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A Wearable Device for Assistance of Alzheimer's disease with Computer Aided Diagnosis

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Abstract

INTRODUCTION: Alzheimer's disease (AD), which is also a pervasive form of dementia primarily common among the elderly, causes progressive brain damage, which might lead to memory loss, language impairment, with cognitive decline. This research proposed a solution that leveraged wearable technology's potential for computer-aided diagnosis. This wearable device, which looks like a pendant, integrates a panic button to notify the closed ones during an emergency.
OBJECTIVES: The primary objective is to effectively scrutinise and implement the wearable device for computer-aided diagnosis in AD. Specifically, this device aims to provide timely alerts to family members during emergencies and other symptoms.
METHODS: The proposed system is developed with the help of a microcontroller and integrates the Android Studio. This device, which resembles a pendant, contains a panic button that connects to a mobile application which receives notifications.
RESULTS: The system successfully achieved its objectives by providing timely alerts with accurate cognitive support for AD patients. The wearable device developed along with the mobile application, with the help of a microcontroller and Android Studio, contributed to the overall well-being of patients with AD.
CONCLUSION: This research introduced a very innovative and promising solution for improving the lives of individuals with AD through this wearable device and mobile application. By addressing these challenges, the system demonstrated its true potential for enhancing the quality of life for individuals with dementia.

Keywords: Global Positioning System (GPS), Alzheimer's disease (AD), Dementia, Caregiver, wearable device

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1. Introduction

In India, more than 4 million people are suffering from the AD epidemic and other kinds of dementia, ranking up next to China and the United States. AD reports for 60% to 80% of dementia cases and leads to severe problems with memory, thinking and behaviour. The symptoms usually appear in advanced middle age or old age; with time, the disease progresses and gradually interferes with the patient's daily life [21]. A recent case study has revealed that currently, around 200,000 Americans under the age of 65 are suffering from AD. In the early phase of AD, there is mild memory loss; as it worsens, the individual loses the ability to talk and becomes irresponsive. Though much research has gone towards treating AD, there is no cure yet, with a majority of the current treatment only focusing towards slowing down the disease and preventing it from getting worse. AD gradually takes the form of regular dementia, which is described as an acquired deterioration in cognitive abilities. The category of dementia involves AD, vascular dementia, Lewy body dementia, Parkinson's disease, and Frontotemporal dementia. AD is the most common type of dementia [1]. However, not all individuals suffering from memory loss have AD.

To diagnose AD, doctors may follow the steps below: -

a) Ask the affected individual's family members about the symptoms, check the individual's overall medical history, and look for deviations in behaviour and ability to perform regular tasks and activities.

b) Conduct tests for memory, attention span, problem-solving, counting and language comprehension.

c) Conduct standard medical tests, including blood and urine tests, to detect additional possible origins of the symptoms.

d) Perform brain scans, including Computed tomography (CT), Magnetic Resonance Imaging (MRI), and Positron Emission Tomography (PET) to rule out other possible causes of the symptoms.

Doctors may perform these tests multiple times during treatment to generate information about the patient's memory and cognitive functions. AD cannot be stopped or reversed, but early diagnosis of AD and subsequent treatment can help preserve the patient's daily functioning for some time.

Researchers suggest that soluble amyloid protein is toxic, which acts as a biochemical trigger that initiates a series of chain reactions, causing neuron decay. Nonetheless, tangles and plaques are crucial factors that determine Alzheimer's diagnosis. However, synaptic loss and neuron death are considered to be the leading cause of dementia. [44]

AD has three stages: mild, moderate and severe [26].

In the mild stage, an individual can function independently with the capability to work and socialise. However, the patient may suffer from memory lapses and forget familiarised words or the location of daily objects. In the moderate stage, AD can last for many years. Patients may require more care as the disease progresses, as they experience frustration and act unexpectedly. In the severe stage, the affected individual may lose the ability to control movement and carry out conversation, making communication more difficult. Significant personality changes may occur, and extensive care may be required over time. Individuals above the age of 65 have a high risk of AD and may exhibit symptoms of early onset.

In the proposed work, we have designed and developed a wearable tracking device shaped like a pendant that the patient can wear. The device can support family members and caregivers and assist them in monitoring the affected individual via a mobile application. Wearable devices for AD patients are an emerging technology. These are gaining popularity due to their efficiency and ease of operation. The proposed pendant has a wearable transceiver that transfers the patient's location and alerts a notice to the database when a patient crosses a predetermined perimeter. A GPS module for the patient's location and panic button is integrated within the device, fitted with a microcontroller which will send a distress message to a paired mobile device.

The mobile application, which will be used to track the patient, will also contain family photographs to evoke positive emotions in the patient. It will have preset medical reminders for patients and caregivers and contain games involving active thinking and analysis. These aim to mitigate the potential risks an AD patient may face.

