Technical Answers for Real World Problems

by

Amrit Sen	19BPS1036
Rajashri Mahato	19BPS1130

A project report submitted to

DR. ASNATH VICTY PHAMILA

SCHOOL OF COMPUTER SCIENCE

ENGINEERING

in partial fulfilment of the requirements for the course of

CSE1901 – TECHNICAL ANSWERS for REAL WORLD PROBELMS

in

B. Tech. COMPUTER SCIENCE AND ENGINEERING spl. in CYBER PHYSICAL SYSTEM

Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

Vandalur – Kelambakkam Road

Chennai – 600127

APRIL 2022

DECLARATION BY THE CANDIDATE

We hereby declare that the report titled "Smart Assistant for Alzheimer's Patients" submitted by me to VIT Chennai is a record of bona-fide work undertaken by me under the supervision of Dr. Asnath Victy Phamila, Associate Professor Grade 2, SCOPE, Vellore Institute of Technology, Chennai.

Amrit Sen

AMRIT SEN

NAME WITH SIGNATURE

Rajashri Mahato.

RAJASHRI MAHATO

NAME WITH SIGNATURE

ACKNOWLEDGEMENT

We wish to express our sincere thanks and deep sense of gratitude to our project guide, Dr. Asnath Victy Phamila, School of Computer Science and Engineering for her consistent encouragement and valuable guidance offered to us throughout the course of the project work.

We are extremely grateful to Dr. R. Ganesan, Dean, School of Computer Science and Engineering (SCOPE), Vellore Institute of Technology, Chennai, for extending the facilities of the school towards our project and for his unstinting support.

We express our thanks to our Head of the Department for his support throughout the course of this project.

We also take this opportunity to thank all the faculty of the school for their support and their wisdom imparted to us throughout the courses.

We thank our parents, family, and friends for bearing with us throughout the course of our project and for the opportunity they provided us in undergoing this course in such a prestigious institution.

BONAFIDE CERTIFICATE

Certified that this project report entitled “Smart Assistant for Alzheimer’s Patients” is a bona-fide work of Amrit Sen (19BPS1036), Rajashri Mahato (19BPS1130) carried out the “J”-Project work under my supervision and guidance for CSE1901 – Technical Answers for Real World Problems.

Dr. Asnath Victy Phamila

SCOPE

Abstract. Context-awareness refers to the adaptability of an application based on the circumstances it encounters and how it reacts to them. This concept can be employed in various sectors like education, manufacturing, healthcare, and finance. Currently, the population of the elderly in our society is increasing steadily. This is due to the increase in chronic diseases, living conditions, and dietary habits. For the purpose of their safety, we need a context-aware system to monitor their health status and remind them to take their medicines on time. Caregivers should be aware of their location and vitals, along with emergency alerts when in danger. Hence a system is developed with a wearable device, a medicine box, and a smart lock that will help in locating the user, monitoring their status, communicating with the doctor or caregiver, and storing user data in the cloud. This ensures the complete safety of the user at all times.

Keywords: Context- Aware, wearable, Alzhiemer's, smart, medicine box, elderly, cloud

1 Introduction

Current improvements in the IT sector have led to the beginning of ubiquitous healthcare. This entirely means the world's healthcare services can be received at any time, at any place, and by anyone. A wearable method might just be a pivotal part of any ubiquitous healthcare setting [1]. Because a wearable device offers a continued admittance to information from or to the user. In a context-aware system, the ubiquitous quality can significantly improve healthcare assistance. Since the information regarding the user is gathered from multiple wearable sensors set in any device, the data generated is huge. This data is then transferred to healthcare aid objects via a completely connected network. Any middleware can be required in order to solve the enigma of interoperability between information from various sensors and ubiquitous healthcare services. The middleware is the mediator that deals with all the service-related provision mechanisms.

Few context-aware structures have been made as middleware for services in the ubiquitous environment. Couderc and Kermarrec gave a general methodology to enhance the level of presented assistance without considering any environmental changes [2]. This is based upon the notion of a contextual target which is in a disseminated client/server system, more precisely, an information system. In another paper, Dey explained the context toolkit used for any context-aware application in reference to programming [3]. It contains encapsulated programming elements like context widgets which helps to deal with identified contexts more efficiently in a distributed surrounding. A context toolkit delivers scientists a programming mechanism that makes it plausible to communicate contexts without considering any dependency between services and sensors. Classification of contexts is basically done by asking the following questions: what, when, who, why, and how.

Most context-aware systems use dynamic processing and algorithms, which use the context data to accommodate the performance of the applications being built. This happens according to the context and hence offers personalized assistance to the users [4]. Nevertheless, these processes and algorithms are determined at development time. When any new technology is launched, the response of the users varies to modify and accommodate according to it. Furthermore, diverse environments where the application is used, for example, a hospital, at home or at workplaces, etc. may have somewhat different conditions about how the context data is accounted for. It is hard to anticipate these differences in behaviour and minute distinctions in workflows at the time of development. This also means that the model developed may be inadequate or the algorithm used for the application may no longer fit. When the users feel that the devices/systems do not accommodate their requirements and everyday patterns, they think that they are less in control of their environment or technology and they have to change for technology [5]. But in practicality, it is the other way round.

In this paper a complete context aware system for the Alzheimer's is developed consisting of three parts: A wellness device, lock system and a medicine box. The intent of the system is to keep the user safe at all times irrespective of where they are. The following sections talk about the challenges, CA architecture, Phases in building the system, proposed work, results and discussion. Following this, the concluding remarks are included.

