

A WEARABLE ASSISTIVE DEVICE FOR DEMENTIA PATIENTS

Submitted in partial fulfilment of the requirements for the award of

Master of Technology degree in Medical Instrumentation

by

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INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

Accredited with Grade "A" by NAAC

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BONAFIDE CERTIFICATE

This is to certify that this report is the bonafide work of **Sabarivel.R** (Reg. No. **40440010**) who carried out the project entitled "**A WEARABLE ASSISTIVE DEVICE FOR DEMENTIA PATIENTS**" under my supervision from **November 2022 to April 2023**.

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DECLARATION

I, Sabarivel.R (Reg. No. 41440010) hereby declare that the project report entitled "A WEARABLE ASSISTING DEVICE FOR DEMENTIA PATIENTS" done by me under the guidance of Dr. J. Premkumar, Ph.D., Department of Biomedical Engineering is submitted in partial fulfilment of the requirements for the award of Master of Technology degree in Medical Instrumentation.

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ABSTRACT

A common clinical syndrome among older adults is dementia, which is characterised by a continuous deterioration in memory and cognitive ability. It affects a person's capacity to work and complete typical household chores. Around 18 million individuals worldwide are thought to have dementia, and by 2025, that figure is predicted to rise to 34 million. People who are providing care for a patient with dementia bear the responsibility of controlling the condition without the use of pharmaceuticals, and it is also recommended to promote functional independence. Innovative technologies are quickly becoming available, providing carers with the assistance and support they need to keep older people with cognitive impairment "at home". With the use of a discrete monitoring device, caregiver stress is decreased and functional independence among dementia patients is increased. The research study describes a tool i.e., wearable band, which improves the quality of life for dementia patients. this wearable smart band which helps to monitor various parameters such as location, sleep, SPO₂, heart rate, sweat, anxiety using GSR sensors of the patient which will act as an artificial caretaker. This device also consists of GPS positioning system to monitor their location and has emergency SOS system for panic situation.

Key words: *dementia, discrete monitoring, GSR sensors, functional independence, SOS.*

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LIST OF ABBREVIATIONS

LCD	-	Liquid Crystal Display
SPO2	-	Oxygen saturation
HR	-	Heart rate
SPP	-	Serial Port Protocol
DMP	-	Digital Monitor Processor
SCL	-	Serial Clock
SDA	-	Serial Data
XDA	-	Auxiliary Serial Data
XCL	-	Auxiliary Serial Clock
INT	-	Interrupt
PSU	-	Power Supply Unit
VCC	-	Voltage Common Collector
SMPS	-	Switched Mode Power Supply
IOT	-	internet of things
V _{in}	-	Input Voltage
MCU	-	Micro controller unit
SRAM	-	Static Random Access Memory
TWI	-	Two Wire Interface
TTL	-	Transistor-Transistor Logic
DTR	-	Dynamic Thermal Rating
MEMS	-	Micro Electro Mechanical System
I2C	-	Inter-integrated circuit

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CHAPTER 1

INTRODUCTION

Dementia is a type of neurological degenerative condition that typically affects persons in their 40s and older. Vascular illness, dementia with Lewy bodies, and frontotemporal dementia are among the disorders. Alzheimer's diseases and vascular dementia account for roughly 90% of dementia cases worldwide, suggesting that they may be the main causes of dementia. There is presently no cure for dementia, which has a significant impact on a patient's everyday activities and abilities to think, analyse, and remember things.

Life expectancy and the number of elderly persons is rising because of medical and technological advancements. In some circumstances, due to carelessness and disregard, patients' health could suffer grave consequences. There is a limited variety of help available for dementia patients and their caregivers. Since the majority of those affected are around 50 years old and are prone to tachycardia and palpitations during stressful situations, it is important to routinely check their stress levels, heart rates, and other vital signs. This cannot be accomplished manually by performing a battery of tests on a regular schedule, which may put a great deal of pressure on the patient and the caregiver.

Dementia patients may incur costs and expenses over their lives that range from 20 lakh to more than 100 billion dollars worldwide, which calls for serious consideration.

The quality of life for patients and caregivers has significantly improved because of the development of sophisticated equipment in the fields of health and technology, including smart phones, the internet of things, and artificial intelligence.

In addition to taking on a significant financial load, the family also takes on the role of primary caregiver, which is frequently an emotionally taxing job. The effects of caregiving may be detrimental to one's health, employment, income, and financial security. One-third of family care givers showed symptoms of depression, and half said their main health issue was related to caring for others. Although most caregivers are located near to their patients, 15% of them reside more than an hour

away. This makes it incredibly challenging for these remote caregivers to keep an eye on patients all the time.

1.1 PLAN OF IMPLEMENTATION

The "dementia patient assist tool" described in the study monitors the patient's vital signs using a variety of sensors and has a design that enhances independence and quality of life in all aspects. It gradually lessens the stress on family members and caregivers and allows for around-the-clock patient monitoring at any time and location.

The purpose of the study is to present a technology platform for dementia-affected elderly individuals and their caregivers that aims to support maintaining health and functional capability, provide the means for self-care and self-management of chronic conditions, add value to the individual by maximising his or her ability, and support the moral and mental development of both the patients and their caregivers.

CHAPTER 2

LITERATURE SURVEY

Non-pharmacological management of dementia puts a burden on those who are taking care of a patient that suffer from this chronic condition. Caregivers frequently need to assist their patients with activities of daily living. However, they are also encouraged to promote functional independence. With the use of a discrete monitoring device, functional independence is increased among dementia patients while decreasing the stress put on caregiver. the application, *I Wander*, runs on several Android based devices with to cost effectively monitor their patients remotely. The data collected from the device is evaluated using Bayesian network techniques which estimate the probability of wandering behaviour. Upon evaluation several courses of action can be taken based on the situation's severity, dynamic settings and probability. These actions include issuing audible prompts to the patient, offering directions to navigate them home, sending notifications to the caregiver containing the location of the patient, establishing a line of communication between the patient-caregiver and performing a party call between the caregiver-patient and patient's local 911. As patients use this monitoring system more, it will better learn and identify normal behavioural patterns which increases the accuracy of the Bayesian network for all patients. Normal behaviour classifications are also used to alert the caregiver or help patients navigate home if they begin to wander while driving allowing for functional independence (Spasaro.F *et al*, 2010).

There has been a significant increase in research into assistive devices for people with cognitive disabilities. The majority of this research has focused on the development of devices for younger adults who have learning impairments or brain injury. These devices have not been acceptable for use by older adults who have dementia. This paper will provide an overview of how the principles of context-aware design may be applied to the design of future assistive devices to make them suitable for older adults with dementia. Several examples of devices specifically designed for this population will be provided (Fernie and mihailidis, 2002).

The extent to which technology may be able to support people with dementia and their carers along the care pathway and in different care settings is of interest

to policy makers and governments. In this paper we provide an overview of the role of technology in dementia care, treatment, and support by mapping existing technologies – by function, target user and disease progression. Technologies identified are classified into seven functions: memory support, treatment, safety and security, training, care delivery, social interaction and other. Different groups of potential users are distinguished: people with mild cognitive impairment and early stages of dementia, people with moderate to severe dementia and unpaid carers and health and social care professionals. We also identified the care settings, in which the technologies are used (or for which the technologies are developed): at home in the community and in institutional care settings. The evidence has been drawn from a rapid review of the literature, expert interviews and web and social media searches. The largest number of technologies identified aim to enhance the safety and security of people with dementia living in the community. These devices are often passive monitors, such as smoke detectors. Other safety interventions, such as panic buttons, require active intervention. The second largest number of interventions aims to enhance people's memory and includes global positioning systems devices and voice prompts. (Lorenz.K, Paul P Freddolino *et al*,).

