

IoT Assistant-Based Secured System for Alzheimer's disease.

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ABSTRACT:

In many countries, the rise in the count of Alzheimer's disease (AD) is an indication that concerns. In order to prevent, detect and help people with AD, new techniques are required. These changes result in a decline in thinking ability, a type of intellectual capacity that is severe enough to interfere with daily life and independence. Relationships, emotions, and conduct are all impacted. When they lose track of familiar individuals or their connections to them, those with Alzheimer's disease are put in an awkward predicament. They tend to remain silent and avoid interacting with others on days when they are always uncomfortable, which is bad for their mental health. That makes it difficult for the patient and the guardians to stay in touch with one another. In order to protect the AD patient, the goal of this work is to build a working model for a system that provides psychological technical assistance and ensures secure transfer of data which may be inspected by a family member. The created transportable prototype can divide the identified images into two groups, including family and non-family persons, by using a Convolutional Neural Network (CNN). This framework combines the use of hardware with headphone-based IoT communication.

I. INTRODUCTION:

Alzheimer's disease is just one of the many distinct medical diseases that fall under the umbrella term of dementia. Abnormal brain alterations are the root cause of the disorders referred to as "dementia" in general. These alterations cause a loss in intellectual capacity known as reasoning ability is severe enough

to affect daily functioning and independence^[6]. They also have an impact on relationships, feelings, and behavior.

Alzheimer's disease is a rare symptom of ageing. The main risk factor for dementia in older persons is age, and those over 65 make up the bulk of cases^[7]. Younger-onset Alzheimer's is the term used to describe Alzheimer's disease that worsens in those under the age of 65. Because dementia is a chronic condition, the symptoms progressively worsen over a period of several years. As Alzheimer's disease is in its later stages, people lose their ability to speak and respond to their environment. Alzheimer's disease initially causes very little memory loss^[8]. Yet, a person with the condition often lives for up to eight years after being diagnosed.

The Internet of Things refers to the network of physical items, or "things," which are fitted with sensors, algorithms, as well as other capabilities for both the purpose of linking and exchange information with other equipment and systems over the internet (IoT). These technologies range from basic household appliances to sophisticated machinery. IoT is now recognised as one of the most important 21st-century technologies. In today's networked environment, digital logic can record, monitor, and alter every contact between connected entities. Physical and digital items become popular, yet they collaborate.

II. LITERATURE SURVEY:

[1] **Author:** Zaven S. Khachaturian.

The development of research activities is significantly impacted by the early and precise recognition of Alzheimer's disease (AD). An

education programme for starting research to address the challenges of order to diagnose AD in its early stages was co-sponsored by the National Institute for Mental Health. The goal of the conference was to emphasise the most pertinent areas for scientific enquiry in addition to the underlying practical and clinical challenges that affect how rapidly AD diagnoses are made.

[2] Author: Shervin Emami

One of the greatest and most efficient uses of image processing and algorithm-based understanding, face identification and recognition has evolved from an unknown to a well-liked field of computer vision research. Because it is widely believed that improvements to computer image processing as well as research will offer new insights into how our brains function and vice versa, computer vision is not just a computer science field of study. The author has recommended to create a program that would grant user access to a certain device based on a thorough analysis of a person's facial features out of given sample and interest in the subject. The.NET framework from Microsoft and the OpenCV computer vision open-source project from Intel will be used to create this application.

[3] Authors: SikandarKhan et. al

Back propagation neural layers, faster RCNNs, single shot detection and region-based convolution systems are a few of the most well-liked object recognition algorithms. The special feature is that a camera placed in the classroom will capture pictures twice, once at the beginning and once at the end, to verify that pupils have attended the entire lesson. YOLO V3 would first count the pupils in a picture, then identify known and unknown faces, making different spreadsheets, and sending an email to students, parents, and faculty at the end of the month. The system's real-time solution for counting and identification works effectively.

[4]Authors: Max Smith-Creasey et. al

Based on retrieved face traits, the system verifies a user and keeps track of the validated face but only attempts to re-authenticate when it is lost. This allows our approach to quickly identify impostor

usage and close attack windows that are present in periodic authentication schemes. Additionally, a reliable existing detection element to the system that can recognize printed faces as well as face recordings is included. In order for the results to reflect genuine situations, we also generate the very first dataset comprising facial videos taken from portable devices during various real-world activities.