This paper is categorised as follows: Section 2 depicts the related work and studies with their explanation. Section 3 details about Proposed Methodology, Architecture design, flowchart, algorithm and system specification. Section 4 describes the Results and implementation compared to existing methods for tracking AD patients. Section 5 is related to the conclusion and Future scope of this work.

2. Literature Review

Various wearable devices are available for AD patients, including digital devices, intelligent sensors, and mobile applications. We studied and reviewed the last ten Research papers (from Year 2010 to Year 2020) related to wearable devices for Dementia patients for this proposed work.

Large pieces of data that can be used for research are generated by-products such as activity trackers and wearable biometric sensors. The incentive to track everyday tasks, such as monitoring steps and diets during the day, is founded explicitly upon a vast range of IoT technologies. A smartwatch or bracelet, for example, is widely used to monitor health and wellness. It is possible to use mobile phones based on an electrocardiogram to estimate and evaluate the state of the heart [22]. The Brain Detecting Headband records the movements of the brain and, through Bluetooth, communicates knowledge to a computer, mobile, or tablet [16]. Wearable sensor devices and IoT can optimise a person's routine, such as preparing healthcare monitoring systems for fitness tracking and management. Author [17] reported that safety issues were posed by the number of elderly patients exhibiting wandering tendencies. This analysis aimed to research individuals impacted by AD on new wearable devices and find the challenges exclusive to this demographic [11]. The technique includes collecting internet search results and interviews with associated corporate members. Author [7] proposed a wearable gait analysis system for AD patients. This device gathers data related to gait features by using accelerated signals. For this work, the 'stride detection algorithm' has been used. Author [23] proposed an affordable GPS monitoring device, a mobile system with GPS functionality. It allows users to track the AD patient's location in real-time and offers preventive resources such as customising an alarm and providing caregivers with comfort. A smartwatch application server framework and step recognition algorithm for patients with dementia was developed by [24]. A 3-axis acceleration sensor was used. This demonstrated accuracy in checking average measures of 96 per cent. Various tracking systems [9] and applications assist AD patients in maintaining their daily lifestyle [15]. The devices currently available in the market (Kourtis et al., 2019) primarily focus on GPS location tracking [14]. Integrated solutions provided by these tracking systems [18] solve many issues and challenges [19] faced by ageing patients and enhance their quality of life [27] and welfare [31]. Some devices can record the individuals' activities while also providing medication management at the same time. They greatly support AD patients, from manual reminders to automatic exits in accurate time intervals [10]. Research is going on to provide a tool that allows the user to track the usage of everyday electrical appliances and ensures that the user remembers to turn the appliances off when not in use. Few home monitoring solutions are also being introduced, including cameras, sensors, and scanners for older adults [29].

An Apple smartwatch has been proposed by [4] based on the IoT concept. This app can help the caregivers by tracking the patient. It shows the patient's location with his heart rate. Further, a reminder facility for various tasks has been included in this work to help older adults.

The prototype of the Internet of Things (IoT) is the supporting concept of many developments in AAL (Ambient Assisted Living). This network facilitates developers to connect different devices, systems and technologies composed of specific tasks [8], for example, health surveillance, etc. The exponential advancement of wearable sensors [5] impacts how data is gained and processed [6].

Author [21] presented a device in which if a patient has passed a pre-set parameter, it has a portable transceiver that transmits the patient's position and is alerted to the database. In the context of a voice prompt, it receives an instruction from the database for details from the individual next to the patient. Also, ZigBee modules have been utilised for the wireless network sensor, the patient localisation GPS module, and the data transfer and receipt Global Mobile Communication System (GSM) module. Typically, it was anticipated that this remedial and creative approach to monitoring patients with AD would help managers and caregivers track patients before reaching their determined boundaries.

An intelligent healthcare monitoring system [13] was developed that has a feature to help caregivers keep track of the patients remotely. It emphasises the physiological data of a person to identify particular disorders that can be treated in the early stages. With 96 per cent of packets received at less than one millisecond and small packets, this research resulted in low latency-only 2.2 per cent of total packets lost was dropped.

A modern intelligent assistive technology (IAT) was created by [13] to recognise the essential moments in a patient's life, centred on patterns of physiological signal variations in people with dementia and their caregivers. IAT parameters are calibrated to the specific physiological input patterns of each organism. This is achieved by an iterative approach of integrating subjective reactions on videos and input received from the essential moment of the applicants. This is an advanced device with MATLAB software to help patients with dementia. Table 1 shows the literature work related to wearable devices for AD patients.

A wearable device containing electromagnetic sensors was designed to non-invasively monitor the progression of Alzheimer's disease-related brain shrinkage and lateral ventricle enlargement. The designed wearable RF device can successfully detect the course of brain atrophy and lateral ventricle enlargement. This work was intended to build a non-invasive gadget for monitoring patients' illness progression. The design of a wearable device that employs RF sensors to detect variations in the brain caused by Alzheimer's disease is the breakthrough in this work [33].