This paper reports on a wearable IoT monitoring system which can be used for the collection of quantified data of patients with autism spectrum disorder (ASD) by which the parent or the guardian can monitor easily. The objective of the project is to monitor the children with Autism by a self-updating monitoring system. Autism is referred to behavioural disorder because of the repeated and non-functional activities of the patients. The long-term objective of the project is to use this system for data-driven detection, therapy, intervention, and progress monitoring for children with Autism. This project consists of accelerometer sensor, GPS module, Wi-Fi Module, Audio sensor, Temperature sensor connected to Arduino UNO. The accelerometer is used to detect the child's activity continuously. The data is transferred to the mobile phones of the guardian or the parent by which the needs can be fulfilled, or accidents may be prevented. Using the data collected over a period, intervention of this disorder can be developed in a vast manner. (Eveline.d *et al* ,2021)

The factors that determine caregiver load and depression are addressed in this article, with an emphasis on care needs and in particular, the variations in the

consequences of different neuropsychiatric illnesses or symptom clusters. In addition, research on carers for frontotemporal and Lewy body dementias were cited in order to highlight distinctions and parallels with the mainstream literature, which is predominately composed of caregivers for Alzheimer's disease. Recent discoveries Regardless of the dementia diagnosis, neuropsychiatric symptoms as a whole are the best predictors of caregiver stress and depression, but the effects seem to be predominantly driven by disruptive behaviours (such as agitation, hostility, and disinhibition), followed by delusions, and mood disruption. Disruptive behaviours are more upsetting because they negatively affect the emotional bond between the caregiver and the care receiver and because they make existing problems worse in other areas (such caring for daily living activities). Due to the care-lack recipients of empathy, these disruptive behaviours are not only more pronounced in behavioural variant frontotemporal dementia but are also more upsetting. Visual hallucinations also seem to be disturbing in Lewy body dementia. (Sheung, Tak Cheng, 2017)

This article summarises the current state of knowledge regarding dementia care in assisted living facilities and suggests areas for further investigation. The demographics of individuals with cognitive impairment in assisted living and associated residential settings are described in the article. In specialised dementia units and integrated assisted living settings, people get services, processes, and structural components in the United States. Finally, we discuss the studies on methodological concerns with this field of study. (Joan Hyde.J, Rosa Perez *et al*, 2007).

The objective of the present study was to create a valid and trustworthy instrument to assess whether person-centred Workers in direct care provide care to dementia patients. At first, face validity developed through several iterations of the CARES Observational Tool (COT) by participants in the study group. After then, the tool's content validity was determined by piloting it on 31 observations. an evaluation by a multidisciplinary team of nine scientific experts conducted across 7 nursing facilities. the last the inter-rater reliability of the 16-item COT version was then examined by 5 reviewers using 5 standardised procedures. videos for dementia care. An intra-class coefficient (ICC) of.77 was obtained using all conceivable Kappa coefficients. (Joseph E. Gaugler, John V. Hobday, 2013).

The Brief Cognitive Assessment Tool (BCAT) is a new screening measure for cognitive dysfunction that emphasizes contextual memory and executive control functions. A total of 104 older adults referred for neuropsychological evaluation were recruited from assisted-living facilities. Psychometric analyses confirmed strong evidence for reliability, construct validity, and predictive validity. The BCAT's utility for identifying dementia versus mild cognitive impairment was excellent, with a sensitivity of .99, a specificity of .77, and an area under the receiver-operating characteristic (ROC) curve of .95. Executive control, contextual memory, and attentional capacity items were the best predictors of diagnostic category and of instrumental activities of daily living. (William E. Mansbach, Elizabeth E. MacDougall & Andrew S. Rosenzweig, 2012).

Innovative technologies are quickly becoming available, providing carers with the tools and assistance needed to let older people with cognitive impairment stay "at home." In order to assure not only safe but also morally relevant therapies, technology research and development activities applied to older persons with dementia demand additional grant evaluation and institutional review board considerations. However, there is evidence that the relationship between inventors and reviewers is becoming more tense.

Reviewers who are biased against technology may hamper necessary innovation. Applications that are not compatible with users' skills may be created by technology developers if they are unaware of the clinical and caring elements of dementia. To bridge this gap, we provide an examination of the moral dilemmas raised by home monitoring, a conceptual framework, and moral principles for the creation of technology for people with Alzheimer's disease and their caretakers. (Diane F. Mahoney *et al*, 2007).

Interviews about pain (pain presence, severity, locations, and duration), a measure of pain-related behaviour, the Mini-Mental State Examination, analgesic drugs, and demographic data. Participants underwent a pain-inducing activity-based programme. The self-reported frequency of pain was 86%. After activity but not at rest, persons with cognitive impairment felt less pain than those with normal cognitive function after controlling for analgesics. Participants with intact or reduced cognitive function showed the same behavioural pain signs. In older adults with

intact cognitive function, the total number of pain behaviours was significantly correlated with self-reported pain intensity ($b = 0.40$, $P = 0.000$). Independent of analgesics, older adults with cognitive impairment self-report less pain than older adults with cognitive health, but only when evaluated after movement. The groups' behavioural pain markers are the same. The link between pain behaviours and self-report is evidence for the reliability of behavioural measures in this group. These results validate the application of multidimensional pain evaluation in dementia patients. (Ann L. Horgas, et al, 2008).

To determine the elements that help or impede people with dementia from making advance plans, we conducted semi structured interviews with 30 family members of patients with advanced dementia. The analysis of all interviews was done utilising qualitative data analysis methods. Most family members (77%) said their loved one had a documented advance directive in place, and at least half said they had previously discussed the patient's choices for medical treatment (57%), living arrangements or placement difficulties (50%), and financial or estate planning (60%) with them. Some themes were cited by family members as planning catalysts, whereas others were cited as planning inhibitors. Medical, housing, or financial problems involving a patient's friend or relative were the situations that most frequently led to planning (57%). These findings suggest potentially effective ways to overcome obstacles to advance planning discussions. (Karen B. Hirschman et al, 2008).

The study outlined in this paper expands on our earlier modelling work on how assistive technology, such as reminder applications, gets adopted. It tries to find a more focused subset of variables that can more precisely predict technology adoption. To reduce the chance of non-adoption, an adoption model is constructed utilising a collection of features taken from a user's past. The research is based on the study of 31 variables from the Cache County Study on Memory and Aging (CCSMA), which varied in age, gender, education level, and health condition information. The best classification models are chosen once feature reduction and selection are completed in the adoption of modelling. When evaluated on 173 people, the technology adoption model developed had an average prediction accuracy of 92.48% using the smaller set of labelled characteristics. It comes to the conclusion that it is advantageous to model user adoption from a variety of angles,

including physical, environmental, and social aspects, when suggesting a technology to a specific user based on their profile. (Priyanka Chaurasia, Sally I. McClean et al, 2016).

CHAPTER 3

AIM AND SCOPE

3.1 AIM

- To detect and analyze the patient vital parameters
- To monitor the patient's location
- To analyze the patients stress level using GSR sensor, Accelerometer, sound detection sensor, SpO₂ to initiate SOS protocol if the patient is in abnormal condition.

3.2 SCOPE

The wearable assistive devices have a wide range of potential uses and advantages for real-time monitoring of dementia patients in healthcare systems. The monitoring and management of dementia complications is a crucial area of scope for wearable assistive devices in the monitoring of dementia. The technology can notify patients and healthcare professionals to potential difficulties, such as elevated stress and panic attack and provide perfect timed warning for treating these problems by delivering visual data and SOS messages and live location and other health variables.

Patients who utilise this system receive a user-friendly dashboard that shows their vital health parameters such as spo₂, heart rate, temperature, stress level in a simple and understandable manner. Patients can use this data to monitor their development over time. To keep patients on track with their medication schedule, exercise routine, and other parts of their diabetes treatment, the system can also send them notifications and reminders.

This also increases the effectiveness and efficiency of healthcare providers. These details can help medical professionals make more educated judgements on the dosage of medications, suggested diets and lifestyles, and other diabetes management-related issues. Additionally, by minimising the need for in-person visits and facilitating more effective and efficient care, the system can expedite interactions between patients and healthcare professionals.

Here GSR sensor and accelerometer and sound detection sensor are used as panic detection system. GPS sensor is connected with the nodeMCU in order to monitor the patient's current location using blynk app. The buzzer is connected with the micro controller in order to provide alarm sound during period.

3.3 EXISTING SYSTEM

In existing system, the dementia patients are mostly taken care by the family members or by external assistance and the products available in the markets are visual aids and software to set reminders for the important tasks to be done and personal ledgers are also available.

3.3.1 Disadvantages

- Cost
- Low technologically advanced
- Availability

3.4 PROPOSED SYSTEM

In Proposed system, to overcome the existing problem we employ wearable type patient monitoring technology to assist them in overcoming their dependence on the second and third person and restlessness, and as well as triggering Emergency Notifications to Caretaker to enable prompt action to assist them.

3.4.1 Advantages

- Portable.
- Cost efficient.
- Reliable.
- Robust in build.
- Accurate.

CHAPTER 4

MATERIALS AND METHODS

4.1 BLOCK DIAGRAM

Microcontroller is the main unit which integrates both input and output. 5V power supply is given to the microcontroller. The input data are collected from sensors. The input data are displayed over OLED display. According to the customized program, the output is performed. The input sensors that are connected to microcontroller are MAX30102 which is a 3 in 1 sensor which has inbuilt temperature sensor, spo2 sensor and heart rate sensor.