[5] Authors: JayanthVadlapati et. All

The method is frequently employed for recognizing real-world objects, including human faces and other objects. As a conclusion, a person from a photograph can be identified using such methods. The trained model is used to distinguish people wearing masks by applying facial recognition modules from the extensive library of libraries available in Python. As 50 percent of the facial characteristics are lost when masks are used, it is essential to design a method for recognizing faces in this way. Biometric technology, video surveillance, and other fields use this particular face detection method. Thus, it is crucial to boost security and efficiency while quickening recognition.

II. PROPOSED METHODOLOGY:

Among distinct illness that fall under the general category of dementia is the Alzheimer's disease. Relationships, emotions, and conduct are all impacted. The main risk factor for Alzheimer's disease in elderly adults is aging, and those above 65 represent the majority of diagnoses. As Alzheimer's disease is in its later stages, people lose their capacity to communicate and adapt to their surroundings. Alzheimer's disease originally causes very little memory loss. Yet, a person with the condition often lives for a maximum of eight years after being diagnosed. The prevailing system according to The US National Library of Medicine states that the typical range for a human body temperature seems to be between 97F (36.1C) and 99F (37.2C) ^[9]. As a result, the camera can measure a material's temperature with a precision of ± 0.006 0.2C. But, our camera cannot detect a human personality if indeed the temperature is greater than

99F (37.2C). Currently, this method just uses software output.

The proposed system makes use of mobile communication technologies and the Internet of Things (IoT) (MCT). The internet of things, or IoT, is a network of connected computers, mechanical and digital machinery, things, or people that have been given unique identifiers (UIDs) and the capacity to transfer data across a network without necessitating human-to-human or human-to-computer interactions. Numerous internet connected devices that are part of the ecosystem receive, transmit, and act on data they receive from their environment via embedded systems are present [10]. connecting to an edge device, such as an IoT gateway, that either delivers information to a cloud for analysis, IoT devices transmit the sensor data they collect. Although individuals can engage with the devices to set them up, give them instructions, or retrieve the data, the gadgets execute the remainder of the job without their assistance. Mobile communications networks as well as other related disciplines use mobile technology widely. It uses a network structure that allows numerous transmitters to send data simultaneously on a single channel ^[11]. Many users can use a specific frequency on this network since it reduces the possibility of enhancing between two or more sources. Tens or even hundreds of layers can indeed be incorporated in a convolutional neural network, and each layer can be trained to classify various features of an image. Each training image is processed to filters at multiple configurations, and the outcome of each preprocessed image is taken as the feed to the following layer. Beginning with relatively basic properties like brightness and borders, the filters can get more complicated until they reach characteristics that clearly identify the object. Global system for mobile communication (GSM) is a cellular modern digital standard which is widely known. The GSM certification group was founded in 1982 to develop standards for a 900 MHz pan-European cellular mobile radio system. The goal of the GSM usually consisting was to establish an integrated European mobile telephone standard.

For fetching the real time datasets, the Cascade Classifiers are used. This system as depicted in Fig.1, is written in Python and Embedded C,

detects the photo of a person and analyses it being a family member if loaded as a dataset. The caretaker of the Alzheimer's disease receives an alert message for the uploaded mobile number when an unknown person is detected through the webcam. Through this prototype, an accuracy of 89% was obtained in predicting the person's face from a sample dataset captured from the user.

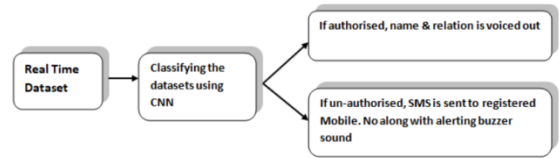


Fig.1. Working flow of the proposed system

III. IMPLEMENTATION:

The Secure IoT Assistant is based on CNN, which detects the faces and predicts them as family member depending on the diseases dataset provided. The real time photos are collected using Webcam from the relations of the Alzheimer's disease suffering person and stored as the dataset. It is then tested with the faces of real person predicting them authorized or unauthorized.

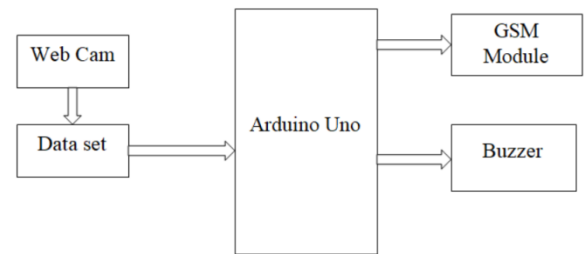


Fig 2: Proposed prototype

As shown in Fig.2, The overall proposed system is classified into threemodules

- A. Arduino Uno and it's setup
- B. GSM Module and it's Configurations
- C. Software Implementation on testing the real time dataset.