Wearable gadgets are essential tools that can assist doctors in diagnosing and treating various brain-related disorders. They analyse data and deliver vital insights by utilising innovative technologies. This article discussed how these wearables capture critical data regarding posture and walking, which might help dementia research. The research also looked at the evolution of wearables and how they are utilised outside of hospitals. This article discussed how they are incorporated into modern systems and the efforts to set standards and regulations for their use in medical studies [34].

AI-based methods will enable researchers to investigate more diverse sensor combinations for various diseases, including Alzheimer's. Recent breakthroughs in artificial intelligence hardware, software, and wearable sensors have demonstrated that merging AI with wearable technology can result in a real-time patient observation and analytics solution. Deep learning algorithms are particularly well suited to this task since they can match the demands of precision medicine in neurology. Deep learning models may now be performed directly at the place where data is received or sensed [35].

Research proposed and described a tiny, wearable gadget for monitoring sleep in Alzheimer's disease and another kind of dementia. This gadget integrates many sensors, including electrical (EEG) and chemical (pH and cortisol) measures and head motion detection. The gadget is meant to be worn with an eye shade and earplug, causing little interruption to the sleep cycle and including only a few grams to the head's weight. The gadget will capture EEG and acceleration data from the forehead while measuring pH levels from perspiration in the ear canal and cortisol levels from ear wax. The gadget communicates wirelessly via Bluetooth Low Energy (BLE), which reduces power usage and allows for longer recordings. This device provided a way to study the relationship between brain waves, cortisol, and pH levels during sleep. This proposed system will allow people with Alzheimer's disease to track their sleep more simply and correctly without inflicting discomfort [36].

Wearable devices, along with sensors, are a common application of IoT, which attracted much attention in the last era, to the point of reasonable fitness applications in the retail market. Such wristbands or smartwatches can monitor an individual’s activities day and night without much interruption. This proposed work presented a systematic literature review of IoT sensors and devices in elderly care. It aims at both existing review studies and case studies. It detects standard parameters- technological, such as the form of devices and clinical, for example, their healthcare focus from AD. In this aspect, the Internet of Things (IoT) is an auspicious solution to offer continuous, objective, and holistic monitoring, improving the burden of human caregiver effort and supporting clinical decision-making. These aspects include the gadgets utilised and the emphasis on healthcare, such as Alzheimer's, frailty, and cardiovascular disease. The evaluation also evaluates the length of the research and the number of participants. The study focuses on research done between 2010 and 2019. It begins by reviewing studies summarising the findings of many investigations [37].

A Smart Biomedical Assistance system was proposed that comprises an electronic gadget which continuously monitors the patient's status [28]. It displays the patient's position on a map, delivers automated medication reminders, and contains an emergency call button for emergencies that may arise during the day. The gadget comprises two parts: one that the patient wears and another that is an Internet of Things (IoT) platform application the caretaker uses. The wearable device includes sensors such as motion processing, GPS, heart rate, microcontrollers, and an LCD. This unit is linked to the caregiver's Internet of Things platform, allowing them to communicate with the patient from any location [38].

The recent progress in healthcare wearable devices has emerged as a promising technology to revolutionise patient monitoring and healthcare management. The research paper explores various advancements in this field, focusing on developing highly accurate and versatile wearables that integrate sensors and data analysis algorithms [12]. These devices enable continuous monitoring of vital signs, physical activity, and sleep patterns, providing valued real-time data for early detection of health issues and personalised healthcare interventions. Moreover, the paper emphasises the significant improvements in wearable device usability and comfort, with the introduction of lightweight and aesthetically pleasing designs.

In a recent European public involvement activity focused on evaluating function in Alzheimer's disease [20], researchers conducted a study to explore the features and preferences of patients and caregivers regarding wearable devices. The study intended to gather insights into the potential use of such devices in monitoring and evaluating the functional abilities of individuals with Alzheimer's disease. The research team engaged with patients and caregivers through interviews and surveys to understand their perspectives on wearable technology. The findings revealed that patients and caregivers valued user-friendly and non-intrusive devices that seamlessly integrate into daily routines. Additionally, participants emphasised the importance of personalised feedback and privacy protection when considering the adoption of wearable devices for assessing function in Alzheimer's disease. The insights gained from this study could inform the development and implementation of future wearable technologies for this patient population, focusing on meeting their specific needs and preferences [39].

With the advancement and expansion in IoT technology, the grounds for the research work have also expanded in healthcare. The survey report of AIMS 2019 [25] shows that the existing 90% health monitoring systems need to provide feedback on the report generated from tracking. Different researchers have carried out several efforts to build and develop computational approaches for examining the remote health of an individual. SHUBHCHINTAK Healthcare Application system is one of the proposed works in this area of concern in 2022 for providing a low-cost solution to monitoring the health of older people [40].