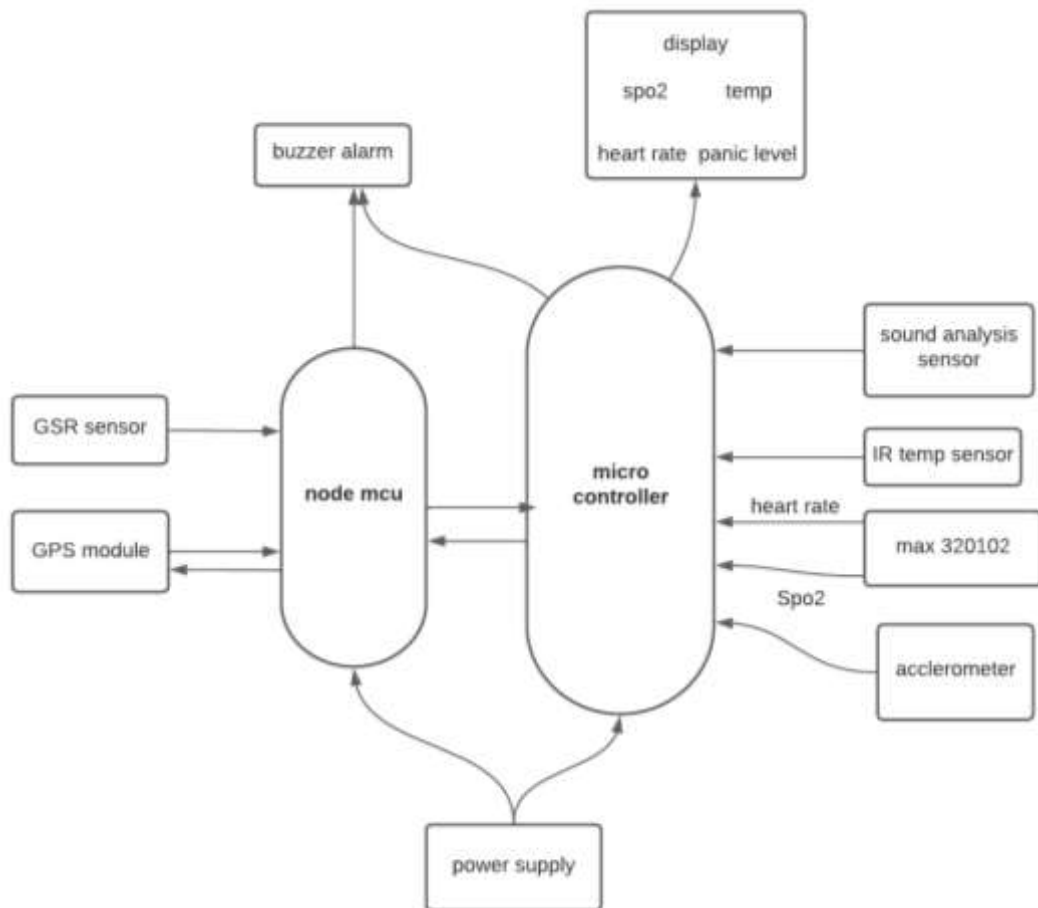


Fig. 4.1: Block diagram of Dementia patient assist tool

4.2 FLOWCHART

The workflow for a system that includes the initialization of a device, calibration of sensors, calculation of vital signs, non-invasive glucose level monitoring, logging into IoT, and visualization of output in IoT, stop the device can be broken down into the following steps:

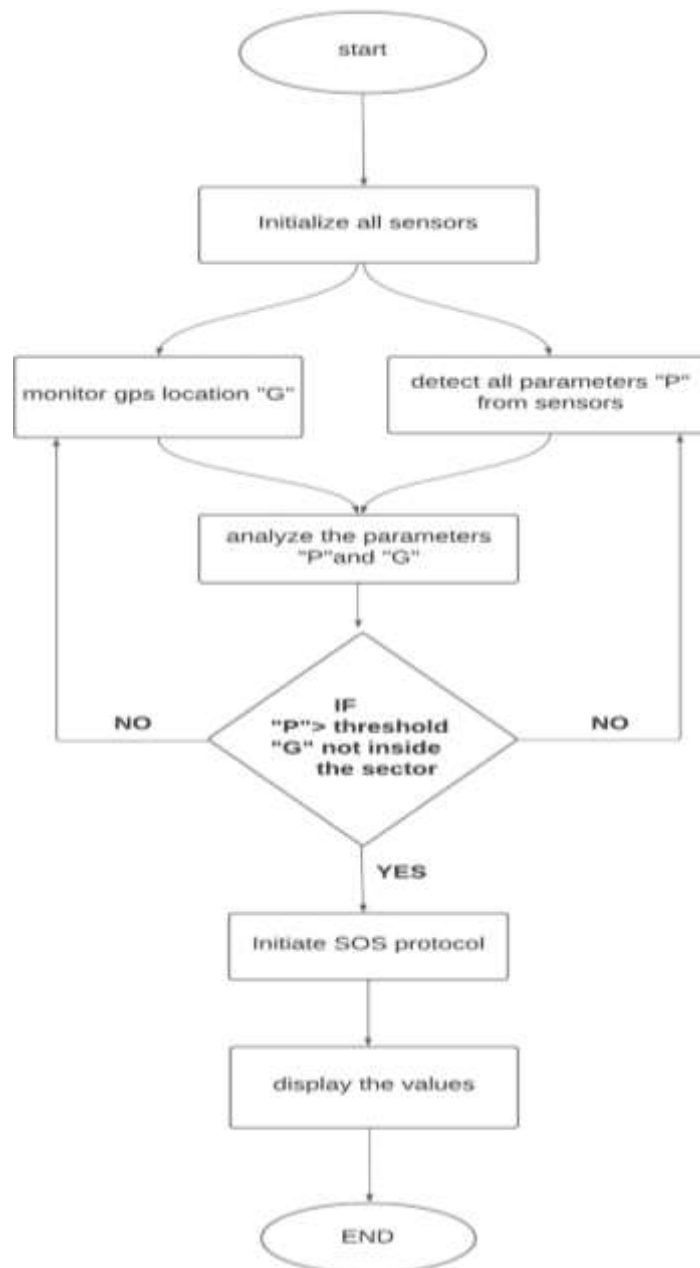


Fig. 4.2: Flow diagram of Dementia patient assist tool

- **Start:** The system starts with the power-up of the device and the initialization of the software.
- **Initialize the device:** The device is initialized, and the sensors are checked to ensure that they are properly connected and functioning.
- **Detect the parameters and location:** The system detects the user's vital parameters such as Spo2, current location heart rate, temperature, stress-level, abnormal acceleration and sound.

- **Analyse the values with threshold values:** The user's parameters are compared with the pre-set threshold values and the location is monitored.
- **Compare the values with the given condition:** compare the value with "IF" condition and detect whether the condition is satisfied or not.
- **Decision initialization:** if the condition is satisfied the SOS protocol will be initiated and if the condition is not satisfied then the system is set to reset and detect and the next cycle will be initiated.
- **Displaying the value:** the parameters "P" and the location of the subject is displayed in the OLED display interfaced with the micro controller and in blynk app.
- **End:** The system shuts down or enters a low-power mode to conserve battery life when not in use.

This workflow provides a comprehensive approach to real-time monitoring of Dementia patients in a healthcare system using advanced technology. By incorporating multiple sensors and location detection technology healthcare providers can more effectively monitor patients and provide timely interventions as needed. The workflow diagram for dementia patient assist tool detailly explains about real-time monitoring of dementia patients. By collecting and analysing real-time health data, healthcare providers can make informed decisions about patient care and help patients better manage their condition.

4.3 INTRODUCTION

All key components such us GSR sensor, MAX30102, ADXL335, are interfaced with breadboard using Pulse oximeter, Force sensor and OLED display relate to Node MCU board for the supply power to the equipment. Node-MCU is connected TO Blynk Application for transfer information to mobile phone or computer.

4.3.1 Hardware requirements

1. Arduino Microcontroller
2. Node MCU
3. GSR Sensor
4. Accelerometer Sensor (ADXL335)
5. MAX30102 Sensor

6. Sound Detection Sensor
7. GPS Module
8. OLED Screen
9. IR temperature sensor
10. Buzzer
11. Bread board and connecting cable

4.3.2 Software requirements

1. Arduino IDE (integrated development environment)
2. Blynk app

4.4 HARDWARE DESCRIPTION

4.4.1 Arduino nano

Arduino Nano is a microcontroller-based development board that is designed to be small, compact, and easy to use. It is based on the ATmega328P microcontroller, which is an 8-bit AVR microcontroller that provides 32KB of flash memory, 2KB of SRAM, and 1KB of EEPROM. The board has a compact form factor, measuring only 45mm x 18mm, which makes it easy to use on a breadboard or in a small project.

