoor air quality is measured. In addition, a cough-detection system that can identify common respiratory illness symptoms has been added. The data collected by connected sensors can be viewed in real-time by patients. Databases also collect and store this kind of data. It enables remote health care providers to examine an old person. Therefore, the suggested method can help individuals get to the hospital promptly if they fall sick.

The research [11] creates novel methods to help the elderly remain self-sufficient and connected to their communities. Information and communication technologies have the potential to help seniors maintain their health and independence for longer periods. Ambient Assisted Living (AAL) researches how new forms of healthcare and rehabilitation technologies can help the elderly and those with physical disabilities. The recent decade has seen a surge in the study and improvement of AAL systems that facilitate independence. AAL can enhance people's lives in a variety of ways, including helping them live longer, healthier, and more independently; assisting those with disabilities; and facilitating the work of carers and medical professionals. This paper's literature review compares and contrasts the various AAL methods currently in use, highlighting their respective strengths and weaknesses.

METHODOLOGY:

It is crucial to keep an eye on the aged population today. Due to the lack of a reliable support system, the elderly is increasingly dependent on the care and attention of others, and this cannot continue forever. With the aid of cutting-edge technology called IoT, we advise the HMS, particularly for the elderly. Continuous measurements of temperature, HR, BP, and oxygen levels are taken. Sensors for measuring these variables are decided after reviewing the relevant literature. It was determined whether or not the measured health values fell within the accepted normal range. An alert message, including the user's current location, will be sent to their registered mobile number via GSM and GPS if the measured parameters deviate from the typical range. The normal range of health parameters is tabulated in table 1. Using a mobile app, doctors and family members may keep tabs on an elderly person's vital signs. The idea behind this mobile app is to capture health parameters from a sensor and upload them to the cloud via a Wi-Fi module. The information is retrieved from the cloud and shown on the mobile app. The preceding idea will be simplified and illustrated in Figure 1.

Table 1. Health parameters range for old age people

Health Parameter	Range
HR	60-100 beats per minute
Blood Oxygen	95-100%
BP	120/80 mm Hg

