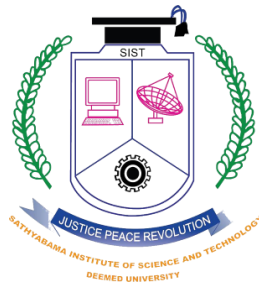


ALZHEIMER'S CARE AND DISEASE DIAGNOSIS BY DEEP LEARNING DRIVEN INTEGRATED SYSTEM FOR PATIENT SUPPORT

Submitted in partial fulfillment of the requirements for the award of Master of
Technology degree in Medical Instrumentation

by

ANAND BALAJI. A (42440001)



**DEPARTMENT OF BIOMEDICAL ENGINEERING
SCHOOL OF BIO AND CHEMICAL ENGINEERING**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade "A++" by NAAC

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APRIL - 2024



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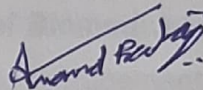
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ABSTRACT

The project aims to create a comprehensive system for Alzheimer's disease detection, patient safety, and caregiver support. This system leverages deep learning techniques, specifically Convolutional Neural Networks (CNNs) implemented using the TensorFlow Keras framework, to analyze MRI scanned images and classify Alzheimer's at different stages: Very Mild Dementia, Mild Dementia, and Non-Dementia. The primary objective is to develop a user-friendly web application using Python and Streamlit, enabling doctors to effortlessly upload MRI scanned images for rapid and accurate Alzheimer's stage diagnosis. By doing so, this system not only expedites the diagnostic process but also alleviates the mental fatigue often experienced by healthcare professionals. In addition to the diagnostic component, the project incorporates an innovative safety and support system designed to enhance the well-being of Alzheimer's patients. Utilizing image processing techniques with Python and OpenCV, the system is equipped to recognize family members and caregivers who interact with the patient. This recognition feature is vital for ensuring the patient's sense of security and familiarity, particularly when they are alone at home. To address the safety concerns associated with Alzheimer's patients venturing outside, the project introduces a wearable device powered by an Arduino Nano, complete with GSM and LCD capabilities. This wearable acts as a constant companion to the patient, periodically prompting them with safety check-ins every 15 minutes. Furthermore, an emergency button is incorporated into the wearable, enabling the patient to manually send distress messages when needed. In summary, this ambitious project merges state-of-the-art deep learning, image processing, and wearable technology to streamline Alzheimer's diagnosis, enhance patient safety, and provide peace of mind to both patients and their families. Given the absence of a definitive cure for Alzheimer's, this integrated system offers a proactive and supportive approach to managing the disease, ultimately improving the quality of life for patients and their caregivers. It addresses the urgent need to reduce diagnostic delays and safeguard patients' well-being, thereby contributing significantly to Alzheimer's patient care.

Keywords: *MRI Images, Face Recognition, Voice Feed-back System, Microcontroller.*

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LIST OF ABBREVIATIONS

ACRONYM	DEFINITIONS
BMS	Battery Management System
CNN	Convolutional Neural Network
EMG	Electromyography
GSM	Global System for Mobile Communication
IDE	Integrated Development Environment
JPEG	Joint Photographic Experts Group
LBPH	Local Binary Patterns Histogram
LCD	Liquid Crystal Display
Li-Po Battery	Lithium-Polymer Battery
MRI	Magnetic Resonance Imaging
PET	Positron Emission Tomography

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CHAPTER 1

INTRODUCTION

Alzheimer's disease is a devastating neurodegenerative condition that affects millions of people worldwide. Its progressive nature and the absence of a cure make early diagnosis and patient safety critical aspects of Alzheimer's care. This project introduces an innovative solution that combines the power of deep learning, image processing, and wearable technology to address these pressing issues.

The primary objective of this project is to develop an integrated system that not only aids in the early diagnosis of Alzheimer's disease but also ensures the safety and well-being of patients, particularly when they are alone at home or outside. By harnessing the capabilities of deep learning and Convolutional Neural Networks (CNNs) through the TensorFlow Keras framework, the system offers a streamlined and efficient approach to Alzheimer's diagnosis. Doctors are provided with a user-friendly web application built using Python and Streamlit, allowing them to upload MRI scanned images for rapid and accurate classification of Alzheimer's stages, including Very Mild Dementia, Mild Dementia, and Non-Dementia. This diagnostic component not only reduces the burden on healthcare professionals but also expedites the commencement of appropriate care.

Recognizing the importance of patient safety, especially for those with Alzheimer's who may wander or face moments of disorientation, the project introduces a novel wearable device. Powered by an Arduino Nano, this device is equipped with GSM and LCD functionalities. It acts as a constant companion to patients, prompting them with regular safety check-ins. If the patient fails to respond within a predefined timeframe, the device initiates location tracking and automatically shares the patient's whereabouts with designated relatives or caregivers. Additionally, an emergency button is integrated into the wearable, enabling patients to send distress signals manually when required. (Alan Bannon et al.,2021)

To further enhance patient comfort and security, the project employs image processing techniques with Python and OpenCV. This system can recognize family members and caregivers who interact with the patient, providing an additional layer of assurance and familiarity, especially when the patient is alone at home.

In a world where Alzheimer's remains an incurable disease, this project offers a holistic and proactive approach to managing the condition. By addressing the critical aspects of diagnosis, patient safety, and caregiver support, it contributes significantly to improving the quality of life for Alzheimer's patients and their families. This endeavor represents a meaningful step forward in the quest to reduce diagnostic delays, alleviate the burden on healthcare professionals, and ensure the well-being of those affected by Alzheimer's disease.

Alzheimer's disease stands as one of the most formidable healthcare challenges of our time, characterized by its inexorable advance and devastating impact on cognitive function and quality of life. As the global population ages, the prevalence of Alzheimer's is poised to escalate, placing unprecedented strain on healthcare resources and underscoring the urgency of innovative interventions. At the heart of this crisis lies the imperative to detect Alzheimer's early, enabling timely interventions that may mitigate its progression and enhance patient outcomes. Additionally, ensuring the safety and well-being of Alzheimer's patients, particularly in moments of vulnerability or solitude, emerges as a pressing concern that demands creative solutions. Against this backdrop, our project endeavors to harness cutting-edge technologies to address these critical needs and usher in a new era of Alzheimer's care. (Praveen et al., 2023)

Central to our approach is the integration of deep learning techniques, specifically Convolutional Neural Networks (CNNs), to revolutionize the diagnostic process for Alzheimer's disease. By leveraging vast repositories of MRI scanned images, our system facilitates rapid and accurate classification of Alzheimer's stages, enabling clinicians to discern subtle neurological changes indicative of disease progression. Through the TensorFlow Keras framework, we empower healthcare professionals with a user-friendly web application, streamlining the diagnostic workflow and expediting the commencement of appropriate care strategies. This innovative diagnostic component not only alleviates the burden on healthcare providers but also holds the potential to reduce diagnostic delays and improve patient outcomes.

In parallel with advancements in diagnosis, our project introduces a groundbreaking wearable device designed to enhance the safety and autonomy of Alzheimer's patients. Powered by an Arduino Nano platform and equipped with GSM and LCD functionalities, this device serves as a constant companion to patients, providing regular safety check-ins and facilitating prompt distress signaling when needed. Importantly, in instances of unresponsiveness, the device autonomously initiates location tracking, ensuring that designated caregivers are promptly informed of the patient's whereabouts. By empowering patients with a sense of security and independence, this wearable technology not only enhances their quality of life but also offers peace of mind to caregivers and loved ones.

Complementing the safety net provided by wearable technology, our project integrates sophisticated image processing techniques to foster familiarity and emotional support for Alzheimer's patients. Leveraging Python and OpenCV, our system can recognize family members and caregivers who interact with the patient, providing an additional layer of reassurance, especially during periods of solitude. By creating a sense of continuity and connection within the patient's environment, this personalized approach promotes emotional well-being and mitigates feelings of isolation. Moreover, by enhancing the caregiver-patient relationship, this facet of our project seeks to cultivate a nurturing and supportive environment conducive to the holistic care of Alzheimer's patients. (Chaihra et al., 2021)

In a landscape marked by the formidable challenges posed by Alzheimer's disease, our project represents a beacon of hope and innovation. By harnessing the collective power of deep learning, wearable technology, and image processing, we endeavour to redefine the paradigm of Alzheimer's care, offering holistic solutions that address the multifaceted needs of patients and caregivers alike. As we embark on this transformative journey, our commitment to advancing Alzheimer's care remains unwavering, driven by a shared vision of a future where individuals affected by this devastating disease are empowered to live with dignity, autonomy, and compassion.

CHAPTER 2

LITERATURE SURVEY

Ainampudi Kumari Sirivarshitha et.al (2023) focused on image quality as it is a major drawback of existing algorithms and used OPEN CV, Face Recognition and algorithms designed using python libraries. This study discusses the facial recognition method along with its implementation and applications.

Alan Bannon et.al (2021) this is achieved using multiple radar sensors networked together with their data outputs integrated and processed to produce high confidence measures of position and movement. It is hoped the data produced by this system will both provide insights into how dementia progresses, and also help monitor vulnerable individuals in their own homes, allowing them to remain independent longer than would otherwise be possible.

Chaihtra et.al (2021) built a CNN architecture using transfer learning method. DenseNet121, MobileNet, InceptionV3, and Xception neural networks were trained using the Kaggle AD dataset. All models in this study were trained on the same dataset to analyse their performance. The DenseNet121 architecture provides the highest accuracy of 91% on AD precision detection test data.

Divya Meena et.al (2016) Given a single image, the challenge is to find a face from that image. Face recognition is a difficult task because faces are not rigid and it changes size, shape, color, etc. Face recognition becomes the task is more difficult when certain images are unclear and obscured by something else and by inappropriate lighting without facing cameras, etc. In this paper, the Via Jones algorithm is used for detection Face and principal component analysis for face recognition.

Ernes Randika Pratama et.al (2020) The system will also automatically receive notifications Patients outside the geofence area. Therefore, we can conclude that by achieving the closest distance between the patient and caregiver, which can increase the speed at which the caregiver attends to the patient exceed the limits of the geolocation area and increase the number of patients protect.

Jammeh et.al (2016) aimed to find the optimal number of blood biomarkers (in terms of number of biomarkers and sensitivity/specificity) that can be used in a portable

PoC device for diagnostics. guess AD. We used the ADNI (Alzheimer's Disease Neuroimaging Initiative) database to identify a small number of blood biomarkers of AD. We identified a panel of 6 biomarkers (including A1Micro, A2Macro, AAT, ApoE, complement C3, and PPP) that, when used with age as a covariate, can differentiate between AD patients and normal subjects. 85.4%. is 78.6%.

Jian Wu et.al (2016) In this article, one portable system for American Sign Language (ASL) recognition in real-time, information fusion from inertial sensors is proposed and sEMG sensor. Select features based on the information obtained This scheme is used to select the best feature subset from a large set A well-established range of features. Four popular classification algorithms are evaluated for 80 out of four commonly used ASL signs topic.

Maria Lima et.al (2022) We summarize the developmental state of interactions using words and natural language processing, providing the basis for longitudinal health monitoring and cognitive assessment. Based on this foundation, we identify open challenges and propose future directions for advancing conversational affective social robots.