The Arduino Nano has 14 digital input/output pins, 8 analog input pins, and 6 PWM (Pulse Width Modulation) pins. These pins can be used to interface with a variety of sensors, actuators, and other electronic components. The board also has a reset pin, a UART (Universal Asynchronous Receiver/Transmitter) interface, and a SPI (Serial Peripheral Interface) interface, which allows it to communicate with other devices, such as sensors and displays.



Fig. 4.3: Arduino Nano

4.4.1.1 General Pin Function

- Digital pins 0-13: These are the digital input/output pins that can be used to interface with a variety of sensors, actuators, and other electronic components. These pins can be configured as inputs or outputs using software.
- Analog pins A0-A7: These are the analog input pins that can be used to read analog voltages from sensors, such as light sensors and temperature sensors.
- PWM pins 3, 5, 6, 9, 10, and 11: These are the pulse width modulation (PWM) pins that can be used to control the brightness of LEDs, the speed of motors, and other similar applications.
- Reset pin: This is the reset pin that can be used to reset the board or to put it into bootloader mode for programming.
- 5V and 3.3V pins: These are the voltage output pins that provide a regulated voltage of 5V and 3.3V, respectively, for powering external components.
- Ground pins: These are the ground pins that provide a common ground reference for the board and external components.
- UART pins: These are the pins that provide a serial communication interface that can be used to communicate with other devices, such as sensors and displays.
- SPI pins: These are the pins that provide a SPI communication interface that can be used to communicate with other devices, such as SD cards and Ethernet modules.

4.4.1.2 Special Pin Function

- AREF pin: This pin is used to provide a reference voltage for the analog-to-digital converter (ADC) when using analog inputs. It can be used to set the maximum voltage for the ADC conversion, which can be useful for accurately measuring small voltage differences.

- I2C pins: The Arduino Nano has two pins (A4 and A5) that can be used for I2C communication. I2C is a popular communication protocol that is used to connect multiple devices together in a network.
- RX and TX pins: These pins are used for serial communication and can be used to send and receive data to and from other devices, such as a computer or another microcontroller.
- INT0 and INT1 pins: These pins can be used as interrupt pins, which allow the microcontroller to respond quickly to external events, such as a button press or a sensor reading.
- Analog reference voltage pins: The Arduino Nano has two pins (AREF and AREF-SEL) that can be used to set the reference voltage for the ADC. This can be useful for accurately measuring small voltage differences.
- ICSP pins: These pins are used for in-circuit serial programming (ICSP) and can be used to program the microcontroller using a programmer.

4.4.2 Node MCU

NodeMCU is an open-source LUA based firmware developed for ESP8266 WIFI chip. By exploring functionality with ESP8266 chip, Node-MCU firmware comes with ESP8266 Development board/kit. NodeMCU is an open source IoT platform. This ESP8266 NodeMCU contains firmware that can run on ESP8266 Wi-Fi SoC chips, and hardware based on ESP-8266 modules.



Fig. 4.4: Node MCU

4.4.2.1 NodeMCU ESP8266 Specifications & Feature

- Microcontroller: Tensilica 32-bit RISC CPU Xtensa LX106
- Operating Voltage: 3.3V
- Input Voltage: 7-12V
- Digital I/O Pins (DIO): 16
- Analog Input Pins (ADC): 1

- UARTs: 1
- SPIs: 1
- I2Cs: 1
- Flash Memory: 4 MB
- SRAM: 64 KB
- Clock Speed: 80 MHz
- USB-TTL based on CP2102 is included onboard, Enabling Plug n Play
- PCB Antenna

4.4.3 GSR sensor

GSR (Galvanic Skin Response) sensor, also known as skin conductance sensor, is a type of sensor that measures the electrical conductance of the skin. It is commonly used in various applications such as lie detection, stress monitoring, and biofeedback. The GSR sensor typically consists of two electrodes that are placed on the skin. When a voltage is applied across the electrodes, a small current flow through the skin, and the resistance of the skin determines the magnitude of this current. The GSR sensor measures this current and converts it into a voltage signal that can be processed by a microcontroller or other device.

The GSR sensor can be used in two modes: DC and AC. In DC mode, a constant voltage is applied across the electrodes, and the resulting current is measured. In AC mode, a high-frequency AC voltage is applied across the electrodes, and the resulting current is measured. AC mode is generally more sensitive than DC mode, but it is also more prone to noise and interference. The GSR sensor typically has two output pins: a signal pin and a ground pin. The signal pin outputs the voltage signal generated by the sensor, while the ground pin is connected to the ground of the system. Some GSR sensors may also have additional pins for calibration or temperature compensation.



Fig. 4.5: GSR Sensor

4.4.3.1 Pin Function

- **Signal Pin:** This pin is used to output the voltage signal generated by the sensor. The voltage signal is proportional to the electrical conductance of the skin and can be measured and processed by a microcontroller or other device.
- **Ground Pin:** This pin is connected to the ground of the system to provide a reference for the signal pin.

Some GSR sensors may also have additional pins for calibration or temperature compensation, but the signal and ground pins are the two essential pins required for measuring skin conductance.

The GSR sensor can be connected to a microcontroller or other device using analog or digital input pins. The voltage signal generated by the GSR sensor is typically in the range of a few millivolts to several volts, depending on the design of the sensor and the level of electrical conductance of the skin being measured. The signal can be amplified and filtered as needed to obtain accurate measurements and reduce noise and interference.

4.4.4 Accelerometer sensor

The ADXL335 is a 3-axis accelerometer sensor that is used to measure acceleration in three perpendicular axes. The sensor measures acceleration up to $\pm 3g$ (g being the acceleration due to gravity) and outputs an analog voltage proportional to the acceleration measured along each axis. This sensor can be used

in a wide range of applications, such as motion and tilt sensing, robotics, and gaming.

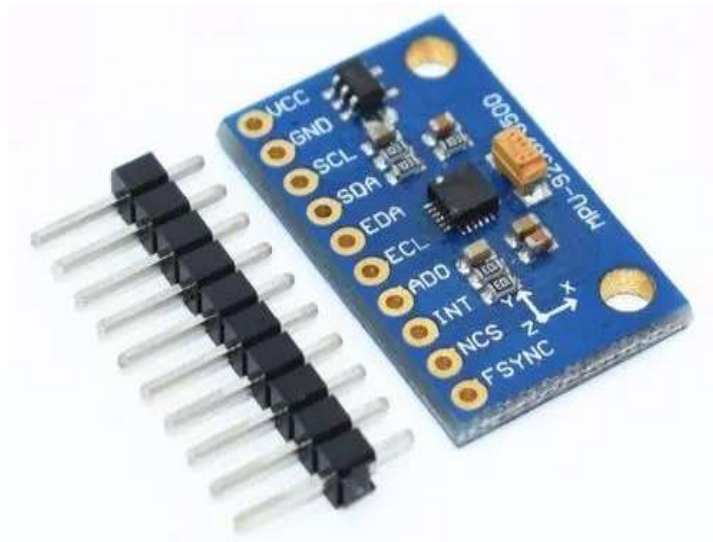


Fig. 4.6: ADXL335 accelerometer

The ADXL335 sensor works on the principle of measuring the change in capacitance of three small, flexible, and thin-film structures, known as "proof masses", that are suspended between two fixed plates. These proof masses are connected to the plates by springs, and when the sensor experiences acceleration, the proof masses move relative to the fixed plates, causing a change in the capacitance between them. This change in capacitance is converted into a voltage by the sensor's internal electronics, which is proportional to the acceleration along each axis.

The sensor includes a built-in signal conditioning circuitry that filters and amplifies the analog voltage outputs from the XOUT, YOUT, and ZOUT pins. The sensor also includes a self-test feature that can be used to verify that the sensor is functioning correctly. To use the ADXL335 sensor with a microcontroller, the analog voltage outputs from the XOUT, YOUT, and ZOUT pins should be connected to the analog input pins of the microcontroller. The microcontroller can then use the appropriate analog-to-digital converter (ADC) function to read the analog voltage and convert it into an acceleration value. The sensitivity and other settings of the sensor can be adjusted using software to match the specific requirements of the application.