2 Literature Survey

Remote monitoring technologies in Alzheimer's disease: design of the RADARAD study

There are three levels to this research. Participants (n = 220) with preclinical AD, prodromal AD, mild-to-moderate AD, and healthy controls, categorized by MMSE and CDR score, will be recruited from clinical sites evenly spread throughout 13 European nations for the primary trial. Participants will be subjected to thorough neuropsychological and physical testing. Walk tests, money management activities, an augmented reality game, two activity monitors, and two smartphone applications were all part of the RMT exams, which took place over an 8-week period. Fixed sensors will be put in the houses of a representative subsample of 40 participants in the first sub-study. In the second sub-study, ten people will spend a week in a smart house. The major endpoint of this study is the difference in functional domain profiles between the four study groups as measured by RMTs. For each RMT outcome measure, the four participant groups will be compared independently. A standard clinical test that assesses the same functional or cognitive domain will be compared to each RMT outcome. Multivariate prediction models will be constructed towards the end. The project's data gathering and privacy will be controlled using the RADAR-base data platform, which will run on specially specialized biomedical research computing infrastructure.

Intelligent Sensing Technologies for the Diagnosis, Monitoring and Therapy of Alzheimer's Disease: A Systematic Review

Alzheimer's disease is a degenerative neurological ailment that affects people for the rest of their lives. It's linked to a lot of money spent on illness management and caregivers. Intelligent sensing systems can deliver adaptive input that is context-aware. These can help Alzheimer's patients with constant monitoring, functional assistance, and prompt treatment interventions, all of which are critical. This study seeks to provide an overview of such systems for the treatment of Alzheimer's disease that have been described in the literature. A total of 253 English language papers published between 2015 and 2020 were found after searching four databases. Twenty papers were judged to be appropriate for inclusion in this review after a number of screening processes. This research provides an overview of the efficacy as well as the limits of the intelligent systems proposed for Alzheimer's disease. The findings show that intelligent technologies may be divided into two categories: distributed systems and self-contained gadgets. Handheld devices provide fast evaluations by touch, vision, and speech, whereas distributed systems rely on long-term monitoring of individual activity patterns. The study continues by exploring the clinical applications of these intelligent technologies, as well as future concerns for improving the design of these Alzheimer's disease remedies.

Non-intrusive Patient Monitoring of Alzheimer's Disease Subjects Using Wireless Sensor Networks

As people age, their cognitive processes in the brain deteriorate, which can lead to behavioral abnormalities like wandering and a proclivity to fall, which are common in Alzheimer's patients. It is vital to non-intrusively monitor brain activity in connection with bodily movements in order to understand how to treat individuals with cognitive impairment. We give a preliminary assessment of a patient monitoring infrastructure and explore related concerns and obstacles to help translate insights gained from wireless monitoring into strong methods for crisis prevention and management.

Smart Antennas and Intelligent Sensors Based Systems: Enabling Technologies and Applications 2020

The Internet of Things (IoT) has grown in popularity over the last decade as a new technology aimed at making life easier and assisting people in all parts of their lives. Smart homes, smart grid stations, smart agriculture, health systems, transportation services, smart cities, and other applications employ this technology. For monitoring the health of patients, a variety of sensors and IoT devices, as well as applications, are employed. These gadgets will track the movements of certain patients at home and away from home. Alzheimer's sufferers will receive therapy based on their behavior and mobility. The information will be gathered using several sensors and smartwatches put in patients' homes to monitor their blood pressure and temperature, which is critical in the current CoronaVirus Disease (COVID-19) epidemic for these individuals. On the other side, people all over the world are suffering from decreased mobility, increased environmental pollution, and stress brought on by contemporary machine life, as well as different brain and neurological disorders such as Alzheimer's and Parkinson's. For sensors and the wristwatch, several communication protocols such as Message Queue Telemetry Transport (MQTT) and WebSocket (with authentication and auto closing of connection) were utilized. Doctors, patients, and ambulances may all be tracked using the secure backend admin interface. These measures are established with security in mind to preserve patients' privacy.

A monitoring system for people living with Alzheimer's disease

Alzheimer's disease is one of the most common neurodegenerative disorders, affecting millions of individuals worldwide. Alzheimer's disease and other dementias have a profound influence on persons who are diagnosed, as well as those who are close to them and society at large. Various researchers and firms have developed solutions to help these folks find comfort. We noted that there are many products aimed at improving patient safety, but there is a gap: there is no relationship between the goods and the demands of caregivers, and most of the products do not adequately secure patient personal data. We created a comprehensive system to track and record patient whereabouts, heart rates, and sleep patterns, allowing caregivers to better understand and meet the requirements of their patients. We describe a monitoring system for persons with Alzheimer's disease in this research. A wearable and an Android application make up this system. It can be utilized by any actor who is involved. A team of engineers and clinicians built our system by keeping in close contact with patients and their caretakers in an outpatient clinic for dementia and memory loss. The evaluation results led to a rating of our system's importance.

Research and development of smart wearable health applications: the challenge ahead

For the assessment and management of personal health status, continuous monitoring of physiological and physical markers is required. It has the potential to drastically reduce healthcare costs by preventing needless hospitalizations and ensuring that those who require urgent treatment receive it sooner. When used in conjunction with cost-effective telemedicine systems, ubiquitous health monitoring can dramatically improve illness prevention, early detection, management, treatment, and home rehabilitation. Today, advances in micro and nanotechnologies, information processing, and wireless communication enable minimally (or non) invasive biomedical monitoring, as well as wearable sensing, processing, and data exchange. Although the systems are being developed to meet specific user needs, a number of common critical issues, such as biomedical sensors, user interfaces, clinical validation, data security and confidentiality, scenarios of use, decision support, user acceptance, and business models, must be addressed in order to achieve reliable and acceptable smart health wearable applications. In the previous several years, major technical breakthroughs have been made. Cutting-edge research combining functional clothes and integrated electronics has opened up a new study field and possibilities for detecting and transmitting health markers on the human body. This study examines the present state of smart wearable health systems and applications research and development, as well as the remaining concerns and future challenges.