For a disease like dementia or its most common form, Alzheimer's, there is no cure or effective treatment available as of now; it can be devastating for any individual and his family as well. In this systematic review, the authors examine using deep learning and artificial intelligence (AI) techniques in intelligent health monitoring [30]. The study explores a broad range of research papers to calculate this domain's current state of the art. The findings suggest that deep learning and AI algorithms have shown great promise in various applications of intelligent health monitoring, including disease diagnosis, prediction, and personalised treatment. These technologies have demonstrated their ability to analyse large volumes of health data, such as medical images, sensor data, and electronic health records, to provide accurate and timely insights for healthcare professionals. However, the review also highlights the requirement for further research to address challenges related to data privacy, algorithm interpretability, and integrating these technologies into existing healthcare systems. Overall, this systematic review underscores the potential of deep learning and AI in revolutionising intelligent health monitoring and improving patient outcomes [41].

The neurodegenerative disorder in older people, which affects their memory and cognitive functioning, causing its degradation and impairment, is known as Alzheimer's. It is characterised by the gradual destruction of thinking skills and, eventually, the loss of the capacity to carry out the simplest tasks. Alzheimer's disease is the primary source of dementia, whose irreversible and catastrophic decline in the cognitive ability of any old-aged adult emotionally and financially burdens the patient and their families. Artificial Intelligence has been a great contributor in this field. There has been extensive research utilising the methods of AI and DL for diagnosis and prevention purposes [42].

The current statistics classify Alzheimer's as a silent pandemic due to the subtle changes that affect the brain cells gradually and may be overlooked or attributed to normal ageing [32]. As a result, individuals with Alzheimer's and their families may not realise the extent of the problem until the disease has significantly advanced. Instead of invasive approaches for the detection or prevention purposes that had faced negative impacts, non-invasive approaches may be helpful to a greater extent. These approaches generate ample data through wearable sensors and bio-sensors, which is fruitful in developing accurate and reliable biomarkers [45]. Wearable devices such as smartwatches or fitness trackers can collect data on the user's daily activities, including physical movements, sleep patterns, heart rate, etc. DL algorithms can analyse this data to establish patterns and detect anomalies that may indicate changes in behaviour or health. Such monitoring can be helpful for caregivers and healthcare professionals in tracking the progress of Alzheimer's disease and detecting potential health issues [43].

Table 1. Study of Existing Work Utilizing Wearable Technology

Name of Study (Author Name)	Year	Health Focus	Technology used	Description
(Linbo Jiang et.al., 2023)	2023	Body temperature	Sensors based	Involved the use of wearable sensors in the measurement of core body temperature, such as rectal and oesophagal measurements
(Nan Bu et. al., 2022)	2022	Heart Rate	Wearable healthcare sensor	Application of data interpolation to PPG data for utilisation of traditional heart rate variability methods in stress evaluation
(Xiaorong Ding et. al., 2021)	2021	Corona virus pandemic	Wearable sensing, telehealth technology	Wearable devices, especially for monitoring populations at quarantine and unobtrusive systems of sensing for disease detection. Inclusion of telehealth technology for remote monitoring and diagnosis of COVID-19-related diseases.
(Stavropoulos et al., 2020)	2020	Alzheimer's and another form of Dementia	IoT	Involved valuation of cognitive status with other disabilities along with care and assistance.
(Al-khafajiy et al., 2019)	2019	Elderly People	Sensors based	Smart healthcare monitoring device capable of remote inspection of older adults.
(Lai Kwan et al., 2019)	2019	Dementia	Intelligent assistive technology (IAT) algorithm with a MATLAB toolbox	Detection of vital moments of people with dementia based on changes in physiological signal order.
(Kourtis et al., 2019)	2019	Alzheimer 's disease	Mobile/ Wearable device	Overview of present methods of early clinical symptoms of AD. It also provided a roadmap to using technology for passive automated phenotyping.
(Aljehani et al., 2018)	2018	Alzheimer's Patients	IoT	Smartphone app for iOS utilising IoT technology as a response to the caregiving phase of Alzheimer's

				and integration with Apple Watch.
(Varatharajan et al., 2018)	2018	Alzheimer disease	Internet of Things (IoT) devices with DTW algorithm	Analysing different foot motions obtained from wearable devices using the Dynamic Time Warping algorithm.
(Mendoza et al., 2017).	2017	Alzheimer 's Disease	ZigBee modules, Global Positioning System (GPS)	Developed a wearable tracking system which helped caretakers and family to manage the patients.
(Margiotta et al., 2017)	2016	Alzheimer's and Parkinson's Disease	Inertial Measurements Units (IMUs)	Portable wireless system for gait analysis with an efficient algorithm for phase recognition.
(Woodberry et al., 2015)	2015	Alzheimer's disease	Wearable camera	.SenseCam, a portable wearable camera that captures critical AD patient incidents.
(Abbate et al., 2014)	2014	Alzheimer's Disease	Wireless sensor devices	Usability analysis of fall control device for long-term care for older adults with AD.
(Hsu et al., 2014)	2014	Alzheimer's Disease	Sensor-based wearable device	Developed gait and balance analysis algorithms for inertial sensors dependent on wearable devices.
(Shin et al., 2013)	2013	Dementia patients	Smart Watch with GPS	Step detection algorithm using 3-axis acceleration sensor in a watch-type wearable device.
(Paiva & Abreu, 2012)	2012	Elder and Alzheimer's patients	GPS Tracking System	Low-cost AD focussed GPS monitoring system emphasising mobile smartphones and GPS features.
(Mahoney & Mahoney, 2010)	2010	Alzheimer's disease	Wearable Technology	Investigation of existing wearable technology with monitoring of AD patients, including telephonic interviews.
(Shoval et al., 2008)	2008	Alzheimer's disease	GPS tracking Kit	Introduced a rapidly emerging monitoring technology for medical and physiological concerns among older people.

