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A smart wearable and assisted system for Alzheimer's Patients

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ABSTRACT

Alzheimer's type dementia is a deadly, progressive neurodegenerative disorder marked by declines in cognition and memory, gradual impairment of daily living functions, and a variety of neuropsychiatric symptoms. In terms of human suffering and expenses, Alzheimer's disease imposes a tremendous burden on the entire world. Around the world, it is the most typical cause of dementia. Devices or systems that "increase, maintain, or improve skills of individuals with cognitive, physical, or communicative limitations" are collectively referred to as "assistive technology." The present study aims to design and implementation a prototype of a wearable technology that aids patients to act normally without obstructing their movements and lifestyle in order to improve the quality of life for people with Alzheimer's disease and decrease the load on their careers. The wearable smart glass with camera designed by artificial intelligent (AI) application used by the patient to Ability to identify faces and emotions through face and emotional recognition algorithms. A motion processing unit sensor was used to make the bracelet, global positioning sensor module (GPS),and microcontrollers. This unit is supported by an (IoT) platform for communication with the patient from anywhere by the caregiver. The proposed assistive prototype capability in relation to its cost allow us to reach the conclusion that it accomplishes the purpose for which it was intended by being easy to use, reasonably priced, portable, and available to a wide range of Alzheimer users.

Keywords
Alzheimer's disease; artificial intelligent; global positioning sensor; internet of things technology.

1 Introduction

A clinical syndrome known as dementia is characterized by generalized cognitive decline, memory impairment, and one additional cognitive impairment that severely impairs daily living activities [1]. Alzheimer's disease-related dementia (DAT) is a deadly neurological disorder that affects cognition functions over time, including memory, attention, judgment, understanding, language, and leads to severe dementia [2]. Alzheimer's disease (AD) is a multifactorial neurodegenerative disorder which has a poor prognosis. It is the leading global cause of dementia [3]. It is one of the main reasons why elderly people have cognitive problems [4].
There were an estimated 46.8 million individuals living with dementia globally in 2016; according to the WHO, someone gets dementia every three seconds. This number will nearly double every 20 years, reaching 75 million in 2030 and 131.5 million in 2050 [5]. In this age group, it ranks as the fifth leading cause of death. According to the World Health Organization, the prevalence will increase fourfold over the following ten years, reaching 114 million cases by 2050 [6].

According to statistics gathered globally, women are more likely than men to get AD, and the risk rises even further with age [7]. 70% of them require caregiver help in order to live independently [8]. Both amnestic and non-amnestic forms of the first and most evident cognitive loss associated with AD dementia are recognized. Amnestic presentation refers to the difficulty to retrieve new information. Non-amnestic symptoms include executive dysfunction, language impairment, and visual-spatial impairment [3].

A significant part of this fiscal and social load that impacts not just public budgets but also the delivery of healthcare services is long-term care in nursing homes and other health care facilities [9]. Caregiving also has a bad influence on the employment, health, and income of many caregivers. Technological innovation is probably going to be a crucial part of the solution to this new global environment.
Recent innovation in artificial intelligence (AI), pervasive and ubiquitous computing (PUC), mobile computing, and robotics connected with new developments in wireless networking and human-computer interaction have opened the

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prospects of transforming dementia care through intelligent innovation [9]. The power of Internet of things (IoT) has upended several industries' established business models, particularly the healthcare sector. The transition of healthcare from a case-based paid provider to a value-based care service has been made possible by the emergence of linked sensors and devices as well as the advent of data analytics, wireless technology, and cloud computing. IoT-enabled healthcare applications are these value-based care solutions [10].

Another well-known field of computer vision and pattern recognition that has attracted substantial research over the past few decades is face recognition [11]. When used generally, face recognition refers to associated technologies for creating facial recognition system. It includes face detection, face position, identity recognition, image preprocessing, etc. [11]. several local image feature extractions, including speed-up robust features, local binary pattern histogram (LBPs), scale invariant feature transform (SIFT), histograms of oriented gradients (HOG), fully affine SIFT, and Gabor features are generally employed in image matching, object detection, and face recognition [12-13]

In order to enhance engagement of AD patient and social participation, we designed a smart glass that uses a face recognition algorithm through the AI to sort some data about a group of regular people (name, relation to the patient) using IOT, that often interact with the patient. Connected with braces that has GPS which helps the caregiver to detect the place of the patient using a platform app set up on the caregiver's smartphone and headphone to tell the AD patient the person's name.