Smart wearable devices in cardiovascular care: where we are and how to move forward

Technological advancements pervade our everyday lives, and a growing trend encourages the usage of commercial smart wearable gadgets for health management. The cardiology community must acquaint itself with the wearable technologies on the market and their vast variety of therapeutic uses in the era of distant, decentralized, and increasingly individualized patient care, catalyzed by the COVID-19 pandemic. The basic technical concepts of typical wearable sensors are highlighted in this Review, as well as areas where they can be error-prone. We also look at how these devices might help with remote screening and diagnosis of common cardiovascular disorders like arrhythmias, as well as the care of individuals who already have cardiac problems like heart failure. Device accuracy, clinical validity, a lack of consistent regulatory standards, and concerns about patient privacy continue to stymie the general use of smart wearable technology in clinical practice. We provide various suggestions for overcoming these obstacles, as well as a simple and practical 'ABCD' guidance for doctors that is tailored to their unique practice needs in order to expedite the integration of these devices into the clinical workflow for the best possible patient care.

Healthcare wearable devices: an analysis of key factors for continuous use intention

The impact of internal and external variables on actual use behavior, health improvement expectancy, and continuous use intention of healthcare wearable devices were investigated in this study. The research offered a research model and related hypotheses, which were tested using structural equation modeling.

Based on data acquired from 288 healthcare wearable devices/apps users, we also conducted a comparison study of the two sample groups (medical staff and general public). Internal and external variables have favorable influence on actual use behavior, according to the study's findings, and actual use behavior can increase health improvement expectancy and ongoing use intention of healthcare wearable devices. Medical workers exhibited higher correlations among the study parameters than the general population, according to the comparison analysis of the two groups. The findings of the study have theoretical and practical implications for how consumers might efficiently use healthcare wearable devices or applications for illness prevention and health management.

A Survey on Wearable Technology: History, State-of-the-Art and Current Challenges

The introduction of billions of new networked "things" and their entrenchment in our daily lives are constantly causing technology to undergo a substantial evolution. Wearables, for example, are one of the underlying adaptable technologies that can gather rich contextual information created by such devices and utilise it to deliver a truly individualized experience. The major goal of this study is to present a historical overview of wearable devices as well as a current state-of-the-art review of the wearable market. Furthermore, the paper includes an extensive and diverse classification of wearables based on a variety of factors, as well as a discussion of wireless communication technologies, architectures, data processing aspects, and market status, as well as a variety of other actual wearable technology information. Finally, the study identifies significant obstacles as well as current and potential solutions.

3 Challenges

Context-awareness represents an essential part in pervasive and ubiquitous computing as alterations of the device's behaviors to context switches serve to accomplish the end goal of computing assistance available universally and also at any point in time. There is a thriving group of investigations on context-aware applications that are considered to be flexible and able to act autonomously on account of the users. Yet, there exist multiple unresolved research problems that confront the ubiquitous computing community.

Building a context-aware system involves context data modeling, management, and reasoning of the data. The most favorable qualities expected in such systems are fault tolerance and self-aware applications [6]. One of the most faced difficulties that hinder the progress of context-aware applications is their high complexity. This section lists out such challenges pertaining to this paper.

In general, the types of challenges faced by CA systems can be broadly classified into technical and non-technical.

- The basic technical difficulty pertaining to the hardware is the reliability of sensors. Since sensors are fragile and tangible, they are susceptible to easy damage and when a case occurs the fix might not always be fast. All the decision-making relies on the information transfer from these devices hence this is a major weak link in the system.

- There are concerns related to the privacy and security of context information. Therefore, the security mechanisms should be enhanced with the help of advanced protocols.

- Another point to note is that deriving reasoning from a healthcare system is critical since one small mistake can have drastic effects.

- The performance of the system is uncertain due to conflicting behaviors, sudden uncertainties, and unresponsive queries. They should be effectively handled if the system has to function accurately.

- The validity of data accumulation should be checked depending on the seriousness of the context situation.

- The above-mentioned scenario gives rise to the use of energy usage in such Context-aware systems. The battery consumption and the lifetime of the devices in the system are limited.

- This system is modelled based on the elderly as the user base. Getting them on board with technology can be considered a challenge in some cases.

4 System Management

The system consists of a server and multiple sensors. The proposed wearable device consists of healthcare sensors to interact with users. Sensors perform data collection, pre processing and transmit the data to the wearable computer wirelessly. There is a local database in the device and a central database for the storage in the server. The local database stores data and gives immediate results. The local database also stores the personal profile of the user, system conditions and the user preference settings. When the battery level reaches threshold, a warning is sent to the user. When abnormality is detected or the output decision is at threshold then the event is triggered. Figure 1 represents Context Management System Architecture.