Temperature	98.6 F

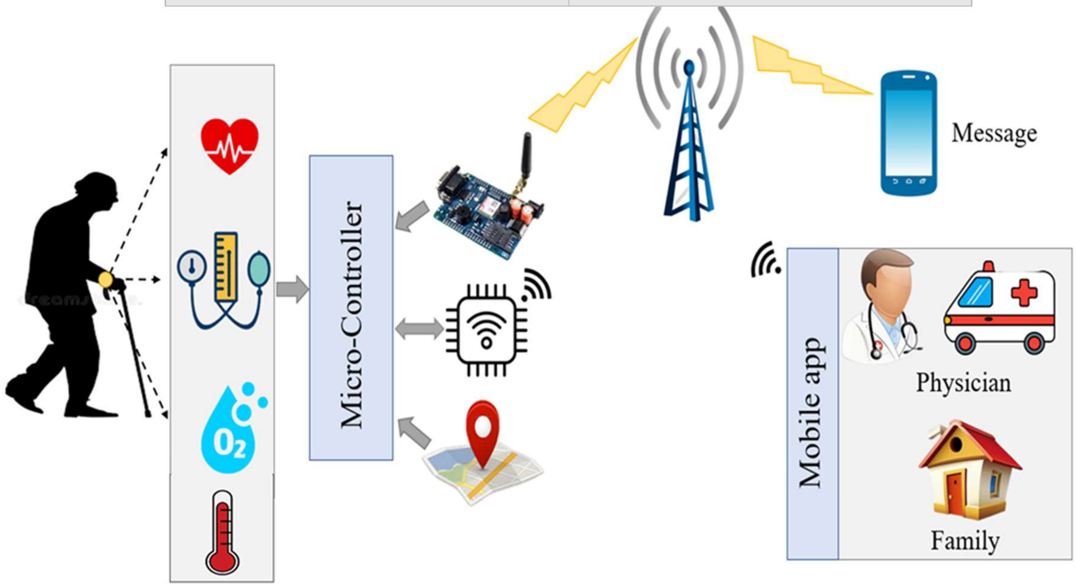

Figure 1. Suggested HMS for old age peoples

1. Hardware Requirements: The hardware used to build the prototype is detailed below.

A. HR and oxygen measurement:

- The MAX30100 detects pulse blood oxygenation and HR over the I2C module and consumes very little power. SpO2 and HR are detected using a photodetector, LEDs, precision optical, and minimal-noise signal processing [12]. The MAX30100, like all optical pulse oximeters and HR sensors, uses a couple of high-intensity LEDs (RED and IR having separate wavelengths) and a photodetector to obtain information. Those LEDs can emit light between 660 to 880nm in wavelength. A photodetector is used to determine the quantity of reflected light after both lights have been flashed on the finger or earlobe. Photoplethysmography is a recording made by detecting pulses using light.
- The oxygenated haemoglobin (HbO2) in arterial blood absorbs infrared radiation. With higher haemoglobin content (and thus a redder colour) blood absorbs more infrared radiation. The amount of reflected light varies for each heartbeat when blood flows through the finger, providing a fluctuating waveform at the photodetector's outcome. We can see a pulse that matches the HR within a few minutes after flashing the light and obtaining photodetector signals. Pulse oximetry assumes that blood oxygen levels influence how much red and infrared light is absorbed. The difference in the absorption spectra of oxygenated haemoglobin (HbO2) and its deoxygenated counterpart, haemoglobin (Hb) without oxygen.

B. BP measurement:

BP measurement is critical because it can indicate the presence of potentially fatal conditions such as a heart attack, stroke, or kidney disease. Because there are no symptoms, high BP should be checked regularly. With each heartbeat, the coronary heart contracts, forcing blood through the body's blood vessels. This force puts strain on our arteries. BP is the force applied by the blood on the artery walls. The conventional numerical representation of BP is systolic over diastolic pressure. The BP sensor's 8-bit ASCII format generates values ranging from 000 to 255. A comma and a space separate the three values (systolic, diastolic, and pulse rate). Because the packet's final byte is always 0x0A, each sensor reading will appear on a new line (or 10 in decimal).

C. Temperature measurement:

In a clinical or medical setting, taking a person's temperature is an important step in diagnosing their health status. While there are several methods for measuring temperature, not all of them are accurate enough for clinical use. The MAX30205 temperature sensor was designed specifically for use in these conditions [13]. We'll be connecting a MAX30205 human body temperature sensor to an external circuit, which will be useful for both fitness trackers and medical applications. Max30205 requires a 2.7-to-3-volt power supply to function. It provides a serial interface compatible with the I2C standard for use with a host microcontroller. The MAX30205's temperature readings are accurate to within 0.1°C and have a precision of 16 bits. It can operate between freezing and boiling temperatures. There are options for one-time use and power-saving shutdown.

D. Micro-controller

The Arduino boards that are commercially available range from the Arduino Uno to the Arduino Due, the Mega, and the Leonardo [14]. The Arduino Uno was used as the system's main controller because its pin layout was ideal for our needs. This microcontroller can be programmed using the Arduino IDE. It is an essential component of this system, serving as a link between the sensors and the rest of the IoT hardware. Figure 4 depicts an Arduino Uno model.

E. WIFI Module

Since Arduino doesn't have a wireless system that can transport data to the cloud, we decided to utilise an ESP8266 wireless module for this system. The ESP8266 module accepts an input voltage range from 7 to 12 V and maintains an operating voltage of 3.3 V. It comes with 4Mb of flash memory and 64Kb of SRAM. With the use of the wireless module, vital signs including HR, oxygen, BP and temperature may be sent to the cloud. This part was picked because it establishes a connection between the server IP address and the microcontroller, making it possible to receive the measured value through a mobile app. This component is critical to our system's operation and was designed with IoT applications in mind.

F. GSM

GSM/GPRS are digital mobile network devices that are frequently utilised by customers. It connects a device to a GSM network. The GSM features an RS232 interface, allowing it to communicate to both a PC and an Arduino equipped with an RS232. The AT command is used to change the baud rate. The GSM device includes the TCP/IP framework that enables GPRS internet access. It is suitable for message, call, and data transfer purposes. We can link a wide range of unregulated power supplies to the onboard Regulate Power Supply. We used basic AT instructions to establish voice calls, transmit messages, receive the message, accept calls, and access the internet. Each instruction starts with "AT" [15]. AT is an abbreviation for "attention". Here the mobile number is supplied, and we inform the GSM through a sequence of AT commands to transmit the message in emergency or abnormal situations.