4.4.4.1 Pin Function

- VCC: This is the power supply pin for the sensor. It should be connected to a voltage supply between 1.8V to 3.6V.
- GND: This is the ground pin for the sensor. It should be connected to the ground of the microcontroller or power supply.
- XOUT: This pin outputs an analog voltage corresponding to the acceleration measured in the X-axis.
- YOUT: This pin outputs an analog voltage corresponding to the acceleration measured in the Y-axis.
- ZOUT: This pin outputs an analog voltage corresponding to the acceleration measured in the Z-axis.
- ST: This pin is used to set the sensitivity of the sensor. It can be left unconnected or connected to VCC or GND, depending on the desired sensitivity setting.

The XOUT, YOUT, and ZOUT pins output a voltage proportional to the acceleration measured along the corresponding axis. The voltage output is typically centred around a voltage of $VCC/2$, which means that the acceleration due to gravity along that axis will be represented by a voltage of $VCC/2$. The voltage output can be converted into an acceleration value using the appropriate formula and calibration.

4.4.5 MAX30102 Sensor

A combined pulse oximetry and heart rate monitor module is the MAX30102. It has inbuilt photodetectors, LEDs, optical components, low-noise electronics, and electronics that reject ambient light. To simplifying the design-in process for mobile and wearable devices, the MAX30102 offers a whole system solution.

The internal LEDs of the MAX30102 are powered by a separate 3.3V power source and are run off a single 1.8V power supply.

An interface that is often I2C compatible is used for communication. The power rails can always be powered since the module can be turned off using software with no standby current.



Fig. 4.7: MAX30102 sensor

The MAX30102 sensor is a highly integrated optical sensor module that fits all of its components into a compact 5.6mm x 2.8mm container. It has two LEDs (red and infrared), an ambient light sensor, and a photodetector. It is made to deliver precise pulse oximetry and heart rate monitoring measurements in wearable fitness equipment, medical devices, and other mobile applications. The sensor is perfect for use in both indoor and outdoor settings since it employs sophisticated algorithms to filter out noise and interference from ambient light sources. The MAX30102 sensor is a popular option among creators of wearable health and fitness devices because to its tiny size, low battery consumption, and great accuracy.

4.4.5.1 Features

- Heart-Rate Monitor and Pulse Oximeter Sensor in LED Reflective Solution
- Tiny 5.6mm x 3.3mm x 1.55mm 14-Pin Optical Module
- Integrated Cover Glass for Optimal, Robust Performance
- Ultra-Low Power Operation for Mobile Devices
- Programmable Sample Rate and LED Current for Power Savings
- Low-Power Heart-Rate Monitor (< 1mW)
- Ultra-Low Shutdown Current (0.7 μ A, typ)
- Fast Data Output Capability
- High Sample Rates
- Robust Motion Artifact Resilience
- High SNR
- -40°C to +85°C Operating Temperature Range

4.4.5.2 General Pin Function

- VIN: This is the power supply pin for the sensor and should be connected to a voltage supply between 1.8V and 5.5V.
- GND: This is the ground pin for the sensor.
- SDA: This is the serial data input/output pin for the I2C interface.
- SCL: This is the serial clock input pin for the I2C interface, Bidirectional (Open-Drain).
- INT: This is the interrupt output pin, which can be used to indicate that a new measurement is available or to signal other events.
- VLED+: LED Power Supply (anode connection). Use a bypass capacitor to PGND for best performance.
- PD: This is the photodiode output pin, which outputs the intensity of light detected by the photodiode.
- PGND: Power Ground of the LED Driver Block.

4.4.6 SOUND DETECTION SENSOR

The sound sensor module offers a simple method for hearing and is often used to measure sound intensity. Applications involving security, switches, and monitoring can all utilise this module. For ease of use, its precision may be quickly modified. It makes use of a microphone as the input source for an amplifier, peak detector, and buffer. The sensor processes an output signal.



Fig. 4.8: sound detection sensor

Voltage that is transmitted to a microcontroller and then completes the necessary processing when it detects sound. The Arduino sound detection sensor module determines if sound levels have risen over a certain level. A microphone up sound, which is then sent into an LM393 op amp. An on-board potentiometer is used to change the sound volume set point. When the volume of the sound surpasses the threshold, an LED on the module is illuminated and the output is set low.

4.4.6.1 Specifications of sound detection sensor module

- Working voltage: DC 3.3-5V
- Adjustable Sensitivity
- Dimensions: 32 x 17 mm
- Signal output indication
- Single channel signal output
- With the retaining bolt hole, convenient installation
- Outputs low level and the signal light when there is sound.
- Output in the form of digital switching outputs (0 and 1 high and low)

4.4.7 GPS module

The NEO-6M GPS module is a compact, low-power GPS receiver module that can communicate with a host device such as a microcontroller or single-board computer via UART interface. It is a popular GPS module for hobbyists, makers, and professional applications alike, due to its simplicity, reliability, and cost-effectiveness. The NEO-6M module receives signals from GPS satellites in orbit and calculates its position, velocity, and time information with high accuracy.



Fig: 4.9 GPS module

It supports up to 50 channels and can track up to 22 satellites at once. The module also supports several satellites positioning systems, including GPS, GLONASS, and Bei Dou, which increases its positioning accuracy and reliability. The module communicates with the host device through a standard serial communication protocol, sending NMEA (National Marine Electronics Association) formatted data strings that contain information such as latitude, longitude, altitude, speed, and time. The module can also output raw GPS data for advanced users who want to perform their own calculations. The NEO-6M GPS module is designed to operate on a low voltage (3.3V to 5V), making it compatible with most microcontrollers and single-board computers. It also has a low power consumption, which makes it suitable for portable applications. Overall, the NEO-6M GPS module is a popular choice for various projects that require accurate location tracking and navigation, including drones, robotics, geocaching, and vehicle tracking.

4.4.8 OLED display

The SSD1306 is a popular monochrome OLED display controller chip that can drive a 128x64-pixel OLED screen. The OLED screen displays images by emitting light from individual pixels, which means that it does not require a backlight and has excellent contrast and visibility in low-light environments. The SSD1306 controller supports both SPI and I2C communication protocols and can be interfaced with a variety of microcontrollers, making it a versatile option for many projects. The controller includes a built-in display RAM, which allows for efficient rendering of graphics and text. The 128x64 OLED screen is a common size for the SSD1306 controller and provides a resolution of 128x64 pixels, with each pixel being able to display one of two colours (usually white or blue). The screen is typically small, with a diagonal size of around 0.96 inches, making it suitable for compact devices. The SSD1306 controller supports a variety of display features, including scrolling, contrast adjustment, and on/off control for individual pixels. It can also display text and graphics using different fonts and sizes.

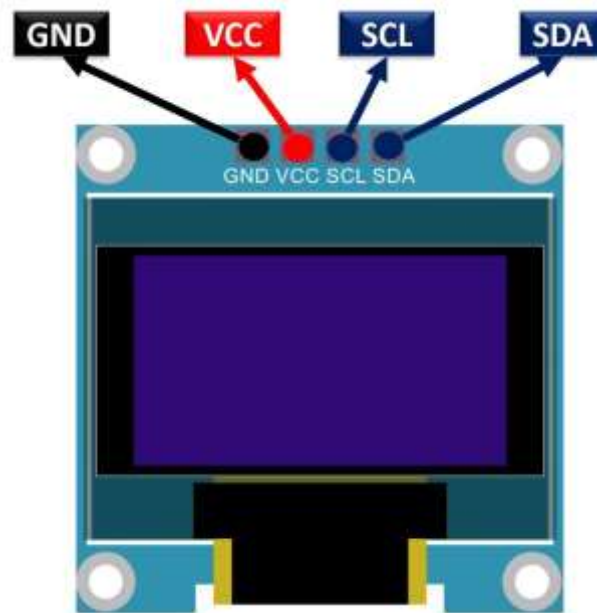


Fig. 4.10: OLED Display

Overall, the SSD1306-128x64 OLED screen is a popular choice for projects that require a small, low-power display with high contrast and visibility. It is commonly used in applications such as wearable devices, IoT devices, and small electronic projects where space and power are at a premium.

4.4.9 IR temperature sensor

The MLX90614 is a contactless infrared (IR) temperature sensor that measures the temperature of things without touching them. It measures an object's temperature using infrared radiation, which is then transformed into a digital signal that can be read by a microcontroller or other digital device. The sensor has a field of view of 90 degrees and functions at temperatures ranging from -40°C to 125°C . It offers a high accuracy of 0.5°C and a resolution of 0.02°C , making it perfect for temperature sensing applications in industrial and medical settings.