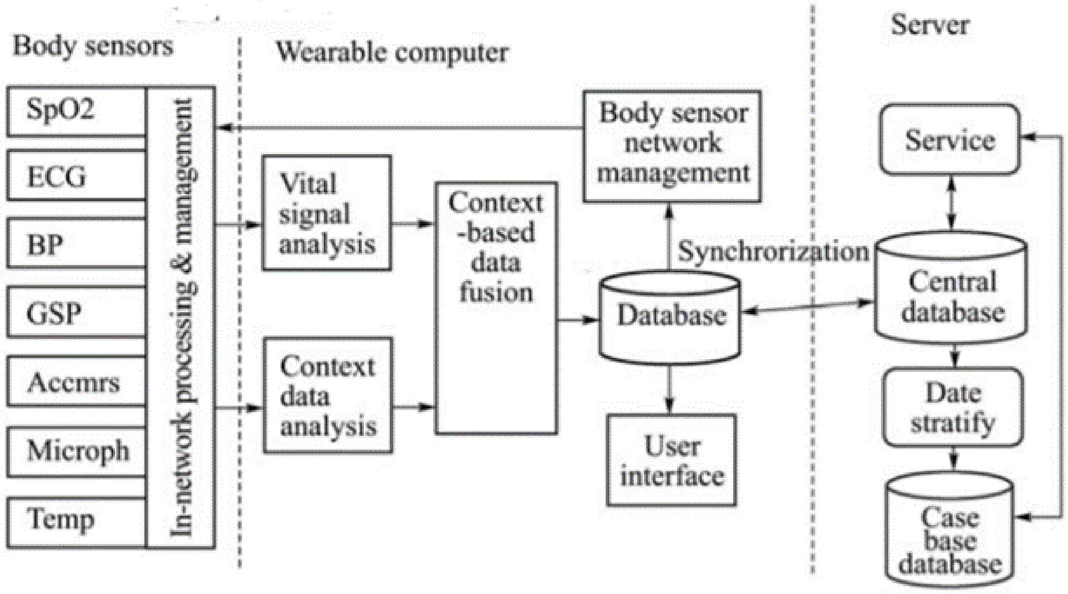

Figure 1 : Context Management System Architecture

5 **Phases**

a. **Context acquisition**

Context acquisition is performed in the systems through sensors. They generate contextual data which changes in terms of usability, complexity, and quality. Every day, the number of users tends to increase rapidly which results in tremendous data and sensor availability in regards to IoT [7].

Primary context values:

Given below are the primary context variables of the system.

Time, Date, Pulse_Rate, Body_Temp, Glucose_Level, Blood_Pressue_Systolic, Blood_Pressure_Diastolic, GPS_Location, Device_status, Mobile_Status, Door_Status, User_present, Trusted_Contact1, Trusted_Contact2, Caregiver_Contacts, Healthcare_Contacts

Derived context obtained from primary context:

Given below are the derived context variables of the system.

User_status(Home/Outside), Pulse(Normal/Abnormal), Glucose (Normal/ Abnormal), Temperature (Normal/Abnormal), Blood pressure Systolic (Normal/Abnormal), Blood pressure Diastolic (Normal / Abnormal), User Position (Next to Box/ Away from Box).

(b)Context Modeling:

Context modeling has been done using a key-value model. The key denotes the name of the context variable and the value denotes the current state of that variable. The reasoning is supported by a simple matching engine. When the keys match the actual context values the defined action is triggered.

Defining range to derived values:

· PULSE: Normal (60<=x<=100), Abnormal (beyond normal range)

· BLOOD PRESSURE: SYSTOLIC:Normal (100-120), DIASTOLIC: Normal (60-80)

· GLUCOSE: Normal (6.9<=x<=7.5), Abnormal (beyond normal range)

· USER STATUS: In the house (23.1002°N 85.1407°E to 24.9874°N 89.8731°E), Outside the house (Any other value)

· TEMPERATURE: Normal (97.5°F<=x<=99°F), Abnormal (Any other value)

· USER POSITION: Near the box (3V), Away from the box (0V)

(c) System adaptation:

The designed system can make decisions on its own and interact with the user, hence its robustness and security are characteristics of utmost significance. Because of the adaptive and context-aware quality of the system, the measurement of such characteristics is challenging [8]. Hence, we list the behaviors here and make them a part of our ruleset so that the system will follow these rules to avoid any cases of failure. The behavior adaptations are the parameters for evaluating the success of the system.

· In case the user is in need of assistance outside their home, a notification is sent to the caregiver and neighbor.

· When at home, if Abnormal vitals are observed, the nearest neighbor is sent a text with a password to unlock the door.

· Identifies if the user is in the house or outside and decides whom to contact during an emergency.

· When a person is sensed in front of the medicine box using the PIR sensor, the LEDs glow.

· According to the time of the day the corresponding Led glows, indicating the user which medicine to take at that time.

· If the Medicine box is almost empty the buzzer beeps for 20 seconds indicating the user to refill. The empty compartment can be identified by the tone of the buzzer.

After the process of identifying the behaviors and the rule set. Various uncertainties and optimizing the rules along with fixing the faults.

(d) Uncertainties:

· Power cut : In the event of a power cut, the Wi-Fi module connecting the wearable device and lock fails.

· Mobile charge: If the user's mobile phone loses charge, the Bluetooth connection to the other home devices is affected.

· Faulty Sensors: If one or more sensors repeat the same value, or completely out of bound values, prediction becomes incorrect.

· NA values in the dataset: In case the dataset has NA values no decision can be taken, which results in danger.

· Unavailable contacts: In the event of the emergency contact's unavailability, the system becomes ineffective.

· Misidentification: When the PIR sensor detects motion that doesn't originate from the user but LED is ON.

(e) Optimizing the System Rules:

● The medicine box will use its buzzer feature to alert the user on when to take medicine, but if the user is already on time in front of the box, there will be no need for the buzzer to beep - Dead context fault

● Buzzer keeps beeping and snoozing till the user takes the medicine. In case the user takes the medicine and the user does not press the off button. The buzzer will not stop- Adaptation Cycle Fault

● If the health vitals are tracked, checked if normal. If abnormal, a notification is sent to the caregiver and doctor. If abnormality tends to fainting, a unique password will be generated and sent to the neighbor. The neighbor can unlock the door with the password- Adaptation Race Fault.