G. GPS

The GPS consists of an antenna and U-blox NEO 6M module. I2C-compliant Display Data Channel (DDC) interfaces allow for connections between host CPUs as well as other equipment having serial interface EEPROMs. It has a maximum throughput of 100 kbit/s. NEO-6 modules support both passive and active antennas. The maximum noise figure is 1.5 decibels, the minimum gain is 15 decibels, and the maximum gain is 50 decibels. GPS receivers can calculate your precise location and time from anywhere on Earth thanks to a network of satellites and ground stations. Because of the satellites' strategic placement, there will never be more than 12 satellites visible in the sky over your location. The twelve visible satellites are primarily used for radio communication with the Earth. A GPS receiver or based receiver may use this data and some arithmetic to determine its location in space and time.

2. Software Requirements: The software used to build the mobile app and cloud employed for data storage is detailed below.

A. MIT

The useful mobile app was created by App, an MIT creator. We simply upload the completed app to the device and provide a download link. Google's MIT App Inventor is a platform for web-app integration. It has a drag-and-drop interface for building mobile apps from various graphical components [16]. The inventor can use firebase to access data stored in the cloud (Real-time database). There is a designer editor as well as a block editor included. The app's UI is created by the designer/editor by laying out the visible and invisible elements that comprise the app's final presentation to the user. Individual parts of the programme are interfaced as they are developed by being dragged and dropped onto a screen. A block editor can be used to programme the app's functionality. Some blocks serve specific functions, and each system component has access to the blocks that it requires to carry out its tasks.

B. FIREBASE:

Firebase is a Cloud-based NoSQL database which operates on a document paradigm. It is horizontally scalable and allows distributed teams to synchronise data in real-time. This would be extremely beneficial for multi-device applications, such as mobile ones. Serverless applications are made possible by Firebase's robust user-based security and offline optimization. Firebase runs on Google's infrastructure and can scale automatically to meet demand. Beyond the features typically associated with NoSQL databases, Firebase supports security, statistics, performance analysis, texting, failure reporting, and so on. Because it is a Google product, it integrates well with the rest of the company's offerings. Developers can use Firebase to create apps, send and receive messages in the cloud, store data in a real-time database, and sync data with another device or server [17]. Google Cloud Storage is a service that allows for the storage of data off-site. You can think of Firebase as a cloud-hosted database. They are the most dependable and fast-responding real-time data stores. We combine MIT's App Inventor 2 with Firebase, a real-time database service.

RESULTS AND DISCUSSIONS

The prototype for old age people HMS is designed successfully as per the discussion made in the previous section. Next, the working of the developed prototype will be tested and the outcome of testing will be shown in table 2. The following scenarios were tested on the prototype:

- Working of sensors (Read and send health measures)
- GPS function
- GSM operation under if the condition
- Data storage in the cloud
- Mobile app testing

Table 2. Designed prototype testing

Test: Manual testing			
Description: Verify the working of the suggested system			
Date: 12.01.2023 Time: 12.45 pm			
Sl. No	Procedure	Pass	Fail
1	Sensors read health parameters correctly	Y	-
2	Sensors send data to micro-controller	Y	-
3	Tracking live location	Y	-
4	Send data to the cloud	Y	-
5	Send message alert if health parameters are abnormal	Y	-
6	The mobile app reads health parameters correctly	Y	-
7	Micro-controller sense and actuate the signal	Y	-

According to table 2, all of the hardware and software of the designed prototype will function successfully under a variety of scenarios. The prototype design was satisfactory in manual testing. Figure 2 depicts the result of the mobile app. The elderly person's essential functions, including temperature, HR, oxygen, and BP are displayed on the mobile app. The location icon at the bottom of the mobile app assists in navigating the elderly person's location if the user (Medical professional / Family) wants to know that.