A. ARDUINO UNO AND ITS SETUP.

The board for the Arduino Uno shown in Fig.3, combines a microcontroller with all the essentials to help developing and debugging applications simple. A microcontroller board termed the Uno is built on the ATmega328P. It has a 16 MHz quartz crystal, 6 analogue inputs, 14 digital input/output pins, a USB port, a power jack, an ICSP header, and a reset button. It includes with everything needed to operate the microcontroller; to get started, just use a USB cable for connecting it to a computer, or an AC-to-DC adapter to power it. A 2.1mm core plug is capable of helping connect the adapter by inserting it into the circuit board's power supply. Battery cables may be placed into the POWER connector's GND and Vin pin headers. The board runs off of a 6 to 20 volt external source. The 5V pin, however, may supply less than five volts if supplied with less than 7V, and the circuit may become unbalanced. The voltage regulator would overheat and injure the board if more than 12V is used. The suggested range is between 7 and 12 volts.

Part	Specification
Arduino Uno	Microcontroller: ATmega328P, Operating voltage: 5V
Breadboard	Number of rows: 2, Number of columns: 30
Jumper wires	Gauge: 22 AWG, Length: 3 to 6 inches
LED	Voltage: 2V to 3.3V, Current: 10mA to 20mA
Resistor	Resistance: 220 Ω to 10k Ω
Capacitor	Capacitance: 1 μ F to 100 μ F
Push button	Contact resistance: <50m Ω , Operating force: 100g to 300g
Potentiometer	Resistance: 10k Ω to 100k Ω , Tolerance: \pm 10%
Servo motor	Voltage: 4.8V to 6V, Torque: 1.5kg/cm to 15kg/cm
Stepper motor	Voltage: 5V to 12V, Steps per revolution: 200
DC motor	Voltage: 3V to 12V, Current: 100mA to 300mA
Motor driver module	Maximum current: 2A to 10A, Maximum voltage: 12V to 24V

Table 1: Parts of Arduino and its specification

The Arduino Software allows the programming of the Uno (IDE). From the Tools > Board menu, choose

- For Rev1 boards, solder the jumper on the board's rear and then reseat the 8U2.
- The 8U2/16U2 HWB line is pushed to ground by a resistor on Rev2 or later boards, making it simpler to enter DFU mode.

A fresh firmware can always be updated using Atmel's FLIP software for Windows or even the DFU programmer for Mac OS X and Linux. Instead, apply an outside programmer and the ISP header (overwriting the DFU boot loader) ^[13]. In addition, some pins have specialized functions. Serial: 0 (RX) and 1 (TX) is used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip. External Interrupts: 2 and 3 are pins that can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the `attachInterrupt()` function for details. PWM: 3, 5, 6, 9, 10, and 11 provides 8-bit PWM output with the `analogWrite()` function. SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK) pins support SPI communication using the SPI library. LED: 13. has a built-in LED driven by digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off. TWI: A4 or SDA pin and A5 or SCL pin supports TWI communication using the Wire library.

The Atmega8, 168, and 328 have an identical mapping. With the `pinMode()`, `digitalWrite()`, and `digitalRead()`

functions, each of the Uno's 14 digital pins can be employed as an input or output^[14]. Every pin includes a 20–50k ohm internal pull-up resistor that is by default disconnected and can transmit or receive 20 mA within optimal work practices. Any I/O pin's maximum current consumption can't be reached in order to safeguard the microcontroller against hard harm.

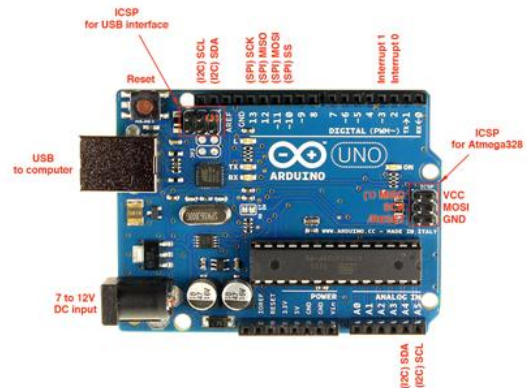


Fig 3: Arduino Board

B. GSM MODULE AND IT'S SETUP.

GSM offers suggestions rather than demands. The GSM specifications have to get into great detail that defines the functionalities and interface specifications, but they skip off hardware. The goal is to place as little constraints on the designers as feasible while yet enabling the users to buy materials from various sources. The switching system (SS), base station system (BSS) and operation and support system (OSS) are the three main systems that make up the GSM network. The basic GSM network elements are shown in below fig 4.