(Since all the CA behaviors in the system are deterministic and produce single output, non-deterministic faults are not found.)

(f) Reasoning:

● If the GPS signal is weak and shows NULL values for a few minutes straight, The value before and after can be compared to see if the user is still in the same position.

● A spike in glucose level after food intake will not be considered as abnormal. The timing of food intake can be gained from the historical data.

● We have defined that if it's medicine time and the user is "near" the box we give a beep that it's time for medicine. if the person is "not present" near the medicine box but he is at home we will still give a beep.

(The system has precise states like yes/no or on/off. Therefore, no in-between states are necessary for it to function, hence fuzzy logic reasoning is not suited here.)

(g) Service dissemination:

· If user’s vitals are abnormal and user is at home message caregiver

· If user’s vitals are abnormal and user is not at home message the ambulance

· If the user’s presence is found put in the LED

· According to the time of the day put on the respective (red/yellow/green) LED

· If the time for medicine intake arises play a buzzer sound for 30 seconds

· If any compartment in the medicine box is empty, play a buzzer for 20 seconds keeping the tone 100,200,300 levels

When the users’ vitals are abnormal and help is needed, neighbors are informed and sent a six-digit passcode.

6 Proposed Methodology

With the latest development of communication and technology, Cyber Physical Systems has occupied a huge part in the domain of Computer Science and technology. Our entire system revolves around smart technologies and helps us deal with all real-time challenges. It consists of three different entities, namely- the Wellness Device, the Smart Door Lock and the Smart Medicine Box. The three different entities make this system complete, with various sensors and actuators, which pair up with various modules, and help in communication.

a. System Modules -

The modes of communications include WSN and Bluetooth, which help in seamless communication between all the three entities and also all the other smart devices. They help in collecting the data by interacting with the sensors and push the data retrieved from these sensors to the cloud.

The other modules include the sensors which can be used for health monitoring. These include the pulse rate sensor, the temperature sensor and the glucometers. The user interacts with these sensors and the data is thus collected and uploaded to the cloud for remote access and future use.

Location tracking is possible due to the GPS module and the RFID modules. These work simultaneously and help is the proper functioning of the system. One module takes over, when the other module fails to detect the location due to bad weather or some different uncertain scenarios.

b. System Design -

The system has been designed in such a way so that it can give the maximum comfort to its users and also handle the uncertainties in the Real World. The various modules have been integrated together to cover a huge domain and serve the society with a lot of features and also, advanced technologies.

The various technologies which have been considered for our system, are-

- **KEYPAD-** PASSWORD ENTERING
- **GPS MODULE -** LOCATION TRACKING
- **PULSE SENSOR -** BPM MONITORING
- **GLUCOSE SENSOR -** BLOOD SUGAR LEVEL MONITORING
- **PIR SENSOR -** DETECTS NEARBY MOTION
- **BLUETOOTH MODULE -** CONNECTION WITH OTHER DEVICES
- **WIFI MODULE -** UPLOAD SENSOR DATA TO THE CLOUD

· **FIREBASE CLOUD SERVICES** - STORES DATA

· **LEDS AND MICROCONTROLLERS** - ARDUINO UNO

· **PIEZO SENSOR** - ALERTS THE USER IN CASE OF HEALTH ABNORMALCY

(i)Wellness Device -

Sensors connected to the microcontroller include the pulse sensor and the glucometer which will keep a track of the regular health conditions of the person by sensing the data and uploading to the cloud. If any abnormalities in the health are traced, i.e, if the sensed data is beyond the normal range, the caregiver will be given a text and also the relatives will be notified. If an emergency situation arises, for example, if the person faints in the house, the caregiver will be informed and if the person faints outside the house, the ambulance driver will be informed.