So far, various wearable devices are available for AD patients with intelligent sensors, and mobile applications. Various tracking systems are also available to support older adults with dementia that can cultivate their health and safety from many simple tools to integrated applications that researchers have proposed to help AD patients. This proposed work also gave a solution for people suffering from AD with advanced features like precise patient location, low development cost, less power consumption and a user-friendly mobile app.

3. Proposed Methodology

a. Proposed Methodology

In our proposed work, a new method has been suggested to track the patients suffering from AD. GPS is used to monitor the AD patient. If the patient has gone out of the range of the device, an alert message is sent to the caretaker's mobile number along with latitude and longitude values. The panic button is integrated within the device through the association of a microcontroller which will send the message of distress on caregiver and family members' mobile devices. The proposed system includes uploading photographs, calling patients, saving emergency contact numbers, reminder modules, and memory games through mobile applications. These features would help in the advancement of existing research.

Furthermore, the fusion of GPS technology in tracking Alzheimer's disease (AD) individuals and patients shared a substantial technical leap in the enhancement of caregiver support along with patient safety. The system's capability to monitor in real-time leveraging the potential of GPS ensured that the caregivers, i.e. patients, are always promptly alerted in the case of abrupt movement beyond the specific range. Moreover, this system was extended beyond the mere tracking functionality by including different features. The features included uploading photographs, calling patients, saving in memory of emergency contacts, and reminder modules through the dedicated platform mobile application with a user-friendly interface. By integrating all these features, this system will serve the core challenges of patient tracking and align with the holistic approach to Alzheimer's care. This fusion of technology and caregiving resources is poised to create a meaningful impact on the lives of patients and their families and caregivers, which will contribute to advancing research in this disease management field.

The whole system proposed under this framework will work with the collaborative efforts of all components involved in this system. The 78xxIC involved will work as a voltage regulator, thus providing a stable and collaborative power supply. The aluminium electrolytic capacitor is used to smooth the voltage fluctuations in power circuits. The ATMega328 microcontroller is the heart of the system and is known for its versatility in robotics and automation. The GPS module will help determine the exact location using global positioning satellites' signals. The other components include resistors and capacitors for limiting the current flow with capacitors storing energy release, an LCD screen for visualising the output and Android Studio for developing the mobile app for seamless integration between the wearable sensor and end user. Thus, the together collaborative efforts of the whole system will end up in the successful working of the framework.

b. Architecture Design

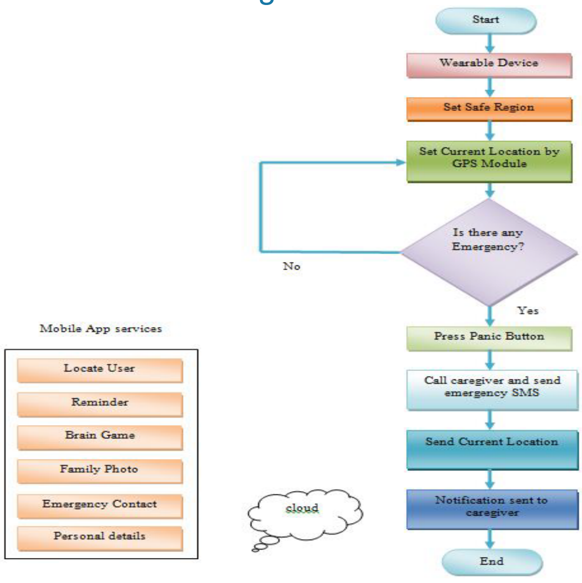

Fig 1: Architecture of proposed system

There are many ways to create a central monitoring system to receive distress signals. Using this concept, we have designed one smartphone gateway, which will be put on the Android application server. In India, there are more than 4 million people estimated to be suffering from AD and other forms of dementia, which makes the country the third highest producer of caseloads after China and the US. This prototype can greatly help serve these patients and their caregivers. An Android mobile app is designed to integrate with a microcontroller. The architecture for the proposed system is shown in Figure 1.

c. Algorithm

The algorithm for the proposed work is given below:

Algorithm: Wearable device for AD Patients
Input: get Login Credentials
//login activity
Output:-

```
1: login validation
2: for (user in users list)
3: if (user.userType.equals(user-selected)
&&user.email.equals(emailEditTextView.text.toString()))
    user exists = true
4:if(user.password.equals(passwordEditText.text.toS
tring()))
  passwordMatched = true
      preferences
editor?.putString(Constants.MY_DATA,

  Gson().toJson(user))?.apply()
4: check user type
  if (this.getSharedPreferences(PREFERENCE,
Context.MODE_PRIVATE).getInt(LOGIN_TYPE,
0)==TYPE_PATIENT)
  Redirect to Patient UI features
```

startActivity(Intent(this, PatientHomeActivity::class.java))
5: else
Redirect to CareTaker UI & Features
startActivity(Intent(this, CaretakerHomeActivity::class.java))
6: if the user doesn't exist or login validation is filed
fall back to the login screen
startActivity(Intent(this, LoginActivity::class.java))
7: register FirebaseCloudMessaging to receive notifications
8: check for image permissions
9: if (all permissions granted())
showImageCaptureLayout() //family photo upload activity
10: else
ActivityCompat.requestPermissions // request for phone permissions
11: if the image exists, show images related to the patient
showFullImage(photos list.get(position)?.photo)
12: locate patient
map = Google map
getLocationFromServer(firstTimeCheck)
13: receive notifications for emergency
14: if (Build.VERSION.SDK_INT >= Build.VERSION_CODES.O
15**: end if**
16**: Return**

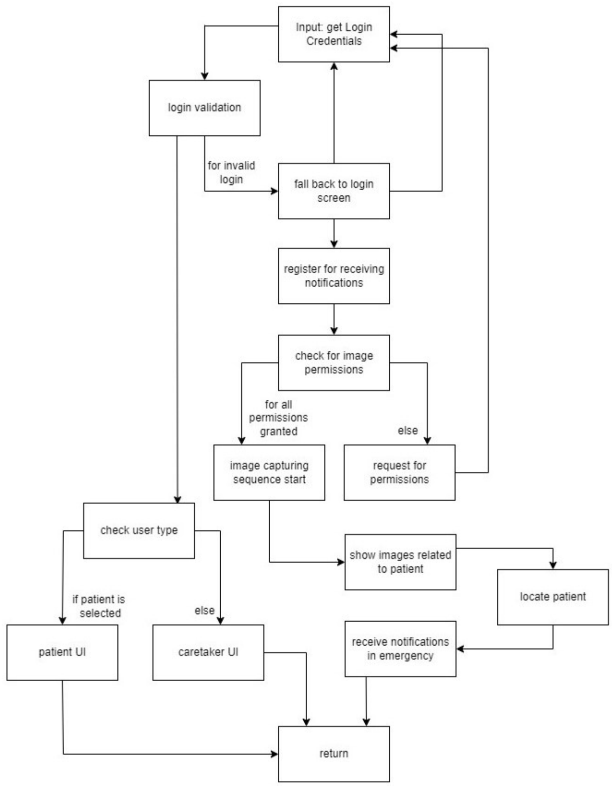

Fig 1.1 Algorithmic diagram of the implementation

Here, the algorithm proposed in Fig. [1.1] begins by obtaining the login credentials from the user. It then moves towards initiating a login validation process, where it checks whether the entered credentials are correct. Then the algorithm iterates over the list of users available in its database and compares the user type and email to finally validate its login. If a match is found, user information is shared using SharedPreferences. Next, the algorithm checks the user type and directs it towards the user interface of patients and caretakers interface separately.

The proposed system will start when power is on and check whether it is connected to the server. The antenna is used for receiving GPS signals transmitted through satellites. This device comprises a hardware ATMega 328 microcontroller with a tracking system for quickly locating the AD patient and related conditions with a mobile application. Also, it provides an option to schedule activities by setting reminders such as medications, exercise, food, and a means to play memory games to keep AD patients focused and entertained, which will be very valuable in healthcare applications. The device also contains a panic button so that in case of trouble, an alert message can be sent to the caregiver and family members of the AD patient on their mobile phone. The mobile application also offers an option to upload a family photograph with names to recognise family and friends. The patient can be called through the mobile application, and his personal information can be stored.

4. System Specifications

The proposed system uses components like 78xxICs, an Aluminium electrolytic capacitor and an ATMega328 microcontroller. The Robokits GPS 02, with Resistors and capacitors, are also used. LCD screen is used for display, and Embedded C is adopted for programming on hardware. Android Studio software is utilised to build the mobile application. Let's discuss each of the different components.

78xxICs: These are mainly voltage regulator ICs belonging to the 78xx series. These are primarily used in providing a stable and controlled power supply. For example, the 7805 IC circuits, which give a constant output of +5V, are constructive in providing power to various components in a circuit board.

Aluminium Electrolytic Capacitor: This capacitor is well-known for its high capacitance power and is used for smoothening the voltage fluctuations in power circuits. This also helps stabilise the power supply to ensure a consistent voltage supply.