Praveen et.al (2023) researched and designed a technique to accurately identify and stage the disease using magnetic resonance imaging (MRI). Deep learning excels in image analysis and disease prediction. A growing body of research suggests that deep learning techniques may be essential in the detection and prognosis of Alzheimer's disease. Therefore, much research is being conducted to find out which deep learning model provides the highest early detection accuracy. Brain imaging will be used to determine the stage of the disease in this investigation. Furthermore, using MRI data, we aim to propose an effective deep learning model for Alzheimer's disease diagnosis. Here the dataset is taken from Kaggle. This study proposes a new deep learning method using CNN algorithm to identify Alzheimer's disease.

Ramesh et.al (2023) proposed a method to be used to improve patient care, reduce costs, and enable rapid and accurate analysis in large-scale investigations. In many fields, including medical image processing, advanced deep learning methods have recently been shown to be effective at the human level. By analyzing brain MRI data, a deep convolutional network model is proposed to diagnose Alzheimer's disease.

Compared with other models, the proposed model performs better in early disease detection because it can recognize distinct stages.

Ravikumar et.al (2023) have limitations on the discriminator, the cGAN-ADD generator learns to incorporate disease category feedback from the classifier into the 2D brain slice image reconstruction to improve the image. Photos during the training phase. During the prediction phase, stacked CNN layers extract high-level brain features from category-enhanced 2D brain slice images. The classifier captures brain features collected to display the posterior probabilities of disease states (normal, AD, mild, and very mild). Tensorflow is used for model training and Keras was used to evaluate classification accuracy. The model is trained and tested on the ADNI dataset.

Zhiyang You et.al (2021) In this article. Additionally, it can serve as a simplified model, Non-invasive and highly accurate clinical support tool for early treatment Diagnosis and differentiation of AD. Experimental results show has an accuracy, sensitivity and sensitivity of 90.48%, 92.00% and 88.24% Corresponding specificity to distinguish Alzheimer's disease by method with the LSTM-based model. Also, gait and stride cycles length in MCI or AD cases was more variable than in healthy controls by redefining and computing the characteristics of skeletal walking data obtained by Kinect devices.

CHAPTER 3

AIM AND SCOPE

3.1 AIM

The aim of this project is to address the multifaceted challenges associated with Alzheimer's disease by developing an integrated system that combines advanced technologies and innovative solutions. The primary objective is to enhance the efficiency and accuracy of Alzheimer's diagnosis through the implementation of a cutting-edge deep learning model, specifically a Convolutional Neural Network (CNN), utilizing the TensorFlow Keras framework. This model will analyze MRI scanned images to classify Alzheimer's stages, facilitating quicker diagnosis and enabling tailored care plans to be initiated promptly. Additionally, the project aims to provide support for caregivers and improve patient safety through novel features such as a user-friendly web application for diagnostic insights, image processing for recognizing family members and caregivers, and a wearable device equipped with safety check-ins and emergency response capabilities. By addressing critical aspects of Alzheimer's care, this project strives to minimize diagnostic delays and enhance the overall well-being of patients and their families impacted by this challenging condition.

3.2 EXISTING SYSTEM

The existing system for diagnosing and caring for individuals with Alzheimer's disease relies heavily on traditional methods that involve subjective assessments and manual evaluations by healthcare professionals. Clinical assessments, which include cognitive tests and interviews, serve as the primary means of diagnosis. Neuroimaging techniques such as MRI and PET scans are used to identify structural and functional changes in the brain, while medical history and biomarker analysis provide additional insights. Caregivers and family members play a vital role in patient care, monitoring daily activities and ensuring medication adherence. Safety measures are typically physical, involving locks and alarms, and emergency response relies on caregivers or family members. However, the existing system has limitations, including subjectivity in diagnosis, challenges in early detection, and concerns about patient safety when caregivers are not present.

The proposed system described earlier offers a comprehensive solution to address these limitations. By integrating deep learning techniques for more objective and accurate diagnosis, the system reduces subjectivity in the diagnostic process. It also introduces innovative safety measures through wearable technology, ensuring continuous monitoring and timely responses to potential risks when patients are alone. Additionally, the system enhances caregiver support by automating tracking and communication, thereby improving the overall management of Alzheimer's disease. This holistic approach aims to minimize diagnostic delays and enhance patient well-being, offering a promising step forward in Alzheimer's care.

3.2.1 Disadvantages

- Subjective evaluations and manual assessments contribute to variability in diagnoses.
- Delays in detecting Alzheimer's pose obstacles to timely intervention and treatment.
- Safety concerns emerge when patients are alone, relying heavily on caregivers.
- The absence of automation in tracking and communication places additional responsibilities on caregivers.
- Diagnostic processes often lack objectivity, compromising the precision of results.
- Dependence on traditional methods may result in prolonged diagnostic timelines.
- Safety measures, contingent on caregivers, may fall short of providing comprehensive security.
- Obtaining and interpreting biomarker data poses challenges in the current system.
- The limited automated support for caregivers may impact the overall quality of care.
- The potential for misdiagnosis is heightened due to subjectivity in assessments and cognitive tests.

3.3 PROPOSED SYSTEM

The proposed system represents a groundbreaking approach to addressing the challenges associated with Alzheimer's disease diagnosis, patient safety, and caregiver support. At its core, the system harnesses the power of advanced technologies and innovative solutions to revolutionize the way we approach Alzheimer's care. The implementation of a cutting-edge deep learning model, specifically a Convolutional Neural Network (CNN), using the TensorFlow Keras framework, promises to significantly streamline the diagnostic process. By analyzing MRI scanned images and accurately classifying the Alzheimer's stage, including Very Mild Dementia, Mild Dementia, and Non-Dementia, this model not only reduces the time required for diagnosis but also enhances the objectivity and accuracy of the results.

Complementing this diagnostic component, a user-friendly web application is provided to doctors, enabling them to effortlessly upload MRI scans and receive instant diagnostic insights. This not only eases the burden on healthcare professionals but also expedites the commencement of tailored care plans. Furthermore, the system introduces a novel feature: image processing with Python and OpenCV for recognizing family members and caregivers. This recognition mechanism enhances patient security and comfort, particularly when they are alone at home, mitigating anxiety and confusion.

Patient safety is a paramount concern, and the system addresses it through a wearable device powered by an Arduino Nano. With GSM and LCD capabilities, this device offers periodic safety check-ins, automatically triggering location tracking if the patient fails to respond within a designated time frame. An emergency button is also integrated, providing patients with a lifeline to request immediate assistance.

In summary, the proposed system takes a holistic approach to Alzheimer's care, combining cutting-edge technology, accurate diagnosis, caregiver support, and patient safety. By addressing critical aspects of Alzheimer's management, it aims to minimize diagnostic delays and enhance the overall well-being of patients and their families faced with the challenges of this incurable condition. This integrated solution represents a significant stride toward more effective and compassionate Alzheimer's care.

3.3.1 Advantages

- Incorporates a state-of-the-art deep learning model for precise and objective Alzheimer's diagnosis.
- The web application expedites the diagnostic process, facilitating prompt initiation of personalized care plans.
- Enhances patient security through image processing, recognizing family members and caregivers.
- The wearable device, powered by Arduino Nano, ensures continuous monitoring and provides a lifeline for immediate assistance.
- Adopts a holistic approach, integrating advanced technology, accurate diagnosis, caregiver support, and enhanced patient safety.
- Strives to minimize diagnostic delays, fostering an environment that prioritizes overall well-being in Alzheimer's care.

3.4 SCOPE

The scope of this project encompasses several key components aimed at revolutionizing Alzheimer's disease care. Firstly, the project will focus on developing and implementing a state-of-the-art deep learning model, specifically a Convolutional Neural Network (CNN), using the TensorFlow Keras framework. This model will analyze MRI scanned images to accurately classify Alzheimer's stages, including Very Mild Dementia, Mild Dementia, and Non-Dementia, thereby streamlining the diagnostic process and improving diagnostic accuracy. Secondly, a user-friendly web application will be developed to enable healthcare professionals to easily upload MRI scans and receive instant diagnostic insights, facilitating prompt initiation of tailored care plans. Additionally, the project will incorporate image processing techniques with Python and OpenCV to recognize family members and caregivers, enhancing patient security and comfort. Furthermore, a wearable device powered by an Arduino Nano will be designed to provide safety check-ins and emergency response capabilities, ensuring the well-being of patients, particularly when they are alone at home. The project's scope also includes testing and validation of the developed components to ensure reliability and effectiveness in real-world scenarios. Overall, the scope of this project is comprehensive, encompassing advanced technological solutions to address critical aspects of Alzheimer's care, from accurate diagnosis to patient safety and caregiver support.

CHAPTER 4

MATERIALS AND METHODS

4.1 METHODOLOGY AND DESCRIPTION

The proposed system's methodology and description encompass several interconnected components, each contributing to the overall objective of improving Alzheimer's disease diagnosis, patient safety, and caregiver support.

4.1.1 Deep Learning-Based Diagnosis

Data Collection: A comprehensive dataset of MRI scanned images, including samples from different Alzhng and optimization are performed to achieve the best performance.

4.1.2 Web Application for Doctors

Interface Design: A user-friendly web application is created using Python and the Streamlit framework. The interface allows doctors to easily upload MRI scans and input patient data.

Model Integration: The deep learning model developed for Alzheimer's diagnosis is integrated into the web application for real-time analysis of uploaded images.

Diagnosis Display: The application displays the Alzheimer's stage diagnosis along with relevant information and recommendations to assist doctors in making informed decisions.

4.1.3 Family Member Recognition using Image Processing

Data Collection: Images of family members and caregivers are collected to create a recognition dataset.

Image Processing: Python and OpenCV are utilized to build a recognition system that identifies familiar individuals when they interact with the Alzheimer's patient.

Integration: The recognition system is seamlessly integrated with the overall system to enhance patient comfort and security.

4.1.4 Safety Wearable Device

Hardware Development: A wearable device, based on Arduino Nano, is designed to include GSM and LCD modules.

Location Tracking: If the patient fails to respond within the specified timeframe, the device activates location tracking and sends updates to designated relatives or caregivers.

4.1.5 Emergency Alert System

Immediate Response: The system includes a mechanism to facilitate immediate responses in emergency situations, enabling patients to request prompt assistance.

In summary, the methodology and description of the proposed system involve a multi-faceted approach to Alzheimer's disease care. It encompasses data collection, deep learning for diagnosis, web application development, image processing for recognition, wearable technology for safety, and emergency response mechanisms. Together, these components aim to minimize diagnostic delays, enhance patient well-being, and provide crucial support to caregivers and families in the challenging context of Alzheimer's disease management. The system's integration of advanced technologies represents a significant advancement in the field of Alzheimer's care.