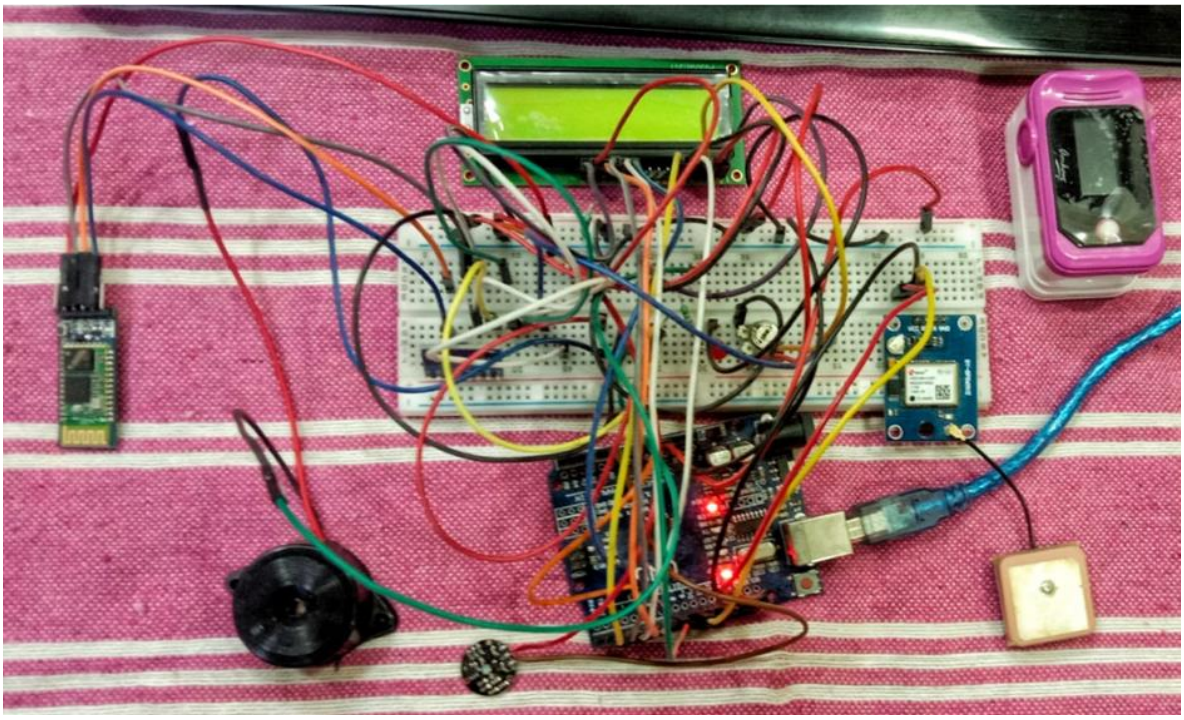

Figure 2

(ii)Smart Medicine Box -

A context-aware pill container that is "aware" of the patient, and reveals itself when near the patient (by lighting the proper container). Senses the user's presence and the LED of the corresponding medicine is turned on. Medicine recommendation based on the time and the current health condition. Recommendation is made after doctor's approval. If the medicine is going to get over, the buzzer beeps for 30 seconds indicating the need for a refill. When it's morning the RED LED glows, YELLOW for afternoon and GREEN for evening/night.

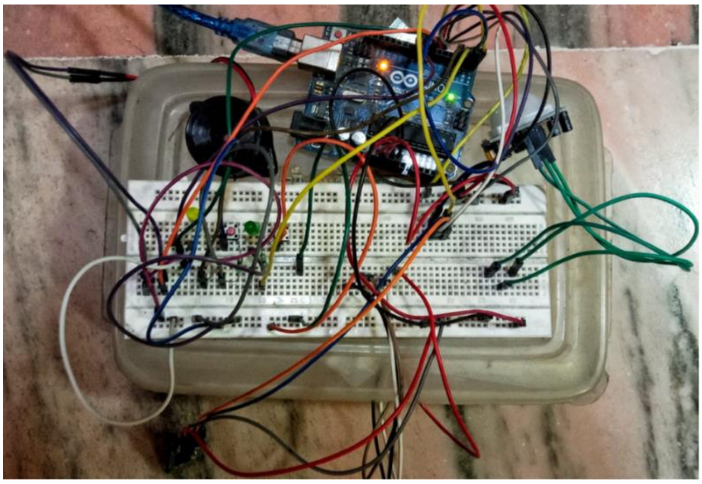

Figure 3: Smart Medicine Box

(iii)Smart Door Lock -

A smart lock system is especially created as an emergency help during the times when the user is alone at home or living by themselves. This scenario puts them in a serious situation. Therefore, their trusted neighbors should have access when in need. When the user's vitals are irregular, the unique ID is sent to the neighbor with the user's name and apartment number. This device opens wirelessly with an authorized users' authentication. In a smart home, smart locks allow access to others without requiring a traditional key.

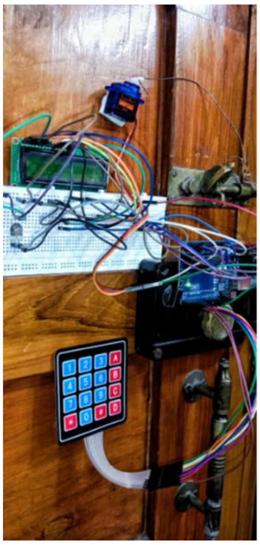

Figure 4: Smart Door Lock

The use case scenario for the entire scenario has been constructed with the help of a use case diagram.