ATMega328 Microcontroller: The ATMega328 is a very popular microcontroller widely used in various types of Arduino boards. It has a wide range of applications and is very versatile for various projects, including robotics and automation.

Robokits GPS 02: This comprises a GPS module provided by Robokits that allows for efficient determination of geographical location using signals received from global positioning satellites. It is very much essential in applications which involve the use of location-based functionalities.

Resistors and Capacitors: These are the most fundamental required components in any circuit board. Resistors limit the flow of current in and out, while capacitors, on the other hand, can store and release electrical energy. These are very crucial in controlling voltage levels and signal conditioning.

LCD Screen: The LCD, also known as Liquid Crystal Display screen, is mainly used to get the output in visual mode. Due to its low power consumption factor, displaying information on LCD screens or embedded systems is a common choice.

Android Studio: Android Studio is an integrated development environment specifically for developing Android applications. This framework is used to develop the mobile application for user interaction and control of the proposed system.

5. Results and Discussions

The proposed system consists of the following functions:

i. GPS is used to monitor the AD patient. For dementia patients, travelling outside their homes unattended can be a cause of serious concern. GPS location and tracking devices help promptly, quickly, and securely address such emergency conditions.

ii. The panic button is integrated within the device through the association of a microcontroller, which will display the distress message on the caregiver and family members' mobile devices.

iii. The caretaker will have multiple patients under him. For each patient, a unique ID will be generated. Once logged into the mobile application, the caretaker can access the user's database and take necessary action.

iv. This proposed system allows uploading photographs in the mobile device application, specially made for people who cannot recognise their loved ones. AD patients can scroll through photographs of their friends and family in this app.

v. There is an option to "call patient" through the mobile app and store the patient's details. Emergency contact numbers can also be saved through mobile applications.

vi. There is a reminder module within the mobile application that notifies the user of planned daily activities, including exercise, food and medications. The app also includes a simple reminder screen that lists all the reminders for the day.

vii. Puzzle/Memory game option is also available for AD patients.

The system entirely focuses on the latest technologies to make better aid for patients; not only can the level of dementia be recognised, but it also helps improve the performance of the system. The mobile application is also made in this proposed system with an integrated microcontroller. It is expected that diseases like AD or other dementia could be monitored using applications and software designed specifically for the cause, thereby helping out the patients.

It is a wearable device connected to AD patients all the time. Its functions are shown in Fig. [2] to Fig. [6].

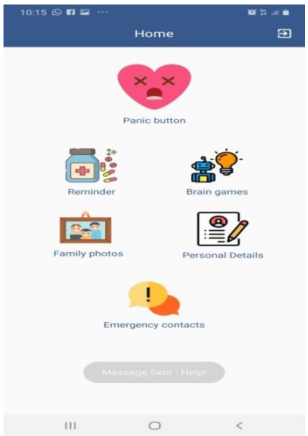

Fig 2 Various options available for patient

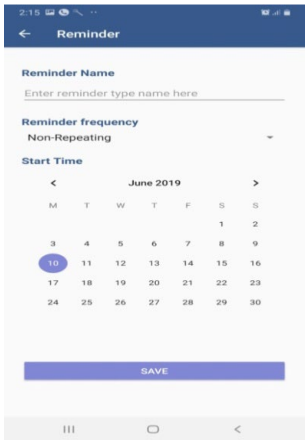

Fig 3 Setting Reminder for patients

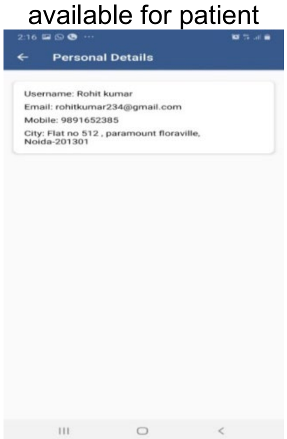

Fig 4 Personal details of the patient

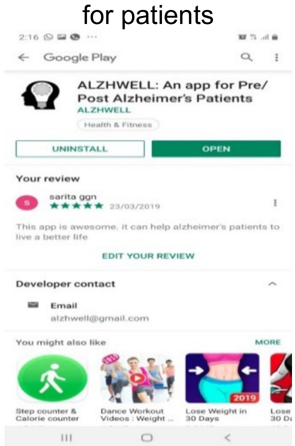

Fig 5 Memory Game app

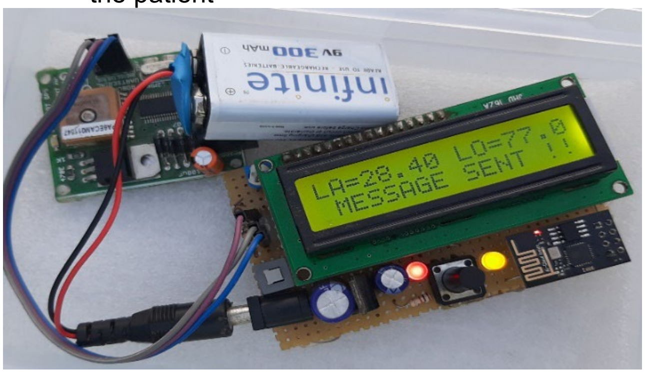

Fig 6 Proposed module of a wearable device for AD Patient

6. Materials and Methods

The proposed system is potent in tracing the daily time locations. The GPS module provides satellite tracking services that are useful in various commercial and personal applications and work in all weather conditions.