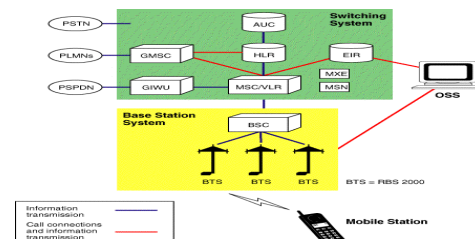


Fig 4: GSM Network Elements

Part	Specification
GSM Module	Frequency bands: 850/900/1800/1900 MHz, SIM card slot, serial communication
Antenna	Frequency range: 824-960 MHz, 1710-1990 MHz, 50 Ohm impedance, SMA connector
SIM Card	Type: Mini SIM or Micro SIM, Storage capacity: 64KB to 256KB
Power Supply	Input voltage: 100-240V AC, Output voltage: 5V DC, Output current: 1A to 2A
Voltage Regulator	Input voltage range: 4.5V to 40V, Output voltage: 1.2V to 37V, Output current: 1A to 5A
Level Converter	Input voltage: 1.8V to 5V, Output voltage: 3.3V or 5V
Resistors	Resistance: 220 ohms to 10k ohms
Capacitors	Capacitance: 1 μ F to 100 μ F
Diodes	Types: 1N4007, 1N4148, or equivalent, Maximum reverse voltage: 50V to 1000V
Transistors	Types: NPN or PNP, Maximum voltage: 30V to 60V, Maximum current: 500mA to 1A

Table 2: GSM Parts and its Specification

A wireless modem that runs with a GSM wireless network is known as a GSM modem. Similar like a dial-up modem, a wireless modem operates. Generally, a serial or USB cable is used to connect an external GSM modem to a computer. A laptop may utilize a GSM modem that is in the format of a PC Card or PCMCIA Card. It must be installed into a particular laptop's PC Card or PCMCIA Card slots [15]. Like a GSM cellular telephone, a GSM modem demands a SIM card from a cellular carrier in for operation. Attention (AT) commands are executed by software to regulate modems. A similar set of basic standard AT commands is accepted by dial-up and GSM modems equally. A GSM modem works similar to a dial-up modem. GSM modems provide an enhanced level of AT commands instead of the

standard AT commands. The GSM specifications define these enhanced AT instructions. The enhanced AT commands are used to read, write, and delete SMS messages. It also keeps track of signal strength, the battery's power level and charging status. Approximately six to ten SMS messages may be transmitted by a GSM modem every minute, meaning a relatively low rate.

The expense of GSM over the other communication systems will rely on if a particular application demands one or more of the features. Data for every transaction must not exceed about three lines. Extremely minute but crucial commercial details can be transmitted through SMS messaging, which is usually free internationally and costs even less than a local phone call. Faxes and significant amounts of data may additionally be transmitted using GSM, although the cost will be on level with or higher than that of landline networks. A buzzer or beeper is a strong sign that is generally electronic and is found in cars, home appliances including radios and game shows. Several industries employ piezo buzzers as a method of audible recognition or alert. The requirements for the most complex audio warning applications could be fulfilled by this product family, that extends in size from absolutely tiny 4 mm SMT buzzers to heavier, high decibel versions.

C. SOFTWARE IMPLEMENTATION ON TESTING REAL TIME DATASET

The software part for the Assistant system is coded using Python, Embedded C and Arduino IDE. To capture the real time data, coding is done in python OpenCV to capture the face and its expression through webcam [17]. The default frontal face detections are loaded in a .xml file which could be easy for a edge to edge facial scan. The dataset folder and its sub folders are created and called which includes setting of path for the dataset and its sub data. The real photos are taken n loops making the webcam read the faces by VideoCapture() and webcam.read() functions respectively. VideoCapture is a function in the OpenCV library that allows you to capture video frames from a camera or a video file. Cascade filters, on the other hand, are a type of object detection algorithm that uses Haar cascades to detect objects of interest in an image or video frame. To use cascade filters with VideoCapture, Initialize the VideoCapture object to capture frames from a video

source. Load the cascade filter file using the `cv2.CascadeClassifier()` function. Loop through each frame captured by the `VideoCapture` object. Convert each frame to grayscale using `cv2.cvtColor()`. Use the `detectMultiScale()` method of the cascade filter object to detect objects in the grayscale frame. Draw rectangles around the detected objects using `cv2.rectangle()`. Display the resulting frame with the detected objects.