The MLX90614 is available in two variants: non-contact temperature sensing MLX90614ESF and high-accuracy temperature sensing MLX90614ESF-AAA.

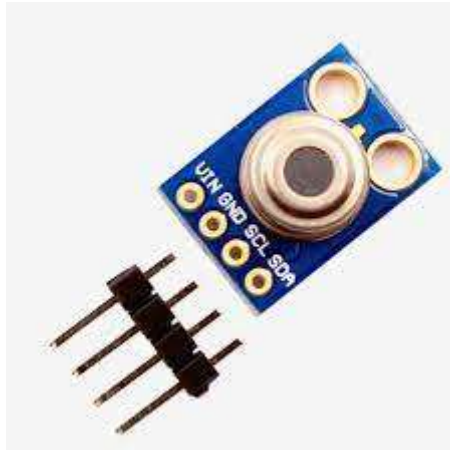


Fig. 4.11: IR temperature sensor

Both variants are appropriate for a wide range of applications because to their tiny form factor, low power consumption, and simple interface. The sensor is simple to incorporate into a wide range of applications, such as industrial process control, home automation, and medical equipment.

4.4.10 Arduino IDE (INTEGRATED DEVELOPMENT ENVIRONMENT)

Arduino IDE (Integrated Development Environment) is a software application used to program and develop software for Arduino microcontrollers. It is an open-source platform that allows users to write, compile, and upload code to Arduino boards. Arduino IDE provides a user-friendly interface that simplifies the programming process for beginners and advanced users alike. It has a text editor for writing code, a serial monitor for debugging, and a library manager for accessing a wide range of pre-built code libraries.

The IDE supports C and C++ programming languages and comes with a set of pre-installed libraries that can be used to interface with various sensors, actuators, and other components. Users can also download additional libraries from the Arduino library manager or create their own libraries to reuse code in different projects. Arduino IDE supports multiple operating systems, including Windows, Mac OS, and Linux, and it can be used with various Arduino boards, such as the Arduino Uno, Mega, Nano, and Due.

Arduino IDE v1 is an integrated development environment (IDE) used for programming and developing software for Arduino microcontrollers. It is an open-

source platform that provides a user-friendly interface for writing, compiling, and uploading code to Arduino boards. Arduino IDE v1 is based on the Processing programming language and uses the GCC compiler toolchain for compiling code. It supports C and C++ programming languages and comes with a set of pre-installed libraries that can be used to interface with various sensors, actuators, and other components.

The IDE has a simple and intuitive interface, making it easy for beginners to get started with Arduino programming. It includes a text editor for writing code, a serial monitor for debugging, and a library manager for accessing a wide range of pre-built code libraries. Arduino IDE v1 is compatible with a wide range of Arduino boards, including the Arduino Uno, Mega, Nano, and Due. It supports multiple operating systems, including Windows, Mac OS, and Linux.

One of the strengths of Arduino IDE v1 is its ease of use, which makes it a popular choice for beginners and hobbyists. The platform has a large and active community that provides support, tutorials, and code examples, making it easy to get started with Arduino programming. However, one limitation of Arduino IDE v1 is its lack of more advanced features, such as code analysis and refactoring tools, which can make programming more efficient and streamlined. Nevertheless, Arduino IDE v1 remains a popular choice for many developers due to its simplicity, stability, and wide range of library support.

Arduino Integrated Development Environment (IDE) v1 Learn how the Arduino IDE v1 works, such as compiling & uploading sketches, file management, installing dependencies and much more. The Arduino Integrated Development Environment – or Arduino Software (IDE) – contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them.

➤ ***Writing Sketches***

Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension. `.ino`. The editor has features for cutting/pasting and for searching/replacing text. The message

area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom righthand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

➤ **IDE VERIFY File**

Verify Checks the code for errors compiling it.

➤ **IDE UPLOAD File**

Upload Compiles the code and uploads it to the configured board. See uploading below for details.

Note: If you are using an external programmer with your board, you can hold down the "shift" key on your computer when using this icon. The text will change to "Upload using Programmer".

➤ **IDE NEW File**

New Creates a new sketch.

➤ **IDE OPEN File**

Open Presents a menu of all the sketches in the sketchbook. Clicking one will open it within the current window overwriting its content.

Note: due to a bug in Java, this menu does not scroll; if you need to open a sketch late in the list, use the File | Sketchbook menu instead.

➤ **IDE SAVE File**

Save-Saves the sketch.

➤ **IDE SERMON File**

Serial Monitor-Opens the serial monitor. Additional commands are found within the five menus: File, Edit, Sketch, Tools, Help. The menus are context sensitive, which means only those items relevant to the work currently being carried out are available.

➤ **File**

New-Creates a new instance of the editor, with the bare minimum structure of a sketch already in place. Open Allows to load a sketch file browsing through the computer drives and folders. Open Recent Provides a short list of the most recent sketches, ready to be opened.

Sketchbook-Shows the current sketches within the sketchbook folder structure; clicking on any name opens the corresponding sketch in a new editor instance. Examples: Any example provided by the Arduino Software (IDE), or library shows up in this menu item. All the examples are structured in a tree that allows easy access by topic or library.

Close-Closes the instance of the Arduino Software from which it is clicked.

Save-Saves the sketch with the current name. If the file hasn't been named before, a name will be provided in a "Save as." window.

Save as-Allows to save the current sketch with a different name. Page Setup It shows the Page Setup window for printing. Print Sends the current sketch to the printer according to the settings defined in Page Setup.

Preferences-Opens the Preferences window where some settings of the IDE may be customized, as the language of the IDE interface.

Quit-Closes all IDE windows. The same sketches open when quit was chosen will be automatically reopened the next time you start the IDE.

Edit-Undo/Redo Goes back of one or more steps you did while editing; when you go back, you may go forward with Redo.

Cut-Removes the selected text from the editor and places it into the clipboard.

Copy-Duplicates the selected text in the editor and places it into the clipboard.

Copy for Forum-Copies the code of your sketch to the clipboard in a form suitable for posting to the forum, complete with syntax colouring.

Copy as HTML-Copies the code of your sketch to the clipboard as HTML, suitable for embedding in web pages.

Paste-Puts the contents of the clipboard at the cursor position, in the editor.

Select All-Selects and highlights the whole content of the editor. Comment/Uncomment-Puts or removes the // comment marker at the beginning of each selected line.

Increase/Decrease Indent-Adds or subtracts a space at the beginning of each selected line, moving the text one space on the right or eliminating a space at the beginning.

Find-Opens the Find and Replace window where you can specify text to search inside the current sketch according to several options.

Find Next-Highlights the next occurrence - if any - of the string specified as the search item in the Find window, relative to the cursor position.

Find Previous-Highlights the previous occurrence - if any - of the string specified as the search item in the Find window relative to the cursor position.

➤ **Sketch**

Verify/Compile-Checks the sketch for errors compiling it; it will report memory usage for code and variables in the console area. Upload Compiles and loads the binary file onto the configured board through the configured Port.

Upload-Using Programmer This will overwrite the bootloader on the board; you will need to use Tools > Burn Bootloader to restore it and be able to Upload to USB serial port again. However, it allows you to use the full capacity of the Flash memory for your sketch. Please note that this command will NOT burn the fuses. To do so a Tools -> Burn Bootloader command must be executed.

Export-Compiled Binary Saves a .hex file that may be kept as archive or sent to the board using other tools. Show Sketch Folder Opens the current sketch folder. Include Library Adds a library to your sketch by inserting #include statements at the start of your code. For more details, see libraries below. Additionally, from this menu item you can access the Library Manager and import new libraries from .zip files.

Add File. -Adds a supplemental file to the sketch (it will be copied from its current location). The file is saved to the data subfolder of the sketch, which is intended for assets such as documentation. The contents of the data folder are not compiled, so they do not become part of the sketch program.

➤ **Tools**

Auto Format-This formats the code nicely: i.e., indents it so that opening and closing curly braces line up, and that the statements inside curly braces are indented more. **Archive Sketch**-Archives a copy of the current sketch in .zip format. The archive is placed in the same directory as the sketch.

Fix-Encoding & Reload Fixes possible discrepancies between the editor char map encoding and other operating systems char maps.

Serial Monitor-Opens the serial monitor window and initiates the exchange of data with any connected board on the currently selected.

Port-This usually resets the board, if the board supports Reset over serial port opening.

Board-Select the board that you're using. See below for descriptions of the various boards.