4.2 HARDWARE BLOCK DIAGRAM

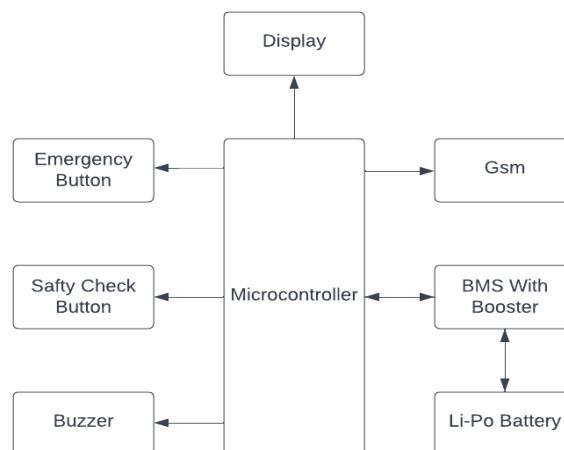


Fig:4.1 : Hardware Block Diagram of Alzheimer

Fig.4.1. shows the block diagram of the proposed Alzheimer system. The hardware block diagram for an Alzheimer's assistance device comprises a microcontroller as the central processing unit, managing all system functions. Connected to the

microcontroller are essential components including an emergency button for immediate assistance, a safety check button for periodic status updates, and a buzzer for audible alerts. Additionally, a GSM module enables communication over mobile networks, facilitating calls or messages to caregivers or emergency services. A Battery Management System (BMS) with a booster ensures stable power delivery from the connected battery, which serves as the device's power source. Furthermore, a display unit provides visual feedback to users, displaying system status and alerts. Together, these components create a comprehensive system designed to aid individuals with Alzheimer's by offering quick access to help, monitoring their safety, and ensuring continuous operation.

4.3 HARDWARE CIRCUIT DIAGRAM

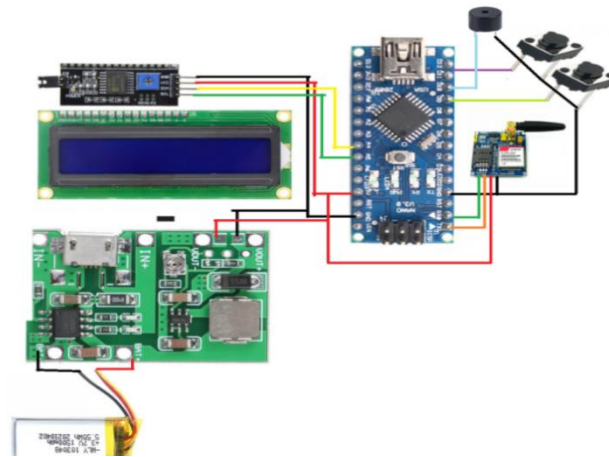


Fig:4.2 : Hardware Circuit Diagram of Alzheimer

Hardware circuit diagram of Alzheimer is shown in Fig.4.2. Microcontroller will act as the central processing unit, receiving input from buttons, controlling the buzzer, managing communication with the GSM module, and interfacing with the display. Emergency and Safety Check Buttons will provide input to the microcontroller. Buzzer will be controlled by the microcontroller for alarms or notifications. GSM Module will handle communication with caregivers or emergency services. Battery Management System with Booster will manage the power supply and regulate voltage to ensure stable operation. Battery will provide power to the system. Display will provide visual feedback or information to the user or caregivers. Connect the Emergency and Safety Check Buttons to digital input pins of the microcontroller. Connect the Buzzer to a digital output pin of the microcontroller. Connect the GSM Module to UART or SPI communication pins of the microcontroller. Connect the

Battery Management System with Booster to the power input of the microcontroller and other components requiring power. Connect the Battery to the Battery Management System. Connect the Display to appropriate communication pins of the microcontroller. When the Emergency Button is pressed, the microcontroller detects the input and triggers the buzzer for alerting caregivers or emergency services via the GSM Module. The Safety Check button can be used for routine check-ins or safety confirmations. Pressing it sends a signal to the microcontroller, which may trigger a visual or audible confirmation. The Buzzer can be activated by the microcontroller for various alerts, such as low battery, system errors, or emergencies. The GSM Module facilitates communication with caregivers or emergency services by sending text messages or making calls. The Battery Management System with Booster ensures that the system operates within safe voltage levels and provides sufficient power to all components. The Display provides visual feedback to the user or caregivers, displaying relevant information such as battery status, system status, or emergency alerts.

4.4 HARDWARE REQUIREMENTS

- Computer Server with high-end CPU and GPU.
- Arduino Nano boards for wearable devices.
- GSM Module with SIM card support.
- Display for the wearable device.
- Emergency Button for manual distress signalling.
- Camera or Laptop Webcam for image processing.
- Power Supply solutions (chargers, batteries).
- Miscellaneous Hardware (microcontrollers, sensors, connectors).
- Prototyping Tools (soldering equipment, development boards).

4.4.1 Safety Check Button

This device periodically prompts the Alzheimer's patient with safety check-ins at predefined intervals (e.g., every 1 minutes). Safety check button is shown in Fig.4.3.



Fig:4.3 : Safety Check Button

4.4.2 Emergency Button

An emergency button on the wearable allows patients to manually send distress signals when necessary. Emergency button is shown in Fig.4.4.



Fig:4.4 : Emergency Button

4.4.3 Buzzer

Fig.4.5. represents the Buzzer. Usually, it refers to a small, electromechanical device that makes a buzzing when it is turned on. It typically consists of a wire coil with an armature that vibrates in reaction to an electric current passing through it and up against the magnet, together with a magnet. This vibration produces the buzzing sound. In emergency buttons, safety check buttons, and other applications where an audible signal is needed to notify a specific circumstance or event, buzzer devices are used. They come in a range of shapes and sizes, from tiny components that are integrated into bigger standalone electronic circuit units.

4.4.3.1 Features

- Black in colour
- With internal drive circuit
- Sealed structure
- Wave solderable and washable
- Housing material: Noryl

4.4.3.2 Applications

- Computer and peripherals
- Communications equipment
- Portable equipment
- Automobile electronics
- POS system
- Electronic cash register

4.4.3.3 Specifications

- Rated Voltage: 6V DC
- Operating Voltage: 4 to 8V DC
- Rated Current*: $\leq 30\text{mA}$
- Sound Output at 10cm*: $\geq 85\text{dB}$
- Resonant Frequency: $2300 \pm 300\text{Hz}$
- Tone: Continuous
- Operating Temperature: -25°C to $+80^{\circ}\text{C}$
- Storage Temperature: -30°C to $+85^{\circ}\text{C}$
- Weight: 2g



Fig:4.5 : Buzzer

4.4.4 Arduino Nano

Fig.4.6. represents ATmega Board. The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328 or ATmega168. It has more or less the same functionality of the Arduino Duemilanove, but in a different package. It lacks only a DC power jack, and works with a Mini-B USB cable instead of a standard one. The Nano was designed and is being produced by Gravitech.

4.4.4.1 Summary

- Microcontroller Atmel ATmega168 or ATmega328
- Operating Voltage (logic level) 5 V
- Input Voltage (recommended) 7-12 V
- Input Voltage (limits) 6-20 V
- Digital I/O Pins 14 (of which 6 provide PWM output)
- Analog Input Pins 8
- DC Current per I/O Pin 40 mA
- Flash Memory 16 KB (ATmega168) or 32 KB (ATmega328) of which 2 KB used by bootloader

- SRAM 1 KB (ATmega168) or 2 KB (ATmega328)
- EEPROM 512 bytes (ATmega168) or 1 KB (ATmega328)
- Clock Speed 16 MHz
- Dimensions 0.73" x 1.70"

4.4.4.2 Power

The Arduino Nano can be powered via the Mini-B USB connection, 6-20V unregulated external power supply (pin 30), or 5V regulated external power supply (pin 27). The power source is automatically selected to the highest voltage source.

4.4.4.3 Memory

The ATmega168 has 16 KB of flash memory for storing code (of which 2 KB is used for the bootloader); the ATmega328 has 32 KB, (also with 2 KB used for the bootloader). The ATmega168 has 1 KB of SRAM and 512 bytes of EEPROM; the ATmega328 has 2 KB of SRAM and 1 KB of EEPROM.

4.4.4.4 Input and Output

Each of the 14 digital pins on the Nano can be used as an input or output, They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms. In addition, some pins have specialized functions:

- Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the FTDI USB-to-TTL Serial chip.
- External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.
- PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output.
- SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Arduino language.
- LED: 13. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

There are a couple of other pins on the board:

- AREF. Reference voltage for the analog inputs.
- Reset. Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

The ATmega168 and ATmega328 also support I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus; see the documentation for details. To use the SPI communication, please see the ATmega168 or ATmega328 datasheet.

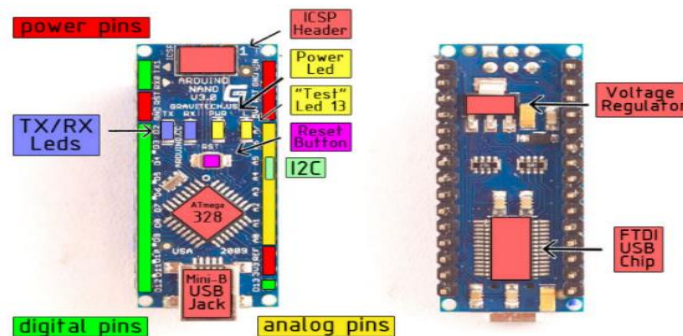


Fig:4.6 : The ATmega Board

4.4.5 LCD Display

Fig.4.7. represents Liquid crystal displays (LCDs) have materials which combine the properties of both liquids and crystals. Rather than having a melting point, they have a temperature range within which the molecules are almost as mobile as they would be in a liquid, but are grouped together in an ordered form similar to a crystal. An LCD consists of two glass panels, with the liquid crystal material sandwiched in between them. The inner surface of the glass plates is coated with transparent electrodes which define the character, symbols or patterns to be displayed. Polymeric layers are present in between the electrodes and the liquid crystal, which makes the liquid crystal molecules to maintain a defined orientation angle. On each polariser is pasted outside the two glass panels. These polarisers would rotate the light rays passing through them to a definite angle, in a particular direction. When the LCD is in the off state, light rays are rotated by the two polarisers and the liquid crystal, such that the light rays come out of the LCD without any orientation, and hence the LCD appears transparent. When sufficient voltage is applied to the electrodes, the liquid crystal molecules would be aligned in a specific direction. The

light rays passing through the LCD would be rotated by the polarizers, which would result in activating / highlighting the desired characters. The LCD's are lightweight with only a few millimeters thickness. Since the LCD's consume less power, they are compatible with low power electronic circuits, and can be powered for long durations. The LCD's don't generate light and so light is needed to read the display. By using backlighting, reading is possible in the dark. The LCD's have long life and a wide operating temperature range. Changing the display size or the layout size is relatively simple which makes the LCD's more customer friendly. The LCDs used exclusively in watches, calculators and measuring instruments are the simple seven-segment displays, having a limited amount of numeric data. The recent advances in technology have resulted in better legibility, more information displaying capability and a wider temperature range. These have resulted in the LCDs being extensively used in telecommunications and entertainment electronics. The LCDs have even started replacing the cathode ray tubes (CRTs) used for the display of text and graphics, and also in small TV applications.