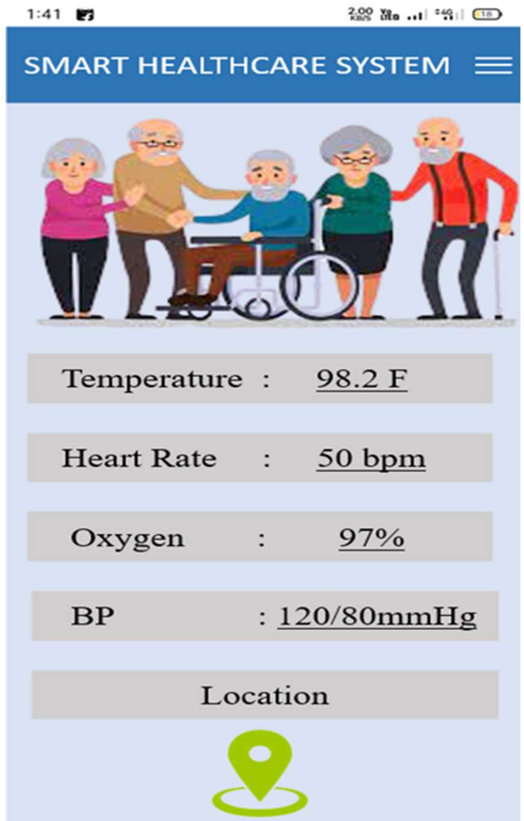

Figure 2. Working on a mobile app

The four health criteria listed above are quite important. The elderly individual needs quick medical attention if any measurement becomes outside the normal range. GSM Communications is utilised to transmit the message to meet this need. Figure 3 demonstrates how this situation would play out. The location and abnormal health metrics are included in the notification sent by the designed system.

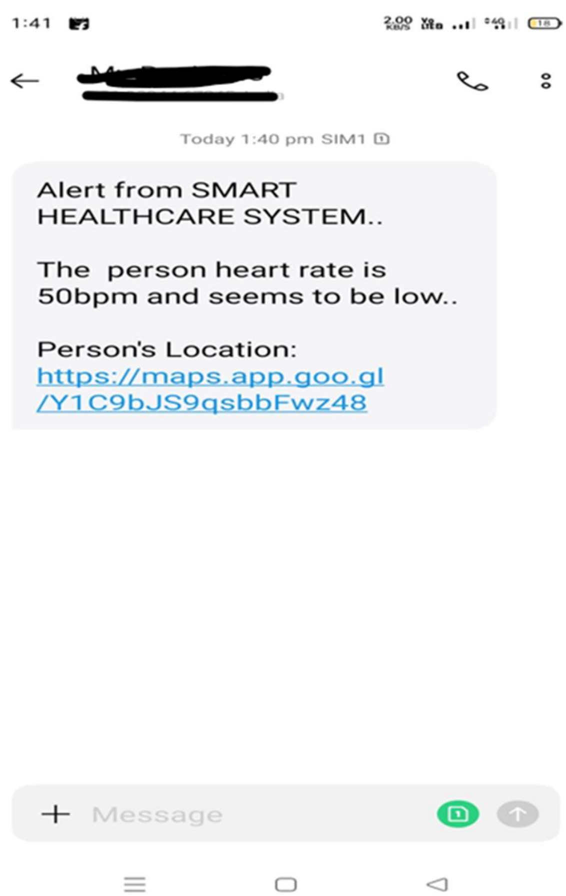

Figure 3. The alert message in the emergency condition

5. CONCLUSION

Technology advancements over the past few decades have directly contributed to a steady rise in the typical human lifespan. It's great that we've made such progress, but the elderly was still sicker and more likely to be depends on someone. This project aimed to create an IoT-based device HMS for old age people. The suggested approach allows for remote monitoring via a user-friendly mobile application that illustrates real-time data concerning the health status of old age people. The warning message should be delivered to the registered mobile number if any health parameter deviates from the nominal value. To demonstrate the usefulness of real-time remote HMS for the elders, the system was examined successfully. In the future, more sensors are integrated with the device to measure other important health parameters of the human body and it helps to increase the safety of the elders.

6. REFERENCE

1. Pinto, Sandro, Jorge Cabral, and Tiago Gomes. "We-care: An IoT-based health care system for elderly people." In 2017 IEEE International Conference on Industrial Technology (ICIT), pp. 1378-1383. IEEE, 2017

2. Balamurugan, J., and G. Ramathirtham. "Health problems of aged people." International Journal of Research in Social Sciences 2, no. 3 (2012): 139-150.