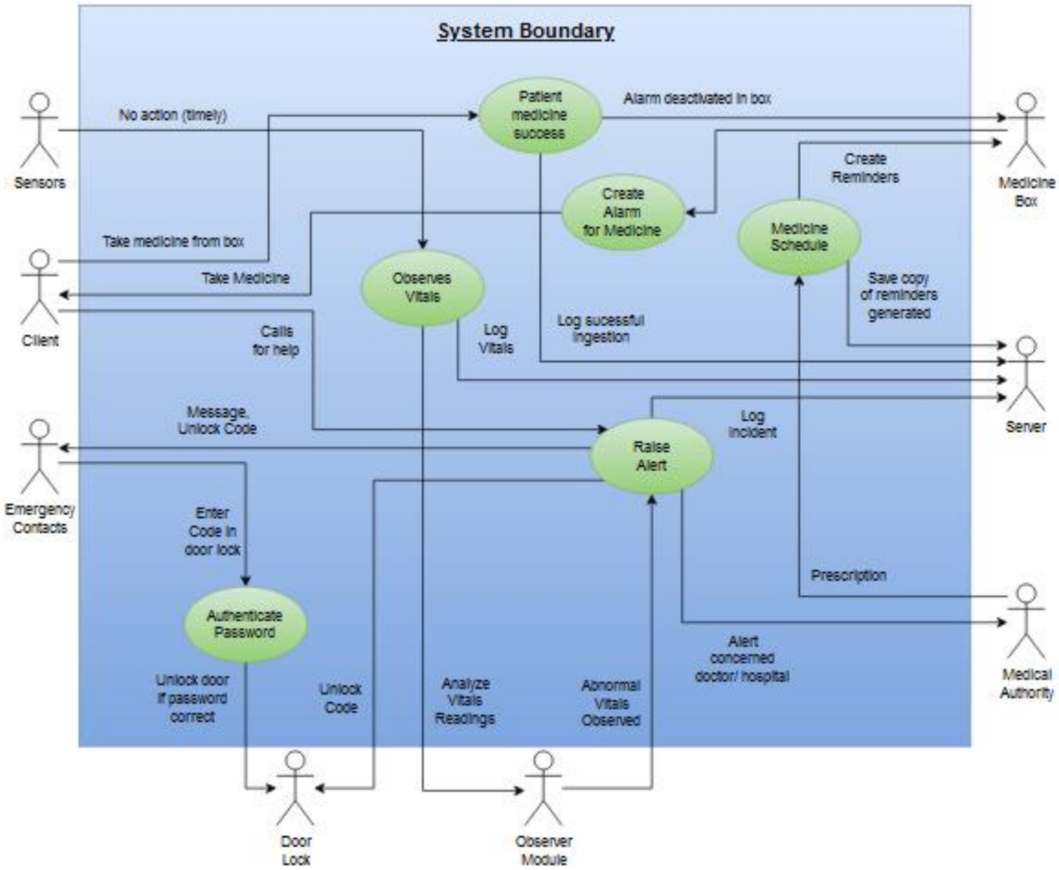

Figure 5: Use Case Scenario

7 Result and discussion

The results as obtained from the hardware of the system and the programming can be justified. The language used throughout the programming is C++. The C++ code was designed and debugged in such a way that we can conclude that the various behaviors and contexts go hand in hand to make the system work efficiently.

The interaction with the Twilio cloud for interaction with the required contacts during emergencies and sending the unique door unlock passcode to the trusted contacts along with the location of the patient to the hospital when the vitals are abnormal. The snapshot of the Twilio message is present in figure 6.