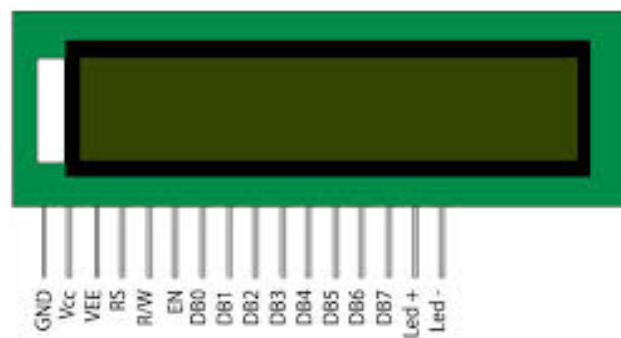


Fig:4.7 : LCD Display

4.4.5.1 I2C Serial Interface 1602 LCD Module

This is I2C interface 16x2 LCD display module, a high-quality 2-line 16-character LCD module with on-board contrast control adjustment, backlight and I2C communication interface. For Arduino beginners, no more cumbersome and complex LCD driver circuit connection. The real significance advantages of this I2C Serial LCD module will simplify the circuit connection, save some I/O pins on Arduino board, simplified firmware development with widely available Arduino library.

4.4.5.2 Setting Up

Hitachi's HD44780 based character LCD are very cheap and widely available, and is an essential part for any project that displays information. Using the LCD piggy-back board, desired data can be displayed on the LCD through the I2C bus. In principle, such backpacks are built around PCF8574 (from NXP) which is a general purpose bidirectional 8 bit I/O port expander that uses the I2C protocol. In short, if the piggy-back board is based on PCF8574T and the address connections (A0-A1-A2) are not bridged with solder it will have the slave address 0x27. Fig.4.8. shows a I2C-to-LCD piggy-back board.



Fig:4.8 : Address selection pads in the I2C-to-LCD piggy-back board

4.4.5.3 I2C LCD Display

At first you need to solder the I2C-to-LCD piggy-back board to the 16-pins LCD module. Ensure that the I2C-to-LCD piggy-back board pins are straight and fit in the LCD module, then solder in the first pin while keeping the I2C-to-LCD piggy-back board in the same plane with the LCD module. Once you have finished the soldering work, get four jumper wires and connect the LCD module to your Arduino as per the instruction given in Fig.4.9.



Fig:4.9 : LCD display to Arduino wiring

4.4.6 GSM Module

There are different kinds of GSM modules available in market. We are using the most popular module based on Simcom SIM900 and Arduino Uno for this tutorial. Interfacing a GSM module to Arduino is pretty simple. You only need to make 3 connections between the gsm module and Arduino.

GSM Module is shown in Fig.4.10. A GSM Module is basically a GSM Modem (like SIM 900) connected to a PCB with different types of output taken from the board – say TTL Output (for Arduino, 8051 and other microcontrollers) and RS232 Output to interface directly with a PC (personal computer). The board will also have pins or provisions to attach mic and speaker, to take out +5V or other values of power and ground connections. These types of provisions vary with different modules.

Lots of varieties of GSM modem and GSM Modules are available in the market to choose from. For our project of connecting a gsm modem or module to Arduino and hence send and receive SMS using Arduino – it's always good to choose an *Arduino compatible GSM Module* – that is a GSM module with TTL Output provisions.

4.4.6.1 Connecting GSM Model to Arduino

In any case, the communication between Arduino and GSM module is serial. So we are supposed to use serial pins of Arduino (Rx and Tx). So if you are going with this method, you may connect the Tx pin of GSM module to Rx pin of Arduino and Rx pin of GSM module to Tx pin of Arduino. You read it right? GSM Tx → Arduino Rx and GSM Rx → Arduino Tx. Now connect the ground pin of Arduino to ground pin of gsm module! So that's all! You made 3 connections and the wiring is over! Now you can load different programs to communicate with gsm module and make it work.



Fig:4.10 : GSM Module

4.4.7 TP4056 with Integrated DC Boost Converter Module

This is an TP4056 18650 3.7V 4.2V Battery Charging Module with Integrated DC Boost Converter module. The TP4056 is a small single cell lithium battery charging module that also includes a 1A step-up (boost) converter for powering a large range of applications. The module will charge most types of a single cell (3.7) LiPo batteries from either 4 to 7.5V power supply input, or from a standard 5V USB port/adaptor. A battery charge and standby LED are also included for visual indication. Fig.4.11. shows BSM with booster.

The TP4056 is a complete constant-current/constant-voltage linear charger for single cell lithium-ion batteries. Its low external component count makes the TP4056 ideally suited for portable applications.

4.4.7.1 Features

- High-quality integrated circuits.
- Exquisite detail and long service life.
- Module TP4056 DIY kit parts.
- Can be used for multimeter, converted to lithium-battery charging

4.4.7.2 Specifications

- Input voltage: 4.5-8V DC
- Output voltage: 4.3-27V DC (Continuously adjustable)
- Charging voltage: 4.2V DC
- Charging current: Max. 1A
- Discharging current: Max. 2A
- Size: 3.3x2.3cm/1.3x0.91"

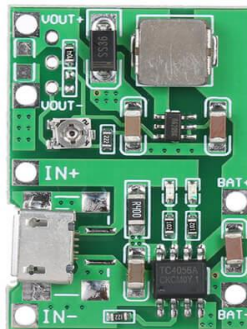


Fig:4.11 : BMS With Booster

4.4.8 Li-Po Battery

Lithium-Polymer Battery used in this project is given in Fig.4.12. It describes the performance characteristics and testing methods for Li-polymer battery.

4.4.8.1 Product type and model number

- Product type - Lithium-polymer battery
- Model number - LP-523334 3.7V 500mAh with PCM

4.4.8.2 Standard Test Condition

Test should be conducted with new batteries within one week after shipment from our factory and the batteries shall not be cycled more than five times before the test. Unless otherwise defined, test and measurement shall be done under temperature of 20 ± 5 and relative humidity °C of 45~85%. If it is judged that the test results are not affected by such conditions, the tests may be conducted at temperature 15~30°C and humidity 25~85%RH.

4.4.8.3 Charge and Discharge

- Battery must be charged in appropriate charger only.
- Never use a modified or damaged charger.
- Do not leave battery in charge over 24 hours.

4.4.8.4 Charging

- *Charging current:* Cannot surpass the biggest charging current which in this specification book stipulated.
- *Charging voltage:* Does not have to surpass the highest amount which in this specification book stipulated to decide the voltage.
- *Charge temperature:* The battery must carry on the charge in the ambient temperature scope which this specification book stipulated. Uses the constant electric current and the constant voltage way charge, the prohibition reverse charges. If the battery positive electrode and the cathode meet instead, can damage the battery.

4.4.8.5 Discharging current

- The discharging current does not have to surpass this specification book stipulation the biggest discharging current, the oversized electric current electric discharge can cause the battery capacity play to reduce and to cause the battery heat.



Fig:4.12 : Lithium-Polymer Battery

4.5 SOFTWARE BLOCK DIAGRAM

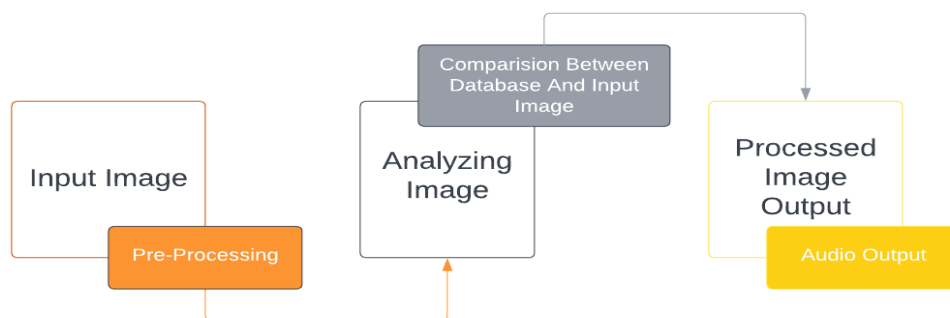


Fig:4.13 : Software Block Diagram

Fig.4.13. shows block diagram of the software proposed. The software block diagram you described seems to be for an image-to-audio conversion system.

4.5.1 Preprocessing Block

This block takes the input image as data. It might perform various tasks to improve the image quality for analysis, such as:

- Resizing: The image might be resized to a standard size for efficient processing.
- Noise Reduction: Techniques to remove unwanted noise from the image can be applied here.
- Grayscale Conversion: The image might be converted to grayscale if color information is not relevant for analysis.

- Contrast Enhancement: This can improve the visibility of features in the image.

4.5.2 Analysing Block

This block likely extracts features from the pre-processed image. Feature extraction techniques like:

- Edge Detection: Identifying edges and contours in the image.
- Shape Recognition: Detecting basic shapes like lines, circles, and squares.
- Object Recognition: Identifying specific objects present in the image (if applicable).

4.5.3 Comparison Block

This block compares the extracted features from the image with a database. The database could contain information about:

- Image-to-audio mappings: A mapping between specific features or objects in an image and corresponding audio sounds.
- Statistical data: Statistical properties of images and their corresponding audio.

4.5.4 Processing Block

Based on the comparison results, this block generates the audio output.

- Audio retrieval: If the database has pre-recorded sounds corresponding to the image features, this block retrieves and combines those sounds to form the output.
- Sound synthesis: The block might use the information to synthesize new sounds based on parameters like pitch, timbre, and duration.

This system essentially translates the visual content of an image into an auditory representation. The specific sounds generated depend on the design of the database and the processing algorithms used.

4.6 SOFTWARE TOOLS

4.6.1 Operating System

- Windows based OS
- Linux-based OS (e.g., Ubuntu) for the server and development environments.

4.6.2 Development Tools

- Python (3.x) for coding.
- Integrated Development Environment (IDE) like PyCharm or Visual Studio Code.

4.6.3 Deep Learning Framework

- TensorFlow and Keras.
- Web Application Development.
- Streamlit for the web application.

4.6.4 Image Processing

- OpenCV for image processing.

4.6.5 Wearable Device Development

- Arduino IDE.
- C/C++ programming for microcontroller code.

4.6.6 Location Services

- GPS software libraries or services.

4.6.7 Communication Services

- SMS gateway or API for SMS communication.

4.7 SOFTWARE FLOW DIAGRAM

4.7.1 Work Flow

The Fig.4.14. represents flow chart of the proposed software. Upon startup, the Alzheimer's patient program initiates a web interface that serves as a conduit for user contact. The software loads a pre-trained model designed exclusively to

recognize and stage Alzheimer's disease after the interface has been configured. This model is necessary to evaluate the disease's severity and interpret input data in an efficient manner. The software then retrieves input images from a dataset that includes relevant data points. The stage of Alzheimer's disease is then identified by processing these photos with the supplied model. The results of the analysis are then shown in a graphical user interface, providing a clear visual depiction of the patient's condition. After analysis is complete and results are shown, the program ensures that additional signal processing is terminated.