3. Stavropoulos, Thanos G., Asterios Papastergiou, Lampros Mpaltadoros, Spiros Nikolopoulos, and Ioannis Kompatsiaris. "IoT wearable sensors and devices in elderly care: A literature review." Sensors 20, no. 10 (2020): 2826.
4. Cheng, Bong Jia, Muhammad Mahadi Abdul Jamil, Radzi Ambar, Mohd Helmy Abd Wahab, and Ahmad Alabqari Ma'radzi. "Elderly care monitoring system with IoT application." In Recent Advances in Intelligent Information Systems and Applied Mathematics, pp. 525-537. Springer International Publishing, 2020.
5. Sumathy, B., S. Kavimullai, S. Shushmithaa, and S. Sai Anusha. "Wearable Non-invasive Health Monitoring Device for Elderly using IOT." In IOP Conference Series: Materials Science and Engineering, vol. 1012, no. 1, p. 012011. IOP Publishing, 2021.
6. Azizan, Azizul, Norashidah Md Din, Dzahir Rashidi Mohd Dzaki, Ahmad Dziaul Islam Abdul Kadir, and Noraimi Shafie. "Implementation of an IoT Cloud-based Elderly Care Health Monitoring Dashboard." In 2022 4th International Conference on Smart Sensors and Application (ICSSA), pp. 150-154. IEEE, 2022.
7. Biradar, Ambresh G., Shubhang Johari, Samarth S. Kulkarni, Ameya Maheshwari, and Katam Venkatesh. "OpenThread Based Mesh Enabled IoT Smart Device Cluster for Health Monitoring of the Elderly in Old Age Homes." In 2020 4th International Conference on Electronics, Materials Engineering & Nano-Technology (IEMENTech), pp. 1-6. IEEE, 2020.
8. Nath, Rajdeep Kumar, and Himanshu Thapliyal. "Wearable health monitoring system for older adults in a smart home environment." In 2021 IEEE Computer Society Annual Symposium on VLSI (ISVLSI), pp. 390-395. IEEE, 2021.
9. Nagaraj, S., Abrar ul Haq, and Abrar Nazir. "IoT Based Remote Patient Health Monitoring System." In 2021 3rd International Conference on Advances in Computing, Communication Control and Networking (ICAC3N), pp. 834-838. IEEE, 2021.
10. Akhila, L., B. S. Megha, Nikhila M. Santhoshlal, B. Sreelakshmi, Vykha Pradeep, Anu Chalil, and K. N. Sreehari. "IoT-enabled Geriatric Health Monitoring System." In 2021 Second International Conference on Electronics and Sustainable Communication Systems (ICESC), pp. 803-810. IEEE, 2021.
11. Purohit, Palak, Pimal Khanpara, Usha Patel, and Preeti Kathiria. "IoT based Ambient Assisted Living Technologies for Healthcare: Concepts and Design Challenges." In 2022 Sixth International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud)(I-SMAC), pp. 111-116. IEEE, 2022.
12. Saçan, Kerim Bedri, and Gökhan Ertaş. "Performance assessment of MAX30100 SpO 2/heartrate sensor." In 2017 Medical Technologies National Congress (TIPTEKNO), pp. 1-4. IEEE, 2017.
13. Sudha, S., P. Shruthi, and M. Sharanya. "IoT based measurement of body temperature using max30205." Int. Res. J. Eng. Technol 5 (2018): 3913-3915.
14. Bhardwaj, Vaneeta, Rajat Joshi, and Anshu Mli Gaur. "IoT-based smart health monitoring system for COVID-19." SN Computer Science 3, no. 2 (2022): 137.
15. Yadav, Sandeep, Rituraj Raghuvanshi, Gaurav Soni, Lokesh Bangali, and Shishank Singh Bundela. "Global system for mobile communication (GSM) monitoring in industries using arduino uno." In IOP Conference Series: Materials Science and Engineering, vol. 1136, no. 1, p. 012019. IOP Publishing, 2021.

16. Mitu, Nuba Shittain, Vassil T. Vassilev, and Myasar Tabany. "Low cost, easy-to-use, IoT and cloud-based real-time environment monitoring system using ESP8266 microcontroller." International Journal of Internet of Things and Web Services 6 (2021).
17. Moroney, Laurence, and Laurence Moroney. "The firebase realtime database." The Definitive Guide to Firebase: Build Android Apps on Google's Mobile Platform (2017): 51-71.