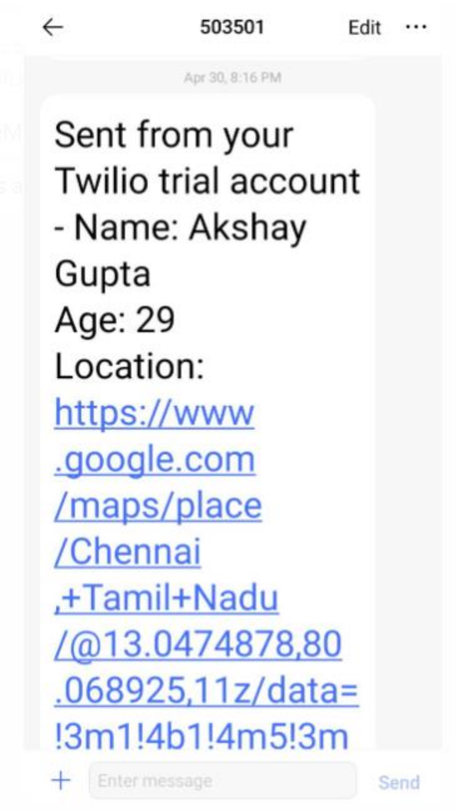

Figure 6: Twilio application message

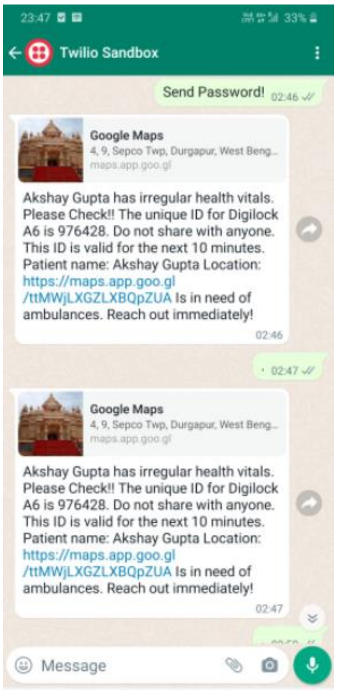

Figure 9: Twilio WhatsApp message

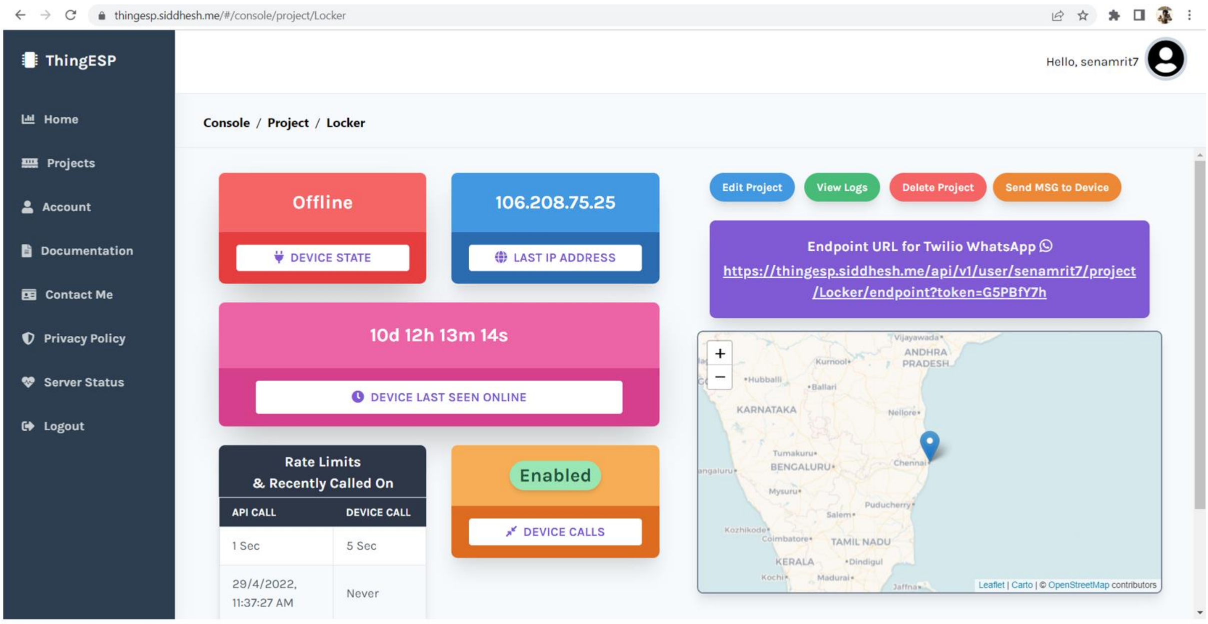

Figure 10: esp8266 with the lock connected to Twilio

8 Conclusion and Future Scope

In this particular paper, a context-aware wellness system for the elderly was proposed. The system has a wearable device which is along with a combined medicine box and lock system. By understanding the process, a more straightforward depiction of the entities of the context-aware framework is achieved. To determine the practicability of the proposed system, we presented 3 reference examples of the system's response to various contents based on the user's health condition and self-awareness. As a part of our future work, this project can be extended to provide a better user application interface, connect to hospital databases, and query in real-time.

The future scope of the project is to make this product available to people who are staying alone so that they can get the maximum benefit out of this product and enjoy staying independently without having any health related tensions.

9 References:

1. Kang, D. O., Lee, H. J., Ko, E. J., Kang, K., & Lee, J. (2006, August). A wearable context aware system for ubiquitous healthcare. In 2006 International Conference of the IEEE Engineering in Medicine and Biology Society (pp. 5192-5195). IEEE.

2. Couderc, P., & Kermarrec, A. M. (1999, October). Improving level of service for mobile users using context-awareness. In Proceedings of the 18th IEEE Symposium on Reliable Distributed Systems (pp. 24-33). IEEE.

3. Dey, A. K., Abowd, G. D., & Salber, D. (2001). A conceptual framework and a toolkit for supporting the rapid prototyping of context-aware applications. Human–Computer Interaction, 16(2-4), 97-166.

4. Ongenae, F., Claeys, M., Dupont, T., Kerckhove, W., Verhoeve, P., Dhaene, T., & De Turck, F. (2013). A probabilistic ontology-based platform for self-learning context-aware healthcare applications. Expert Systems with Applications, 40(18), 7629-7646.

5. Criel, J., & Claeys, L. (2008). A transdisciplinary study design on context-aware applications and environments. Observatorio (OBS*), 2(2).

6. Indulska, J. (2008, June). Challenges in the design and development of context-aware applications. In International Conference on Ubiquitous Intelligence and Computing (pp. 1-1). Springer, Berlin, Heidelberg.

7. Sukode, S., Gite, S., & Agrawal, H. (2015). Context aware framework in IoT: a survey. International Journal, 4(1), 1-9

8. Micskei, Z., Szatmári, Z., Oláh, J., & Majzik, I. (2012, June). A concept for testing robustness and safety of the context-aware behaviour of autonomous systems. In KES International Symposium on Agent and Multi-Agent Systems: Technologies and Applications (pp. 504-513). Springer, Berlin, Heidelberg.

9.Tabakis, I. M., Dasygenis, M., & Tsolaki, M. (2017, November). A monitoring system for people living with Alzheimer's disease. In *2017 Panhellenic Conference on Electronics and Telecommunications (PACET)* (pp. 1-4). IEEE.

10. Oskouei, R. J., MousaviLou, Z., Bakhtiari, Z., & Jalbani, K. B. (2020). IoT-based healthcare support system for alzheimer's patients. *Wireless Communications and Mobile Computing*, *2020*.

11. Avvenuti, M., Baker, C., Light, J., Tulpan, D., & Vecchio, A. (2009, August). Non-intrusive patient monitoring of Alzheimer's disease subjects using wireless sensor networks. In *2009 World Congress on Privacy, Security, Trust and the Management of e-Business* (pp. 161-165). IEEE.

12. Gillani, N., & Arslan, T. (2021). Intelligent Sensing Technologies for the Diagnosis, Monitoring and Therapy of Alzheimer's Disease: A Systematic Review. *Sensors*, *21*(12), 4249.

13. Sposaro, F., Danielson, J., & Tyson, G. (2010, September). iWander: An Android application for dementia patients. In *2010 Annual International Conference of the IEEE Engineering in Medicine and Biology* (pp. 3875-3878). IEEE.

14. Maresova, P., Tomsone, S., Lameski, P., Madureira, J., Mendes, A., Zdravevski, E., ... & Rodile, K. (2018). Technological solutions for older people with Alzheimer's disease. *Current Alzheimer Research*, *15*(10), 975-983.

15. Alam, Z., Samin, H., & Samin, O. B. (2018, February). Healthband for dementia patients: fall and scream detector and caretaker helper. In *Journal of Physics: Conference Series* (Vol. 976, No. 1, p. 012015). IOP Publishing.

16. Lymberis, A. (2004). Research and development of smart wearable health applications: the challenge ahead. *Stud Health Technol Inform*, *108*, 155-161.

17. Bayoumy, K., Gaber, M., Elshafeey, A., Mhaimeed, O., Dineen, E. H., Marvel, F. A., ... & Elshazly, M. B. (2021). Smart wearable devices in cardiovascular care: where we are and how to move forward. *Nature Reviews Cardiology*, *18*(8), 581-599.

18. Lee, S. M., & Lee, D. (2020). Healthcare wearable devices: an analysis of key factors for continuous use intention. *Service Business*, *14*(4), 503-531.

19. Ometov, A., Shubina, V., Klus, L., Skibińska, J., Saafi, S., Pascacio, P., ... & Lohan, E. S. (2021). A survey on wearable technology: History, state-of-the-art and current challenges. *Computer Networks*, *193*, 108074.