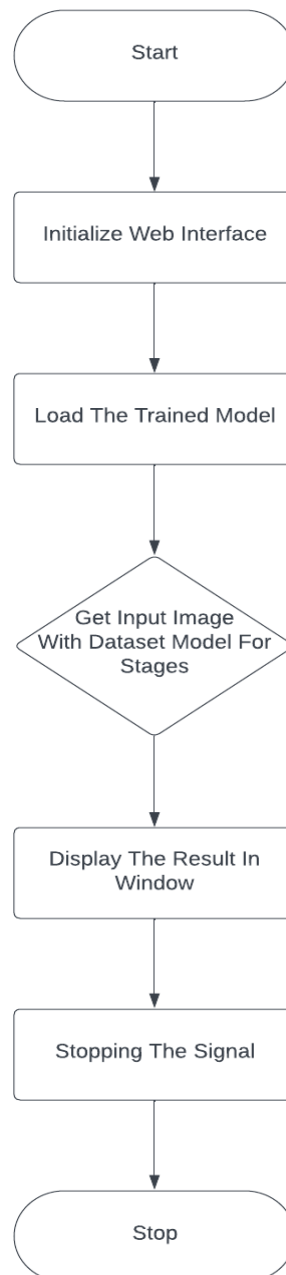


Fig:4.14 : Flow Chart

4.8 ALGORITHM OF THE PROPOSED SOFTWARE

4.8.1 Face Detection

Face detection is a type of application classified under “computer vision” technology. It is the process in which algorithms are developed and trained to properly locate faces or objects (in object detection, a related system), in images. These can be in real time from a video camera or from photographs. An example where this technology is used are in airport security systems. In order to recognize a face, the camera software must first detect it and identify the features before making an identification. Likewise, when Facebook makes tagging suggestions to identify people in photos it must first locate the face. On social media apps like Snapchat, face detection is required to augment reality which allows users to virtually wear dog face masks using fancy filters. Another use of face detection is in smartphone face ID security.

In this project, I implemented a system for locating faces in digital images. These are in JPEG format only. Before we continue, we must differentiate between face recognition and face detection. They are not the same, but one depends on the other. In this case face recognition needs face detection for making an identification to “recognize” a face. I will only cover face detection.

Face detection uses *classifiers*, which are algorithms that detects what is either a face (1) or not a face (0) in an image. Classifiers have been trained to detect faces using thousands to millions of images in order to get more accuracy. OpenCV uses two types of classifiers, LBP (Local Binary Pattern) and Haar Cascades. I will be using the latter classifier.

4.8.2 Haar Cascades

A sequence of rescaled “square-shaped” functions which together form a wavelet family or basis.

It is based on the Haar Wavelet technique to analyze pixels in the image into squares by function. This uses machine learning techniques to get a high degree of accuracy from what is called “training data”. This uses “integral image” concepts to compute the “features” detected. Haar Cascades use the Adaboost learning algorithm which selects a small number of important features from a large set to give

an efficient result of classifiers. This is a brief illustration of Features Extraction and the difference between Face Detection and Face Recognition is shown in Fig.4.15. Face detection is about locating, while face recognition is about identifying.

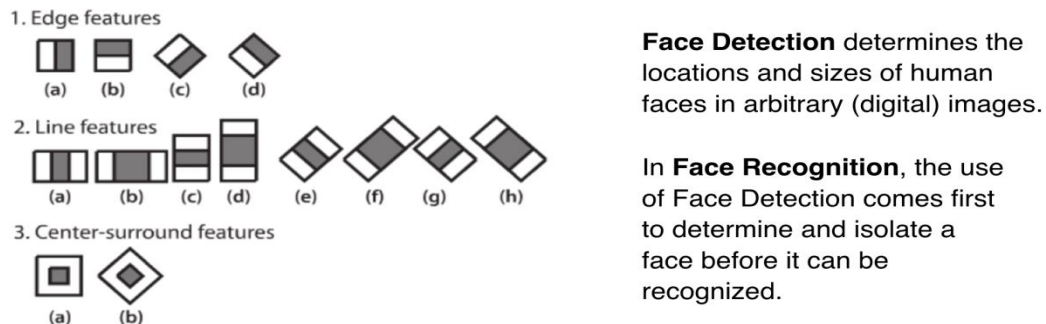


Fig:4.15 : Face Detection vs Face Recognition

4.8.3 Feature Extraction

Haar Cascades use machine learning techniques in which a function is trained from a lot of positive and negative images. This process in the algorithm is feature extraction. Fig.4.16. explains the feature extraction from the model.

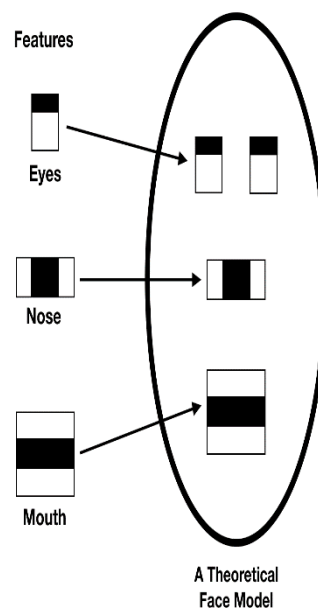


Fig:4.16 : Feature Extraction

In feature extraction, the algorithm uses training data to best identify features that it can consider a face. The training data used in this project is an XML file called: haarcascade_frontalface_default.xml

4.8.4 Face Detection System Architecture

4.8.4.1 Local Binary Patterns Histogram (LBPH)

Local Binary Patterns Histogram algorithm was proposed in 2006. It is based on local binary operator. It is widely used in facial recognition due to its computational simplicity and discriminative power. Architecture of the model is given in Fig.4.17.

The steps involved to achieve this are:

- face acquisition
- feature extraction
- creating dataset
- classification

The LBPH algorithm is a part of OpenCV.

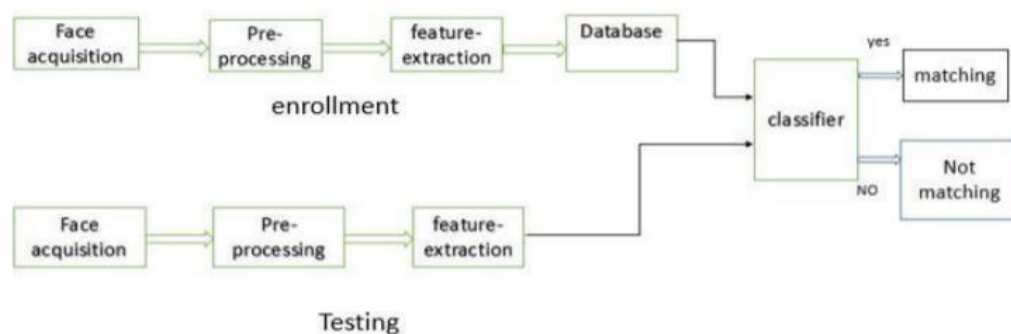


Fig:4.17 : Architecture of the model

4.8.4.2 Parameters: the LBPH uses 4 parameters

- **Radius:** the radius is used to build the circular local binary pattern and represents the radius around the central pixel. It is usually set to 1.
- **Neighbours:** the number of sample points to build the circular local binary pattern. Keep in mind: the more sample points you include, the higher the computational cost. It is usually set to 8.
- **Grid X:** the number of cells in the horizontal direction. The more cells, the finer the grid, the higher the dimensionality of the resulting feature vector. It is usually set to 8.

- **Grid Y:** the number of cells in the vertical direction. The more cells, the finer the grid, the higher the dimensionality of the resulting feature vector. It is usually set to 8.

4.8.4.3 Training the Algorithm

First, we need to train the algorithm. To do so, we need to use a dataset with the facial images of the people we want to recognize. We need to also set an ID (it may be a number or the name of the person) for each image, so the algorithm will use this information to recognize an input image and give you an output. Images of the same person must have the same ID. With the training set already constructed, let's see the LBPH computational steps.

4.8.4.4 Applying the LBP operation

The first computational step of the LBPH is to create an intermediate image that describes the original image in a better way, by highlighting the facial characteristics. To do so, the algorithm uses a concept of a sliding window, based on the parameter's **radius** and **neighbors**. Representation of LBP operation is shown in Fig.4.18.

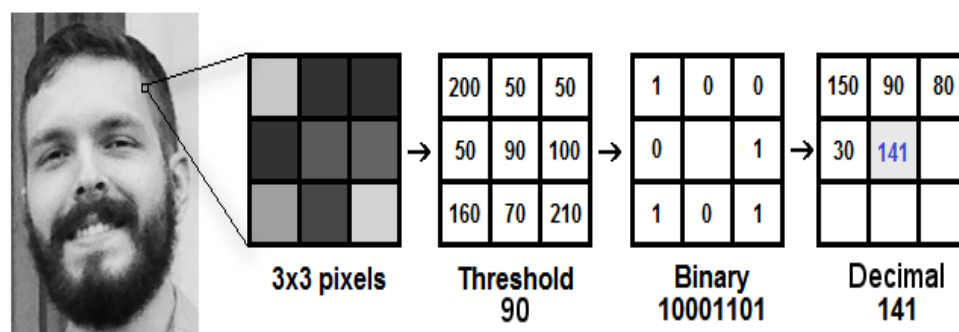


Fig:4.18 : LBP Operation

4.9 SOFTWARE REQUIREMENTS

- Fuzzy Logic
- Arduino IDE
- Python Installation
- OpenCV

4.9.1 Fuzzy Logic

The Fuzzy Logic is given in Fig.4.19. Fuzzy Logic is a mathematical framework that deals with reasoning and decision-making under uncertainty. Unlike traditional binary logic that operates in crisp, true/false terms, fuzzy logic allows for a more nuanced representation of uncertainty by using degrees of truth. This is particularly useful in scenarios where human reasoning is involved and where information is imprecise or incomplete.

4.9.1.1 Fuzzy Logic Algorithm

- **Fuzzy Sets:** Fuzzy sets are a fundamental concept in fuzzy logic. In classical set theory, an element either belongs to a set or does not. In fuzzy sets, membership is defined by a degree of belonging between 0 and 1. For example, instead of saying "hot" or "not hot," fuzzy logic might express the temperature as "0.8 hot."
- **Membership Functions:** Membership functions define the degree of membership for each element in a fuzzy set. These functions map input values to degrees of truth. They are often shaped as curves or other mathematical functions that describe the gradual transition between true and false.
- **Fuzzy Rules:** Fuzzy rules capture the expert knowledge or human reasoning in a system. They consist of "if-then" statements with linguistic variables and fuzzy logic operators. For example, "if the temperature is high and the humidity is low, then increase the air conditioning."
- **Inference Engine:** The inference engine evaluates the fuzzy rules based on the input values and membership functions. It determines the degree to which each rule contributes to the overall decision.
- **Fuzzy Aggregation:** Fuzzy aggregation combines the outputs of different rules to produce a single fuzzy output. Various aggregation methods, such as the maximum or average, can be employed based on the application.
- **Defuzzification:** The defuzzification process converts the fuzzy output into a crisp value that can be used for decision-making or control. Common methods include the centroid method or the weighted average.