Port-This menu contains all the serial devices (real or virtual) on the machine. It should automatically refresh every time you open the top-level tools menu.

Programmer-For selecting a hardware programmer when programming a board or chip and not using the onboard USB-serial connection. Normally you won't need this, but if you're burning a bootloader to a new microcontroller, you will use this.

Burn Bootloader-The items in this menu allow you to burn a bootloader onto the microcontroller on an Arduino board. This is not required for normal use of an Arduino board but is useful if you purchase a new AT mega microcontroller (which normally come without a bootloader). Ensure that you have selected the correct board from the Boards menu before burning the bootloader on the target board. This command also set the right fuses.

➤ **Help**

Here you find easy access to several documents that come with the Arduino Software (IDE). You have access to Getting Started, Reference, this guide to the IDE and other documents locally, without an internet connection. The documents are a local copy of the online ones and may link back to our online website.

Find in Reference-This is the only interactive function of the Help menu: it directly selects the relevant page in the local copy of the Reference for the function or command under the cursor.

➤ ***Sketchbook***

The Arduino Software (IDE) uses the concept of a sketchbook: a standard place to store the programs (or sketches). The sketches in the sketchbook can be opened from the File > Sketchbook menu or from the Open button on the toolbar. The first time you run the Arduino software, it will automatically create a directory for your sketchbook. You can view or change the location of the sketchbook location from with the Preferences dialog.

➤ ***Tabs, Multiple Files, and Compilation***

Allows you to manage sketches with more than one file (each of which appears in its own tab). These can be normal Arduino code files (no visible extension), C files (.c extension), C++ files (.cpp), or header files (.h). Before compiling the sketch, all the normal Arduino code files of the sketch (.ino, .pde) are concatenated into a single file following the order the tabs are shown in. The other file types are left as it is.

➤ ***Uploading***

Before uploading the sketch, you need to select the correct items from the Tools > Board and Tools > Port menus. The boards are described below. On the Mac, the serial port is probably something like /dev/tty.usbmodem241 (for an UNO or Mega2560 or Leonardo) or /dev/tty.usbserial-1B1 (for a Duemilanove or earlier USB board), or /dev/tty.USA19QW1b1P1.1 (for a serial board connected with a Keyspan USB-to-Serial adapter). On Windows, it's probably COM1 or COM2 (for a serial board) or COM4, COM5, COM7, or higher (for a USB board) - to find out, you look for USB serial device in the sports section of the Windows Device Manager.

On Linux, it should be /dev/ttyACMx, /dev/ttyUSBx or similar. Once you have selected the correct serial port and board, press the upload button in the toolbar or select the Upload item from the Sketch menu. Current Arduino boards will reset automatically and begin the upload. With older boards (pre-Diecimila) that lack auto-reset, you will need to press the reset button on the board just before starting the

upload. On most boards, you will see the RX and TX LEDs blink as the sketch is uploaded. The Arduino Software (IDE) will display a message when the upload is complete or show an error.

When you upload a sketch, you are using the Arduino bootloader, a small program that has been loaded on to the microcontroller on your board. It allows you to upload code without using any additional hardware. The bootloader is active for a few seconds when the board resets; then it starts whichever sketch was most recently uploaded to the microcontroller. The bootloader will blink the on-board (pin 13) LED when it starts (i.e., when the board resets).

➤ ***Libraries***

Libraries provide extra functionality for use in sketches, e.g., working with hardware or manipulating data. To use a library in a sketch, select it from the Sketch > Import Library menu. This will insert one or more `#include` statements at the top of the sketch and compile the library with your sketch. Because libraries are uploaded to the board with your sketch, they increase the amount of space it takes up. If a sketch no longer needs a library, simply delete its `#include` statements from the top of your code.

There is a list of libraries in the reference. Some libraries are included with the Arduino software. Others can be downloaded from a variety of sources or through the Library Manager. Starting with version 1.0.5 of the IDE, you do can import a library from a zip file and use it in an open sketch. See these instructions for installing a third-party library.

➤ ***Third-Party Hardware***

Support for third-party hardware can be added to the hardware directory of your sketchbook directory. Platforms installed there may include board definitions (which appear in the board menu), core libraries, bootloaders, and programmer definitions. To install, create the hardware directory, then unzip the third-party platform into its own sub-directory. (Don't use "Arduino" as the sub-directory name or you will override the built-in Arduino platform.) To uninstall, simply delete its directory.

➤ **Serial Monitor**

This displays serial sent from the Arduino board over USB or serial connector. To send data to the board, enter text and click on the "send" button or press enter. Choose the baud rate from the drop-down menu that matches the rate passed to Serial. Begin in your sketch. Note that on Windows, Mac or Linux the board will reset (it will rerun your sketch) when you connect with the serial monitor. Please note that the Serial Monitor does not process control characters; if your sketch needs a complete management of the serial communication with control characters, you can use an external terminal program and connect it to the COM port assigned to your Arduino board. You can also talk to the board from Processing, Flash, MaxMSP, etc.

4.4.11 BLYNK app

Blynk is a mobile app that allows users to control and monitor various internet of things (IoT) devices, sensors, and other connected devices. The app provides an easy-to-use interface for creating custom dashboards, controlling devices, and visualizing data. The Blynk app uses a cloud-based server to connect the user's mobile device to the IoT devices. Users can choose from a variety of communication protocols, including Wi-Fi, Ethernet, Bluetooth, and cellular data. The app provides an extensive library of pre-built widgets, including buttons, sliders, graphs, and gauges, that users can drag and drop onto their dashboard to create a customized interface.

One of the primary features of the Blynk app is the ability to create custom notifications and alerts. Users can set up triggers based on sensor readings or other events and receive push notifications when the trigger is activated. This feature is particularly useful for monitoring and controlling devices remotely. Blynk also provides an API that allows developers to integrate their IoT devices with the app.

This API includes libraries for various programming languages, including Arduino, Raspberry Pi, and ESP8266. The app can also integrate with popular IoT platforms, such as Amazon Web Services (AWS) and Google Cloud Platform (GCP).

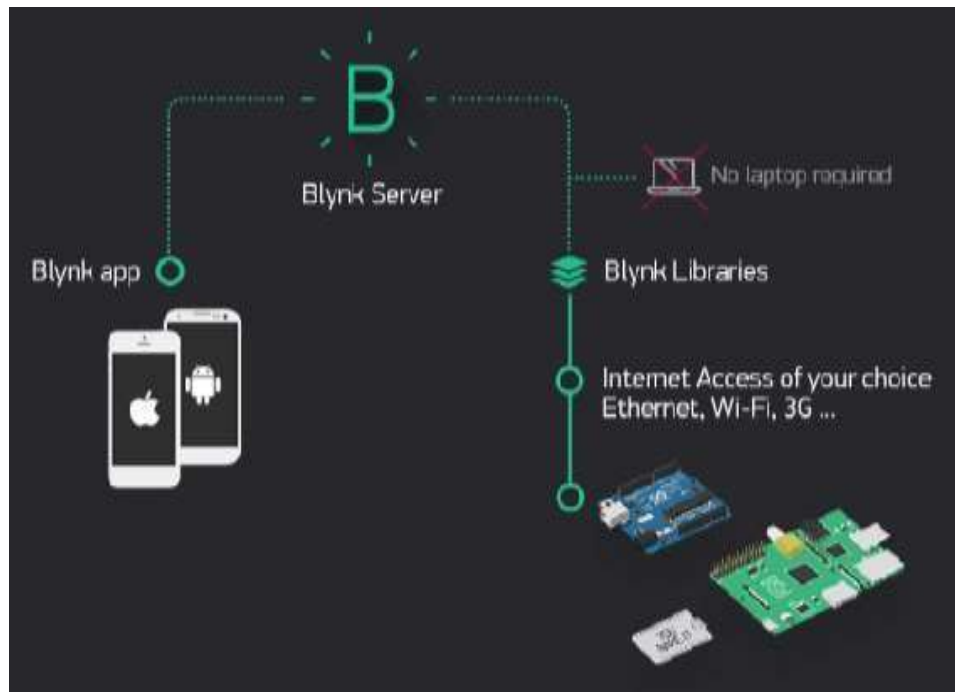


Fig. 4.12: Working of Blynk app

The Blynk app works by providing an interface for users to control and monitor various IoT devices and sensors. The app communicates with the devices through a cloud-based server, which acts as an intermediary between the mobile device and the IoT devices. When a user creates a new project in the Blynk app, they can choose from a variety of communication protocols, including Wi-Fi, Ethernet, Bluetooth, and cellular data. They can then drag and drop various widgets onto the app's dashboard to create a customized interface for controlling and monitoring them devices. Each widget in the Blynk app is associated with a specific function or task, such as turning a device on or off, adjusting a variable, or displaying sensor data.