To run and voice out the relations, Tkinter is a Python GUI (Graphical User Interface) library that provides a set of tools to create and manipulate windows, buttons, labels, textboxes, and other graphical elements in a graphical application. The `ttk` module in `tkinter` provides additional widgets and functions that are not available in the standard `tkinter` library, such as themed widgets, which can be customized to match the look and feel of your operating system. By using `"from tkinter import ttk"`, you can access all the widgets and functions provided by the `ttk` module, such as `ttk.Button`, `ttk.Entry`, `ttk.Treeview`, and `ttk.Notebook`, among others. It's likely that part of a larger program that uses various libraries to interact with hardware and provide user feedback. The `if` statement is likely used to check if the person trying to access a system is authorized and then perform certain actions based on the result.

A serial communication port between a Python program and an Arduino board using the `PySerial` library is used. This specifies the serial port to use for communication, the baud rate, which is the rate at which data is transmitted over the serial connection and the timeout period for the serial connection in seconds^[16]. Once the serial port is opened, you can use the `arduino.write()` method to send data to the Arduino board and `arduino.read()` method to receive data from it. The code snippet provided is a Python `if` statement that checks if the variable is equal to the string value. If the condition is true, the code displays a message box using the `pymsgbox` library with a timeout of 1000 milliseconds (1 second) that says "Thank You" and has a title of "Success!!". It also sends the character 'a' to an Arduino board using the `arduino.write()` method and prints the message "Authorized Person" to the console. The `pytsx3` library is used to convert the text into speech and plays it using the `engine.say()` and `engine.runAndWait()` methods which pauses the program execution for 2 seconds using the

`time.sleep()` method.

In addition to a word processor for writing software, a message area, a textual console, a toolbar with buttons for frequently used operations, and a number more menu, the Arduino Integrated Development Environment, commonly known as the Arduino Software (IDE), is also accessible. In order to load codes and communicate with them, it links to the Arduino hardware. An AT command used for sending an SMS message through a GSM modem. The command is in the form of a string that is sent to the modem or module through a serial communication port. AT is the standard prefix for all AT commands and indicates that the command is for the modem or module. `+CMGS` is the specific command for sending an SMS message. `"="+91 ph.no"` is the phone number of the recipient of the SMS message. The backslashes and double quotes are included in the string to properly format it for the AT command and `\r` is a carriage return character that indicates the end of the AT command. Together, the command tells the GSM modem or module to send an SMS message to the phone number specified in the command.

IV. EXPERIMENTAL RESULTS:

IoT face recognition assistant for Alzheimer's disease using Arduino and GSM module can be used to compare authorized and unauthorized persons. The system can be programmed to recognize the faces of authorized persons such as family members and caregivers and send an alert if an unauthorized person is detected.

Authorized Persons:

1. Access to patient information: Authorized persons can be granted access to patient information, medication schedules, and other important details.
2. Ease of communication: Family members and caregivers can be easily contacted in case of emergency or any changes in the patient's condition.
3. Enhanced safety: The system can detect and alert authorized persons if the patient wanders away or experiences any unusual activity, improving safety.

Unauthorized Persons:

1. Potential privacy concerns: The system may

raise privacy concerns if it records and stores data about unauthorized persons without their consent.

2. False positives: The system may falsely identify some people as unauthorized, leading to unnecessary alerts and inconvenience.
3. Safety concerns: If an unauthorized person gains access to the patient, it can lead to safety concerns for the patient.

Overall, using IoT face recognition assistant for Alzheimer's disease using Arduino and GSM module to compare authorized and unauthorized persons can provide enhanced safety and care for Alzheimer's patients, while also raising potential privacy and accuracy concerns. It is important to consider the potential drawbacks and limitations of the technology when implementing it.