4.9.1.2 Applications

Fuzzy Logic is widely applied in various fields, including control systems, decision support systems, and artificial intelligence, due to its ability to handle imprecise and uncertain information. Some practical applications include:

- **Temperature Control:** Fuzzy logic is used in air conditioning and heating systems to adjust temperature settings based on imprecise user preferences.
- **Automotive Systems:** Fuzzy logic is employed in vehicle control systems, such as anti-lock brakes and cruise control, to adapt to varying road conditions.
- **Consumer Electronics:** Fuzzy logic is applied in appliances like washing machines to adjust washing time and water consumption based on the degree of dirtiness in clothes.
- **Financial Decision-Making:** Fuzzy logic can be used in investment decision-making systems to model and analyze uncertain financial data.
- **Medical Diagnosis:** Fuzzy logic can assist in medical diagnosis by handling imprecise symptoms and uncertainties in patient data.

In essence, Fuzzy Logic provides a framework for dealing with uncertainty and imprecision in a way that mirrors human decision-making, making it a valuable tool in systems where clear-cut, binary decisions may be inadequate.

4.9.1.3 Description

The term **fuzzy** refers to things that are not clear or are vague. In the real world many times we encounter a situation when we can't determine whether the state is true or false, their fuzzy logic provides very valuable flexibility for reasoning. In this way, we can consider the inaccuracies and uncertainties of any situation.

Fuzzy Logic is a form of many-valued logic in which the truth values of variables may be any real number between 0 and 1, instead of just the traditional values of true or false. It is used to deal with imprecise or uncertain information and is a mathematical method for representing vagueness and uncertainty in decision-making.

Fuzzy Logic is based on the idea that in many cases, the concept of true or false is too restrictive, and that there are many shades of gray in between. It allows for partial truths, where a statement can be partially true or false, rather than fully true or false.

Fuzzy Logic is used in a wide range of applications, such as control systems, image processing, natural language processing, medical diagnosis, and artificial intelligence.

The fundamental concept of Fuzzy Logic is the membership function, which defines the degree of membership of an input value to a certain set or category. The membership function is a mapping from an input value to a membership degree between 0 and 1, where 0 represents non-membership and 1 represents full membership.

Fuzzy Logic is implemented using Fuzzy Rules, which are if-then statements that express the relationship between input variables and output variables in a fuzzy way. The output of a Fuzzy Logic system is a fuzzy set, which is a set of membership degrees for each possible output value.

In the Boolean system truth value, 1.0 represents the absolute truth value and 0.0 represents the absolute false value. But in the fuzzy system, there is no logic for the absolute truth and absolute false value. But in fuzzy logic, there is an intermediate value too present which is partially true and partially false.

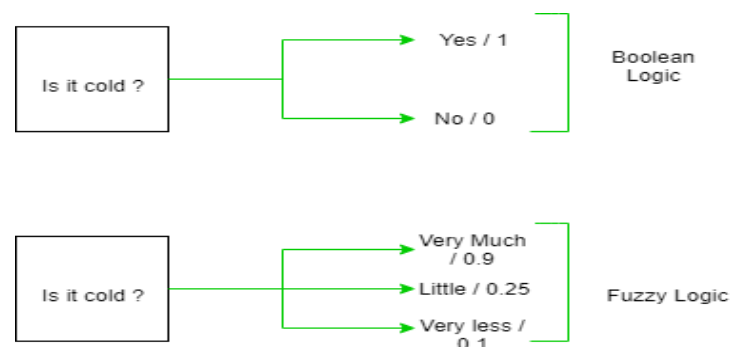


Fig:4.19 : Fuzzy Logic

4.9.1.4 Architecture

Architecture of Fuzzy Logic is given in Fig.4.20. Architecture contains four parts:

- **Rule Base:** It contains the set of rules and the IF-THEN conditions provided by the experts to govern the decision-making system, on the basis of linguistic information. Recent developments in fuzzy theory offer several effective methods for the design and tuning of fuzzy controllers. Most of these developments reduce the number of fuzzy rules.
- **Fuzzification:** It is used to convert inputs i.e., crisp numbers into fuzzy sets. Crisp inputs are basically the exact inputs measured by sensors and passed into the control system for processing, such as temperature, pressure, rpm's, etc.
- **Inference Engine:** It determines the matching degree of the current fuzzy input with respect to each rule and decides which rules are to be fired according to the input field. Next, the fired rules are combined to form the control actions.
- **Defuzzification:** It is used to convert the fuzzy sets obtained by the inference engine into a crisp value. There are several defuzzification methods available and the best-suited one is used with a specific expert system to reduce the error.

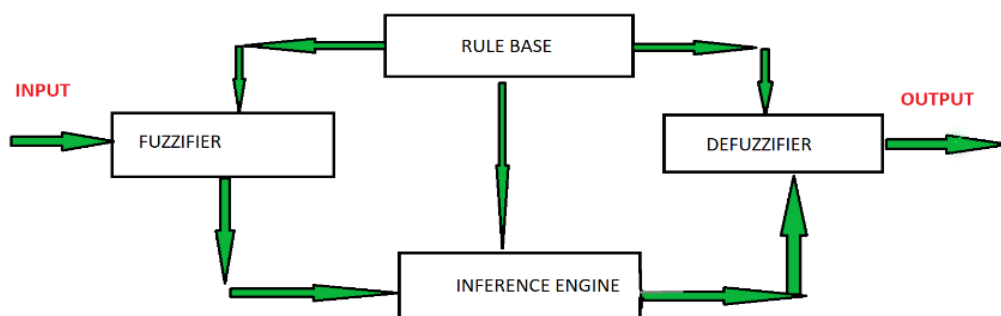


Fig:4.20 : Architecture of Fuzzy Logic

4.9.1.5 Membership Function

A graph that defines how each point in the input space is mapped to membership value between 0 and 1. Input space is often referred to as the universe of discourse or universal set (u), which contains all the possible elements of concern in each particular application.

There are largely three types of fuzzifiers

- Singleton fuzzifier
- Gaussian fuzzifier
- Trapezoidal or triangular fuzzifier

4.9.1.6 What is Fuzzy Control?

- It is a technique to embody human-like thinking's into a control system.
- It may not be designed to give accurate reasoning but it is designed to give acceptable reasoning.
- It can emulate human deductive thinking, that is, the process people use to infer conclusions from what they know.
- Any uncertainties can be easily dealt with the help of fuzzy logic.

4.9.1.7 Advantages of Fuzzy Logic System

- This system can work with any type of inputs whether it is imprecise, distorted or noisy input information.
- The construction of Fuzzy Logic Systems is easy and understandable.
- Fuzzy logic comes with mathematical concepts of set theory and the reasoning of that is quite simple.
- It provides a very efficient solution to complex problems in all fields of life as it resembles human reasoning and decision-making.
- The algorithms can be described with little data, so little memory is required.

4.9.1.8 Disadvantages of Fuzzy Logic Systems

- Many researchers proposed different ways to solve a given problem through fuzzy logic which leads to ambiguity. There is no systematic approach to solve a given problem through fuzzy logic.
- Proof of its characteristics is difficult or impossible in most cases because every time we do not get a mathematical description of our approach.

- As fuzzy logic works on precise as well as imprecise data so most of the time accuracy is compromised.

4.9.1.9 Application

- It is used in the aerospace field for altitude control of spacecraft and satellites.
- It has been used in the automotive system for speed control, traffic control.
- It is used for decision-making support systems and personal evaluation in the large company business.
- It has application in the chemical industry for controlling the pH, drying, chemical distillation process.
- Fuzzy logic is used in Natural language processing and various intensive applications in Artificial Intelligence.
- Fuzzy logic is extensively used in modern control systems such as expert systems.
- Fuzzy Logic is used with Neural Networks as it mimics how a person would make decisions, only much faster. It is done by Aggregation of data and changing it into more meaningful data by forming partial truths as Fuzzy sets.

4.9.2 Arduino IDE

Arduino IDE is an open-source software that helps to write and upload the code to Arduino board. The Arduino Integrated Development Environment (IDE) is a software platform used for writing, compiling, and uploading code to Arduino-compatible microcontroller boards.

- **Purpose:** The Arduino IDE provides a user-friendly interface for programming Arduino boards. It abstracts away many of the complexities of embedded programming, making it accessible to hobbyists, students, and professionals alike.
- **Cross-Platform:** The Arduino IDE is available for multiple operating systems including Windows, macOS, and Linux, making it accessible to a wide range of users.

- **Open Source:** The Arduino IDE is open-source software, meaning that its source code is freely available for modification and redistribution under the GNU General Public License (GPL).
- **Code Editor:** The IDE includes a text editor where users can write their Arduino sketches (programs). It provides features like syntax highlighting, auto-indentation, and code completion to assist programmers.
- **Sketches:** In Arduino terminology, programs are referred to as "sketches." A sketch typically consists of two main functions: `setup()` and `loop()`. The `setup()` function is executed once when the program starts, while the `loop()` function is executed repeatedly for as long as the Arduino board is powered on.
- **Library Manager:** The Arduino IDE includes a Library Manager, allowing users to easily add third-party libraries to their projects. Libraries contain pre-written code that can be used to interface with various hardware components and sensors, saving time and effort in writing code from scratch.
- **Board Manager:** The Board Manager enables users to install support for different types of Arduino-compatible boards, including official Arduino boards as well as third-party variants.
- **Serial Monitor:** The IDE features a built-in Serial Monitor tool that allows users to communicate with their Arduino board via the serial port. This tool is useful for debugging purposes and for sending/receiving data between the Arduino board and a connected computer.
- **Compilation and Upload:** The Arduino IDE compiles the sketch into machine code that can be understood by the microcontroller on the Arduino board. It then uploads the compiled code to the board via a USB connection or other supported interfaces.
- **Extensibility:** The Arduino IDE can be extended with additional features and functionalities through plugins and extensions, allowing users to customize their development environment according to their specific needs.

4.9.2.1 To Download Software

Step 1: First, launch Internet Explorer and look for the Arduino IDE.

Step 2: Select the link that the search page's top displays. [www.arduino.cc]

Step 3: On that webpage, select Software.

Step 4: Click the Arduino IDE 2.0.4 tab and select the appropriate download options based on your system model.

Step 5: Select "Just Download", and the download begins in the background.

Step 6: Go to the location of the downloaded file.

Step 7: The file begins to download when you click on it.

Step 8: Select the storage path, grant the necessary permissions, and install it.

4.9.2.2 To Create and Run Program

Step 1: Launch the Arduino IDE.

Step 2: Click New Sketch after opening the file.

Step 3: From the Menu bar, open the Tools and choose Arduino UNO as the Port.

Step 4: Type the code into the workspace and press the Enter key.

Step 5: Check and compile the code.

Step 6: To view the graphical representation, select Serial Plotter from the menu bar, and to monitor the data received as output, click Serial Monitor from the Tools menu bar.

4.9.3 Python Installation

- Visit the [Python official website](https://www.python.org/downloads/) and download the latest version of Python.
- Run the installer and follow the installation instructions.
- Make sure to check the box that says "Add Python to PATH" during the installation process. This will allow you to run Python from the command line.

OpenCV Installation using pip

After installing Python, you can install OpenCV using the `pip` package manager. Open your command prompt or terminal and run the following command:

```
pip install opencv-python opencv-contrib-python
```

This command will download and install the OpenCV library along with the extra contributions package. Once the installation is complete, you can start using OpenCV in your Python projects. Make sure you have a working internet connection to download the necessary files during the installation process.