When the user interacts with a widget, the app sends a command to the cloud-based server, which then forwards the command to the corresponding IoT device. The Blynk app also allows users to create custom notifications and alerts based on sensor readings or other events. For example, a user could set up an alert

to notify them when a temperature sensor detects a temperature above a certain threshold. The app will send a push notification to the user's mobile device when the alert is triggered. In addition to its built-in widgets and features, the Blynk app also provides an API for developers to integrate their IoT devices with the app. This API includes libraries for various programming languages, such as Arduino, Raspberry Pi, and Node MCU. Overall, the Blynk app provides an easy-to-use and flexible interface for controlling and monitoring IoT devices. It simplifies the process of creating custom dashboards and notifications, making it an excellent tool for both hobbyists and professionals.

CHAPTER-5

RESULTS AND DISCUSSION

5.1 RESULTS

The dementia patient assist tool integrated with GSR sensor, heart rate and SpO2 sensors, accelerometer sensor, Node MCU and Arduino nano were used to collect readings of heart rate, Spo2, stress monitoring, physical activity and location.



Fig. 5.1: “Dementia patient assist tool” Prototype

The result of this project yielded promising results. The system was able to collect and transmit real-time data points such as stress level, heart rate, Spo2, noise level and current location to healthcare providers and carers. This allowed healthcare providers to remotely monitor the patients' conditions and adjust the treatment plan as needed.

Figure 5.1 represents the prototype of the Health Monitoring device. The principal components of the system that is Arduino Nano, GPS module, Node MCU, sound detection sensor, MAX30102, GSR sensor and accelerometer sensor IR

temperature sensor have been connected. The inputs are obtained from the sensors and the output is obtained in both the prototype and IoT platform.

5.1.1 Prototype Output

Heart rate, Spo2, GSR stress level output, temperature and current location are calibrated using the microcontroller. The output values of the sensors calculated and displayed in the OLED, so that these values are visible to the users.



Fig. 5.2: Output display of the prototype

Fig.5.2 represents the display of the health monitoring device. H, S, T, R, I, N and A denotes the measurements of Heart rate, Spo2, temperature, GSR output, Location, noise level, accelerometer respectively.

5.1.2 parameters and corresponding measurand

Heart rate (H)	- 89 bpm
GSR(R)	- 0 (no stress detected)
Temperature(T)	- 98 F
Spo2 (S)	- 98%
Location(L)	- 12.872 ,80.223 (inside the boundary)
Noise level(N)	-0 (no abnormal noises)
Accelerometer(A)	- 0 (no abnormal movement)

5.1.3 Blynk app Output

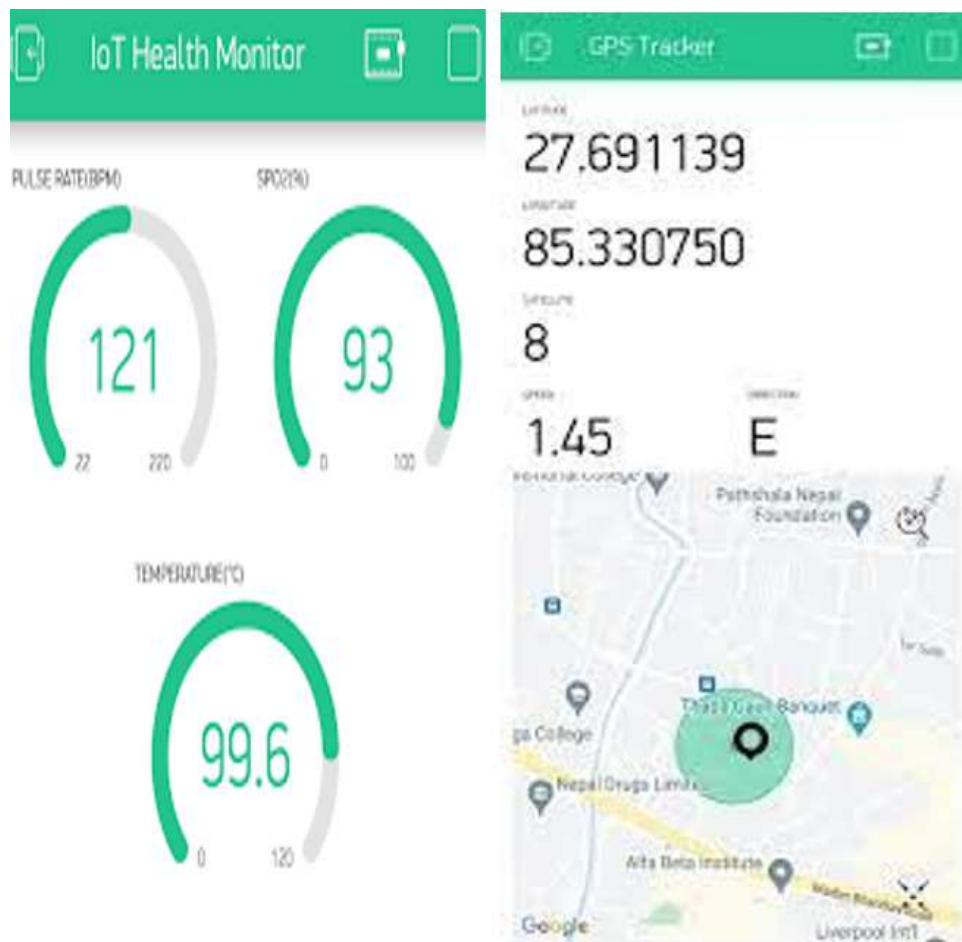


Fig. 5.3: Blynk app Output

The obtained output is displayed on the OLED display and additionally with the aid of IoT-cloud based app (blynk) the doctor can monitor real time health data. The output is displayed on Blynk android Application. The screenshot of the result of the designed system obtained on android application (Blynk app) are shown in

Figure 5.3. The figure shows the measurands of Heart rate, Spo2, Temperature and the location of the patient. The below table 5.3 shows the measurand values (i.e.) obtained in Blynk app.

5.2 DISCUSSION

There are many benefits to using a smart dementia assist tool to watch over dementia patients in real time. The system may be set to capture a variety of data points, including stress level through GSR sensor, heart rate, Spo2, noise created by the environment and the patient, rapid acceleration, and the subject's position. This enables healthcare practitioners to remotely monitor and change a patient's treatment plan, thereby enhancing care quality and decreasing hospitalisations. This has the potential to enhance patient involvement and adherence to treatment programmes, both of which are significant challenges in dementia care. Furthermore, the system may make use of cutting-edge social IoT technologies to help patients and carers form a supportive community. Patients can benefit from emotional support, information, and personalised peer-to-peer coaching to improve their self-management skills and independence.

However, there are various concerns that must be solved before implementing such a system. Patient data privacy and security, for example, must be protected. To safeguard sensitive patient information, the system must be built to meet HIPAA (Health Insurance Portability and Accountability Act) standards.

Furthermore, the system must be developed to accommodate patients with varied degrees of technological literacy, which can be challenging among the elderly. to make it possible.

The system must be scalable and cost-effective in order to gain widespread adoption. Finally, utilising sophisticated social IoT to continuously monitor dementia patients has the potential to enhance patient outcomes.

Improve patient empowerment and foster a supportive community of patients and caretakers. To gain these benefits, however, the system must handle challenges like as privacy and security, technological literacy, scalability, and cost-effectiveness.

CHAPTER – 6

CONCLUSION AND FUTURE SCOPE

With the growing aging population, there is a rising demand for healthcare solutions that cater to the specific needs of dementia patients. This project A smart wearable device equipped with advanced sensors that can monitor various health parameters and integrated with GPS and location-based services to track the patient's movements and provide real-time location updates to caregivers is a game changing solution to both patients and caregivers.

The future scope of a dementia patient assists smart wearable device that, the device can be further enhanced by using AI and machine learning algorithms to analyse the data collected from the sensors and provide personalized insights and recommendations to caregivers. This can help caregivers better understand the patient's behaviour, anticipate their needs, and provide appropriate care. Another potential future application for this device is to incorporate voice assistants and communication technologies. This can enable patients to interact with their caregivers and loved ones in a more seamless and natural manner, helping to reduce social isolation and loneliness, which are common problems among dementia patients.

Overall, with advancements in technology and healthcare, we can expect to see more sophisticated and intelligent wearable devices that offer better care and support for dementia patients and their caregivers.

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