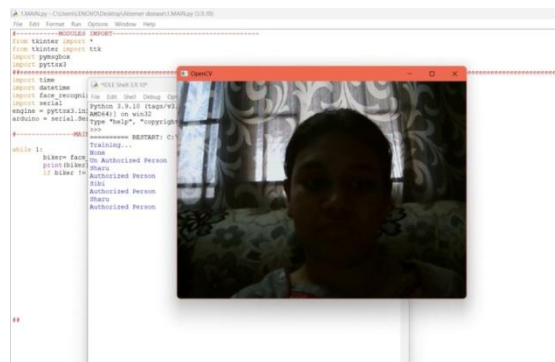


Fig 5a Identifying the authorized person along with their relation

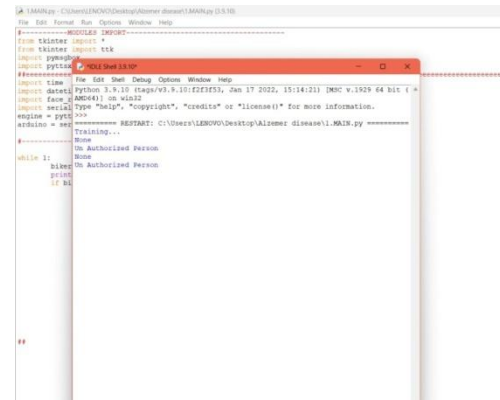
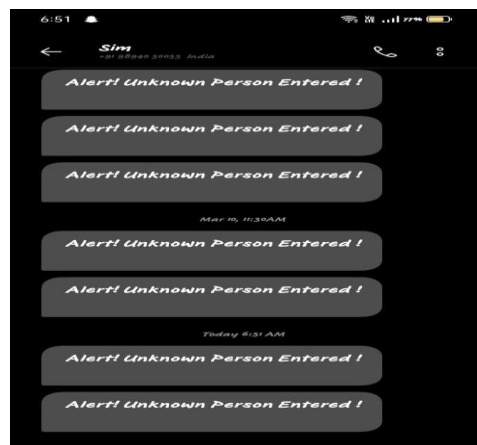


Fig 5b Alerting with the buzzer sound for the unknown person entered

This output shown in Fig.5a shows the message as “Thank you” and “Success” along with person name and their relation. The name of the person and their relation is also converted from text to speech. As shown is Fig.5b the “Unknown person entered” message was sent to the registered phone number and buzzer sound was high to alert the surroundings. When the loop level reached 40 the accuracy of predicting the face the accuracy graduated up to the level of 86%. When the loop level reached 90 the accuracy of predicting the face the accuracy graduated up to the level of 89%. The accuracy mainly depends on the light facilitation and brightness.

V. CONCLUSION AND FUTURE SCOPE:

In conclusion, an IoT face recognition assistant for Alzheimer's disease using Arduino and face recognition technology can be a useful tool for improving the safety and care of Alzheimer's patients. The system can provide personalized reminders, real-time monitoring, and enhanced independence for patients. However, it is important to consider the potential privacy concerns, accuracy issues, and cost associated with implementing this technology. Overall, if implemented responsibly and with proper consideration of these factors, an IoT face recognition assistant for Alzheimer's disease using Arduino and face recognition technology can be an effective solution for providing improved care for Alzheimer's patients. The main goal of this project is to examine and predict various relations of the Alzheimer's Patient in order to help them mentally giving them a support, confidence and to see how this

approach may be improved in the future to attain greater accuracy. The survey covers over the elderly stages of Alzheimer's Patient to help them hearing the name and relation with the person with a help of Arduino and GSM module setups.

The future scope of IoT face recognition assistant for Alzheimer's disease using Arduino and face recognition technology is vast. Some of the potential future developments in this field include:

1. Integration with wearable devices: Wearable devices such as smartwatches and fitness trackers can be integrated with IoT face recognition assistant for Alzheimer's disease to provide even more personalized care and monitoring.
2. Improved accuracy: Advancements in facial recognition technology can lead to even more accurate identification and tracking of Alzheimer's patients, reducing the risk of false positives or false negatives.
3. Artificial Intelligence integration: The integration of artificial intelligence can enable the system to learn and adapt to the

patient's behavior, improving the accuracy of reminders and alerts.

4. Expansion to other neurodegenerative diseases: Similar technology can be developed and customized to assist patients with other neurodegenerative diseases such as Parkinson's disease and Huntington's disease.
5. Cloud integration: Integration with cloud technology can allow for remote access and monitoring of patient data, enabling doctors and caregivers to provide more effective and timely care.

Overall, the future scope of IoT face recognition assistant for Alzheimer's disease using Arduino and face recognition technology is promising, with potential for continued advancements and improvements to provide better care for patients and caregivers alike. On a future development, the unauthorized person's face would be stored in a separate file to have it as a proof of confirmation. Furthermore, the classifications of dataset could also be improved to acquire higher accuracies.

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