After installing, you can verify whether OpenCV has been installed successfully by opening a Python shell and running the following command:

```
import cv2

print(cv2.__version__)
```

This should print the version of the OpenCV library you have installed.

4.9.4 OpenCV

OpenCV (Open Source Computer Vision Library) is an open-source computer vision and machine learning software library. It was originally developed by Intel and was later supported by Willow Garage and Itseez. OpenCV is written in C++ and supports multiple programming languages such as Python, Java, and MATLAB, among others. It is widely used for real-time computer vision and image processing applications.

OpenCV provides a wide range of functionalities for image and video analysis, including various algorithms for object detection, image recognition, feature detection, image processing, and more. Some of the key features of OpenCV include:

- **Image processing:** OpenCV allows you to perform various operations on images, such as filtering, transformation, and colour manipulation.
- **Object detection and recognition:** OpenCV provides pre-trained models and tools for object detection, face recognition, and other similar tasks.
- **Feature detection and matching:** It offers various algorithms for detecting and matching features in images, which can be used for tasks like image stitching and 3D reconstruction.
- **Machine learning integration:** OpenCV can be integrated with machine learning frameworks, allowing you to build and deploy computer vision models for various applications.

- Camera calibration and 3D reconstruction: It provides tools for camera calibration, stereo vision, and 3D reconstruction, which are essential for applications like augmented reality and 3D modelling.

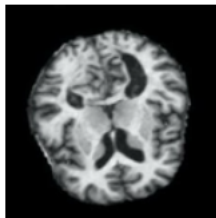
OpenCV is widely used in various industries, including robotics, healthcare, automotive, security, and entertainment, to develop applications such as facial recognition systems, autonomous vehicles, medical imaging, and augmented reality applications. Its popularity stems from its open-source nature, extensive documentation, and active community support.

CHAPTER 5

RESULTS AND DISCUSSION

5.1 RESULTS

Alzheimer's disease progresses through various stages, each characterized by different levels of cognitive decline and functional impairment. It's important to note that the progression of Alzheimer's disease can vary widely from person to person, and not all individuals will experience all stages. Additionally, other types of dementia may have different patterns of progression and symptoms. Early detection, accurate diagnosis, and appropriate management are essential for optimizing quality of life and providing support to individuals and their caregivers throughout the disease.



Predicted Type

Mild Demented

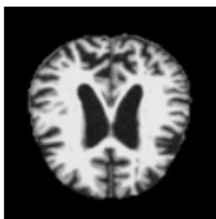
Moderate Demented

Non Demented

Very Mild Demented

Fig:5.1 : Non Demented

Fig.5.1. shows the non-demented, in these cases, diagnosis may require a comprehensive assessment by a healthcare professional, which may include a medical history review, cognitive testing, neurological examinations, and sometimes brain imaging to rule out other causes.



Predicted Type

Mild Demented

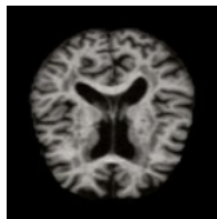
Moderate Demented

Non Demented

Very Mild Demented

Fig:5.2 : Moderate Demented

Fig.5.2. shows the moderate demented, In the moderate stage of Alzheimer's disease, individuals typically experience more noticeable cognitive decline. Memory loss becomes more pronounced, and they may have difficulty with tasks such as managing finances, understanding instructions, and remembering recent events or conversations. They may also experience changes in behavior and personality, such as increased confusion, agitation, or withdrawal from social activities.



Predicted Type

Mild Demented

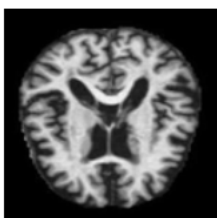
Moderate Demented

Non Demented

Very Mild Demented

Fig:5.3 : Mild Demented

Fig.5.3. shows that the mild demented, it's important to note that while the symptoms are mild, they are progressive, meaning they will worsen over time. Mild dementia can progress to moderate and severe stages, where the individual's cognitive abilities decline further, impacting their independence and requiring more significant support and care. Early diagnosis and appropriate management strategies, including medication, cognitive exercises, and support services, can help slow down the progression of the disease and improve the individual's quality of life for as long as possible.



Predicted Type

Mild Demented

Moderate Demented

Non Demented

Very Mild Demented

Fig:5.4 : Very Mild Demented

Fig.5.4. shows that the very mild demented, very mild" or "early-stage" dementia due to Alzheimer's disease refers to the initial phase of the condition where

symptoms are subtle and may not significantly interfere with daily functioning. In this stage, individuals may experience occasional memory lapses, such as forgetting names or where they placed items, but these instances are often dismissed as normal age-related forgetfulness. Other symptoms may include difficulty finding the right words in conversation, trouble with planning and organization, or mild confusion about time or location.

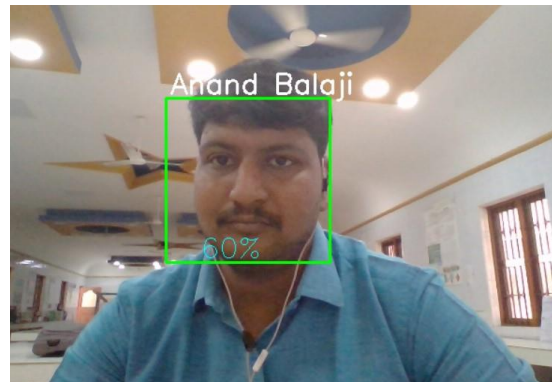


Fig:5.5 : Face Detection

Fig.5.5. shows the face detection by voice note over the person in close proximity is recognized by the webcam. Furthermore, the voice needs to already have a recording of the identified individual's voice.

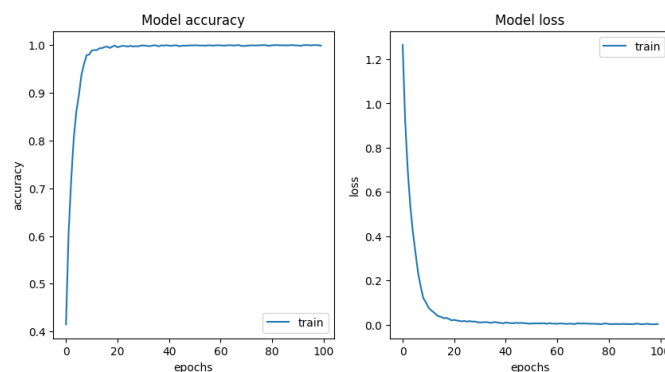


Fig:5.6 : Train Accuracy of the Model

Fig.5.6 shows the training accuracy of the model. The training accuracy is done by the images that are taken from the MRI images. These images were inserted in the coding part and we got a train accuracy rate of 99.08%.

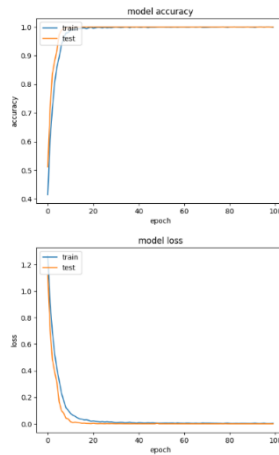


Fig:5.7 : Test accuracy of the model

The model was tested by the testing accuracy rate and in the testing, we got an accuracy rate of 98%, which is shown in the image Fig.5.7.

HARDWARE OUTPUT

The hardware output has shown each image in below figures which describes the monitoring and the time loading and it also suggests the safety reminder of the person. The device also connected to the emergency part with the alarm with the beep sound which sends the message to the person who is caregiver.



Fig:5.8 : Starting of LCD Display

In Fig.5.8. The LCD starts to display the name (Alzheimer Monitoring) for 4 seconds.



Fig:5.9 : Initializing of the output

In Fig.5.9. This device periodically prompts the Alzheimer's patient with safety check-ins at predefined intervals for every 1 minute.

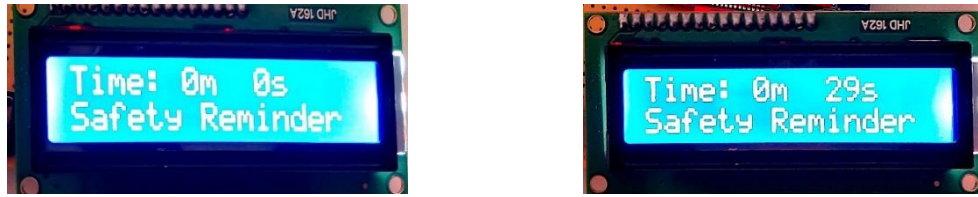


Fig:5.10 : Safety Reminder

In Fig.5.10. The buzzer begins to beep nonstop for 30 seconds. If the Alzheimer Patient presses the Safely Check Button on the wearable device, with in that time when he hears the sound of the buzzer. The buzzer stops and it denotes that Alzheimer Patient is ok and the message is not sent to the Doctor/Caregiver.



Fig:5.11 : Emergency and Lost response

In Fig.5.11. The buzzer begins to beep nonstop for 30 seconds. If the Alzheimer Patient fails to press the Safety Check Button on the wearable device, with in that time when he hears the sound of the buzzer. Then the Emergency! and Lost Response is denoted in the LCD Display and the Message is sent to the Doctor/Caregiver.

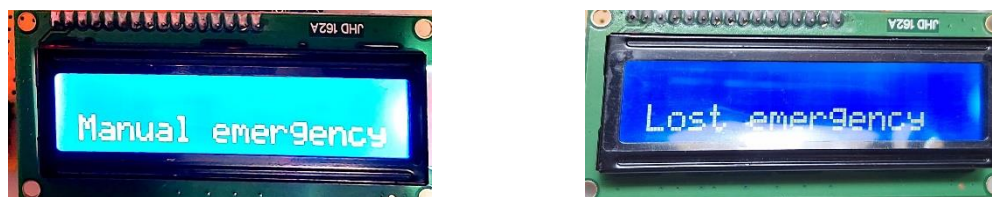


Fig:5.12 : Manual emergency and Lost emergency

In Fig.5.12. Denoting Manual emergency and Lost emergency, an emergency button on the wearable allows patients to manually send distress signals when necessary. The buzzer will not go off until the doctor or caregiver receives the message.



Fig:5.13 : Sending SMS

In Fig.5.13. Displays the message sent to the Doctor/Caregiver. When the Alzheimer Patient fails to respond to the Safety Check Button or manually pressed Emergency Button on the wearable device.

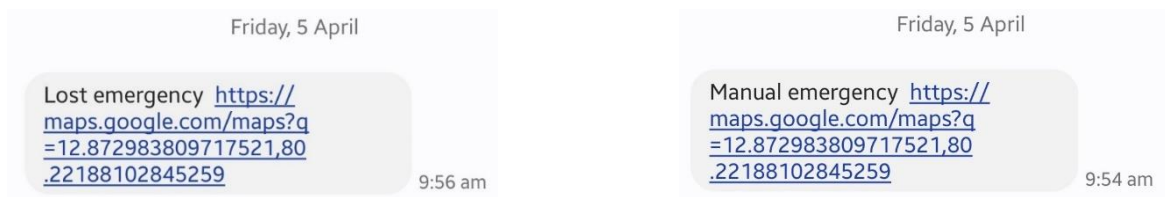


Fig: 5.14 : SMS and Link of Lost emergency and Manual emergency

In Fig.5.14. Shows the sent message to the Doctor/Caregiver denoting the Lost Emergency and Manual Emergency.