GPS cost is meagre in comparison with other navigation systems. The device communicates quickly with family members or caregivers after pressing the panic button and has adequate sensitivity. Within five seconds, the message gets displayed, which could prove crucial in saving a patient's life, and the alert messages come with an audible beep sound, which is very useful in case there is any noise in the surrounding area. This device has a lower development cost than the existing system, and the power consumption is also less [23]. A clear understanding of this GPS module can be seen in Fig. [7].

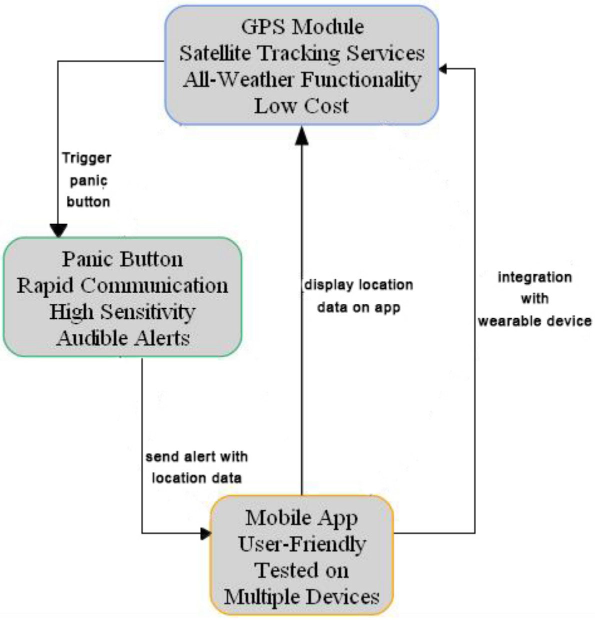

Fig 7 Working of the GPS module with a panic button

The mobile app is user-friendly and straightforward to use, and at the same time, it is reliable with less chance of malfunction or crash. The proposed mobile application is tested on over ten devices with different resolutions and Android versions. It is a small, lightweight device that is relatively easy to carry. LCD size is good at 16/2 cm, so even older adults can easily view the message. Our proposed approach would be better in terms of the device's size and the different components' cost-effectiveness than the devices [17] currently available in the market [3].

This device would greatly support healthcare applications, and its implementation is also feasible. It is a novel device to help AD patients using wearable technology. The proposed device can recoup the position of AD patients with precise latitude and longitudinal values. Smart phone app is integrated with this wearable device. It is an inexpensive device that can decrease the load on the healthcare network and raise the efficiency of clinical trials.

Moreover, this framework emphasised user safety by integrating robust security features. The efficient communication between the wearable device and the developed mobile app will always be encrypted, ensuring the user's privacy concern. This end-to-end encryption will also help safeguard against potential hackers or unauthorised access. Additionally, with the long-lasting battery of the device, it will eliminate the need for frequent charging and keep its use for a longer time. This extended battery life enhanced the usability and reliability of the device, which is essential in emergencies. For the continued tracking, the factor of low power consumption will play an important role, which will not only contribute to the efficiency of the device but also align itself with sustainable and eco-friendly practices.

Furthermore, the device's design is aligned with durability, at most capable of withstanding various environmental conditions. The device's resilience made it suitable for everyday use, ensuring continued functionality even in challenging situations or during outdoor activities. The robust design of the device, along with the framework, together builds up the system's reliability, thus building a dependable solution for the monitoring and assistance of individuals with Alzheimer's disease.

7. Conclusion and Future Trends

The proposed device is in the form of a pendant which integrates various components and can provide an accurate location of the patient with the help of a GPS Module, as well as help messages through the user's mobile application in case of any trouble. In rural areas, people affected by AD face a lot of technology and treatment challenges as compared to people living in urban areas. This proposed work would enlighten people with dementia and their caretakers about products that may ease their burden. Using wireless devices and accumulating data on the internet can also be a guide to possible safety concerns. This pendant design can be incorporated into an overall necklace and utilised in the healthcare industry. This method would advance the quality of life, health, and safety of senior citizens living with AD. The proposed work has proved to be a better and more easily adaptable technology to help the caretakers of AD patients. In future, a new technology will be developed with more emphasis on creating apps to identify early symptoms of dementia. Further efforts will emphasise developing apps to support caregivers and individuals who reveal early warning signs of dementia, therefore receiving medical support and provisions. In future concept of Artificial intelligence (AI) can be presented further.

8. Declarations

All authors declare that there is no conflict of interest.

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