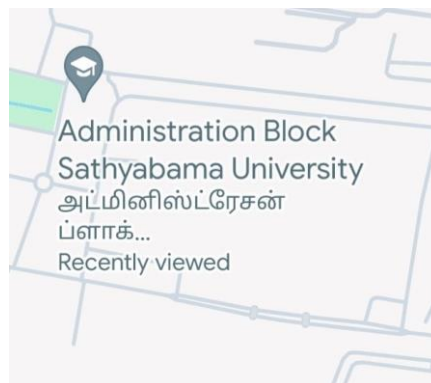


Fig: 5.15 : Location of the Alzheimer Patient

The location of the Alzheimer Patient is shown the in Fig.5.15. After sending the SMS, we can touch the link in the SMS, and it will show the location of the Alzheimer Patient to the Doctor/Caregiver for both Safety Remainder & Manual Emergency.

5.2 DISCUSSION

The discussion of the project encompasses a critical examination of the findings, implications, and limitations of the developed system for Alzheimer's disease detection, patient safety, and caregiver support. Firstly, the high accuracy and efficiency demonstrated by the Convolutional Neural Network (CNN) algorithm in diagnosing Alzheimer's disease from MRI images underscore its potential as a valuable tool for healthcare professionals. However, considerations regarding data quality, model generalization, and interpretability highlight the need for ongoing refinement and validation in real-world clinical settings.

Moreover, while the web application interface streamlined the diagnostic process and facilitated rapid image analysis, challenges related to user interface design, accessibility, and integration with existing healthcare systems warrant further attention. Additionally, the discussion delves into the implications of the image processing functionalities and wearable device on patient safety and caregiver support. While these components show promise in enhancing patient security and familiarity, concerns regarding privacy, reliability, and usability need to be addressed to ensure their effectiveness and acceptance by users.

Furthermore, the discussion highlights the broader impact of the developed system on Alzheimer's care, emphasizing its potential to improve patient outcomes, reduce caregiver burden, and enhance healthcare resource utilization. Considerations regarding scalability, sustainability, and ethical considerations are also addressed, laying the groundwork for future research and implementation efforts in Alzheimer's care.

The discussion underscores the significance of the developed system as a promising step towards addressing the multifaceted challenges of Alzheimer's disease. By acknowledging its strengths, limitations, and areas for improvement, the discussion serves as a catalyst for continued innovation and collaboration in Alzheimer's research and care, ultimately striving towards the goal of improving the quality of life for individuals affected by this devastating disease.

CHAPTER 6

SUMMARY AND CONCLUSION

6.1 SUMMARY

The system designed for Alzheimer's disease care presents an innovative and holistic approach to addressing the multifaceted challenges associated with the condition. Leveraging advanced technologies such as deep learning models and image processing, the system offers solutions to diagnosis, patient safety, and caregiver support. By employing Convolutional Neural Networks (CNNs) and TensorFlow Keras, the system effectively analyzes MRI scans, enabling rapid and precise classification of Alzheimer's stages, thus minimizing diagnostic delays and enhancing treatment planning accuracy. The accompanying web application facilitates seamless communication between healthcare providers, expediting the initiation of tailored care plans and improving patient outcomes. Furthermore, the integration of image recognition capabilities enhances patient security by identifying family members and caregivers, thereby mitigating anxiety and confusion in solitary environments. Additionally, wearable devices equipped with emergency features ensure timely intervention in case of emergencies, prioritizing patient safety. Overall, this integrated approach signifies a significant advancement in Alzheimer's care, addressing critical needs while emphasizing efficiency, accuracy, and patient well-being.

6.2 CONCLUSION

In conclusion, the proposed integrated system represents a significant advancement in the realm of Alzheimer's disease care and management. This holistic solution, driven by cutting-edge technologies such as deep learning, image processing, wearable devices, and real-time communication, is designed to comprehensively address the complex challenges associated with Alzheimer's. By employing deep learning, the system expedites and enhances the accuracy of Alzheimer's stage diagnosis, providing healthcare professionals with a valuable tool to reduce diagnostic delays and subjective assessments. The integration of image processing and recognition fosters a reassuring environment for patients through the identification of family members and caregivers, promoting a sense of security

even in moments of solitude. Patient safety is paramount, and the wearable device, equipped with GSM, and LCD, functionalities, ensures continuous monitoring and swift emergency response, instilling confidence in patients and their families. While Alzheimer's remains an incurable condition, this integrated system takes a proactive and compassionate approach, striving to improve patient well-being, reduce diagnostic uncertainties, and offer reliable support mechanisms. Ultimately, this project embodies both innovation and empathy, paving the way for enhanced Alzheimer's care and positively impacting the lives of those affected by this formidable disease.

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BIOMEDICINES (NCBB - 23)**

19th November 2023 Pune, India

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We are pleased to inform you that your paper has been accepted by the review committee for Oral / Poster Presentation at the **NATIONAL CONFERENCE ON BIOTECHNOLOGY AND BIOMEDICINES (NCBB - 23)**

Article Title: "A systemic review on Alzheimer's Care and Disease Diagnosis by Deep Learning Driven Integrated System"

Paper ID: National Conference_2081694

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You are requested to release the payment and mail us the screen of successful payment release with your name and title of paper to confirm your registration.

Sincerely,



Dr. Tara Srivastava
National Conference

APPENDICES

```
#include <LiquidCrystal_PCF8574.h>
```

```
#include <Wire.h>
```

```
#include <SoftwareSerial.h>
```

```
SoftwareSerial gsm_rx_tx(2,3);
```

```
#define gsm_g gsm_rx_tx
```

```
LiquidCrystal_PCF8574 lcd(0x27);
```

```
String latout = "12.872983809717521", lonout = "80.22188102845259";
```

```
//12.872983809717521, 80.22188102845259
```

```
String smsmsg, gpsval, text;
```

```
String usernum = "09445090680";
```

```
#define key1 7
```

```
#define key2 8
```

```
#define buz 12
```

```
int k1_r, k2_r;
```

```
unsigned long lastReminderTime = 0;           // Variable to store the last reminder  
time
```

```
unsigned long lastReminderResponseTime = 0;    // Variable to store the time of last  
reminder response
```

```
unsigned long emergencyAlertTime = 0;         // Variable to store the time of  
emergency alert
```

```
const unsigned long REMINDER_INTERVAL = 600000; // Reminder interval: 10  
minutes in milliseconds
```

```
const unsigned long RESPONSE_TIMEOUT = 30000;  // Response timeout: 30  
seconds in milliseconds
```

```
const unsigned long EMERGENCY_ALERT_INTERVAL = 30000; // Emergency alert
interval: 30 seconds in milliseconds
```

```
void setup() {
  Serial.begin(9600);

  gsm_g.begin(115200);
  LcDSet();

  pinMode(key1, INPUT_PULLUP);
  pinMode(key2, INPUT_PULLUP);
  pinMode(buz, OUTPUT);
  digitalWrite(buz, LOW);
}
```

```
void LcDSet() {
  lcd.begin(16, 2);
  lcd.clear();

  lcd.home();
  lcd.setBacklight(1);
  splash(0, "Alzheimer");
  splash(1, "Monitoring");
  delay(2000);
}
```

```
void loop() {
  setDisp();

  checkReminder(); // Check if it's time for the reminder
  k1_r = digitalRead(key1);
  k2_r = digitalRead(key2);
  if (!k1_r) {
    sendManualEmergency();
  }

  delay(200);
}
```

```
}
```

```
void checkReminder() {  
    // Add your reminder logic here  
}
```

```
void remindUser() {  
    unsigned long startTime = millis();    // Store the initial time  
    unsigned long lastMinuteReset = millis(); // Store the time of the last minute reset  
    while (1) {  
  
        unsigned long currentMillis = millis();  
        unsigned long elapsedTime = (currentMillis - startTime) / 1000; // Convert milliseconds  
to seconds  
        unsigned long minutes = elapsedTime / 60;  
        unsigned long seconds = elapsedTime % 60;  
  
        // Check if a minute has elapsed (60 seconds)  
        if ((currentMillis - lastMinuteReset) >= (30 * 1000)) {  
            // Reset the start time  
  
            sendEmergencyAlert();  
            startTime = millis();  
            unsigned long currentMillis = millis();  
            lastMinuteReset = currentMillis; // Update the last minute reset time  
        }  
    }  
}
```

```
k2_r = digitalRead(key2);  
if (!k2_r) {  
    // Reset all timers  
    lastReminderTime = millis();  
    lastReminderResponseTime = millis();  
    emergencyAlertTime = millis();  
    break; // Exit the while loop  
}
```

```
lcd.setCursor(0, 0);
```

```

    lcd.print("Time:   ");
    lcd.setCursor(6, 0);
    lcd.print(minutes);
    lcd.print("m ");
    lcd.setCursor(10, 0);
    lcd.print(seconds);
    lcd.print("s");

    splash(1, "Safety Reminder");
    digitalWrite(buz, HIGH);
    delay(50);
    digitalWrite(buz, LOW);
    delay(10);
}
}

void sendManualEmergency() {
    digitalWrite(buz, HIGH);
    splash(0, "Emergency");
    splash(1, "Sending SMS");
    // Send emergency alert via GSM
    alert("Manual emergency");
    digitalWrite(buz, LOW);
}

void sendEmergencyAlert() {
    splash(0, "Emergency!");
    splash(1, "Lost response");
    // Send emergency alert via GSM
    alert("Lost emergency");
}

void setDisp() {
    unsigned long currentMillis = millis();

```

```
    unsigned long elapsedTime = (currentMillis - lastReminderTime) / 1000; // Convert  
    milliseconds to seconds
```

```
    unsigned long minutes = elapsedTime / 60;
```

```
    unsigned long seconds = elapsedTime % 60;
```

```
    lcd.setCursor(0, 0);
```

```
    lcd.print("Time:   ");
```

```
    lcd.setCursor(6, 0);
```

```
    lcd.print(minutes);
```

```
    lcd.print("m ");
```

```
    lcd.setCursor(9, 0);
```

```
    lcd.print(seconds);
```

```
    lcd.print("s");
```

```
    if (minutes == 1) {
```

```
        remindUser();
```

```
    }
```

```
    // Add your additional display logic here
```

```
}
```

```
void splash(int line, String message) {
```

```
    lcd.setCursor(0, line);
```

```
    lcd.print(message);
```

```
    delay(1000);
```

```
    lcd.clear();
```

```
}
```

```
void alert(String msg) {
```

```
    splash(1, msg);
```

```
    gpsval = " https://maps.google.com/maps?q=";
```

```
    gpsval += latout;
```

```
    gpsval += ",";
```

```
    gpsval += lonout;
```

```
    smsmsg = "";
```

```
    smsmsg += msg;
```

```
    SendSmS(username, smsmsg, gpsval, "Sending SMS.....");
```

```
}
```