2 Method

Easy usage, compactness, and invasiveness are crucial considerations when it comes to healthcare and the elderly because they greatest control the technology's acceptance aspects. The current proposal design uses two units of wearable devises by the patient, glasses with a camera and headphones and the other unit is the bracelet, as shown in Figure1, which allows users to see and interact with people in front of them without any abnormality in forgetting them through face recognition algorithm with AI and dealing with the information received in a smartphone application like name of the person and his/her relativity to the patient. This will provide the ability of people to practice their normal activities in the most frequent places they go to with the same people.

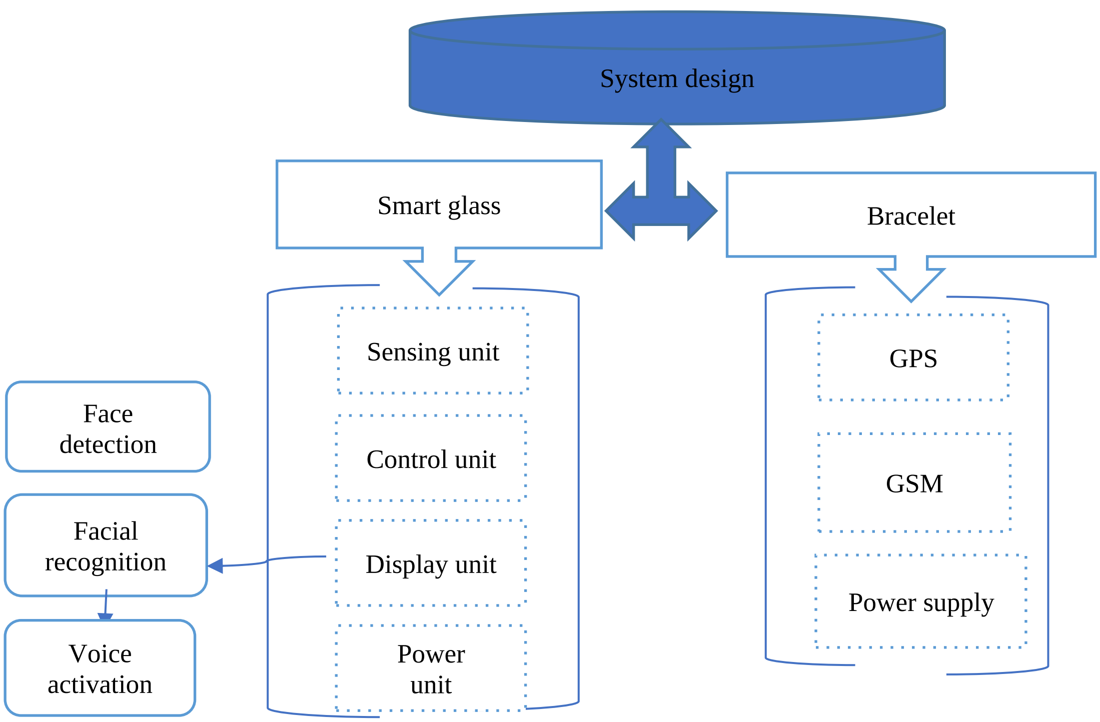

Figure 1 The proposed design

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3 Methodology

1. The smart glasses

The glasses unit was built from four units: the power unit, the display unit, the control unit, and the sensing unit. The smart glass with camera is coupled with voice activation connected to headphone.

1.1 The sensing unit

By opting for the Raspberry Pi 3B(RPi3), which may be deployed and operated without any additional hardware in any setting. Using raspberry Pi 3B for live recognition by capturing the images then sends them to the Microcontroller. To preserve the face and emotional recognition database locally, the complete date and connection with the internet server can be performed easily with the internet server can be performed with ease in local memory to save the face and emotional recognition database locally in the case of communication is lost. Using the 1080p, 720p, and 480p compatible Pi camera module which supports the RPi3B's 5MP color camera, with 3g wight as Shows in figure 2.

Figure 2 Raspberry Pi Camera connection

1.2 The control unit

Face detection and recognition is one of most relevant applications of image analysis. Humans constantly recognize visual patterns, and our eyes are how we take in visual data. The brain interprets this information as meaningful ideas. Whether it be a picture or a video, for a computer it is a matrix of numerous pixels.

1.2.1 Proposed face recognition technique

The steps involved in the proposed face recognition technique are summarized in figure 3,

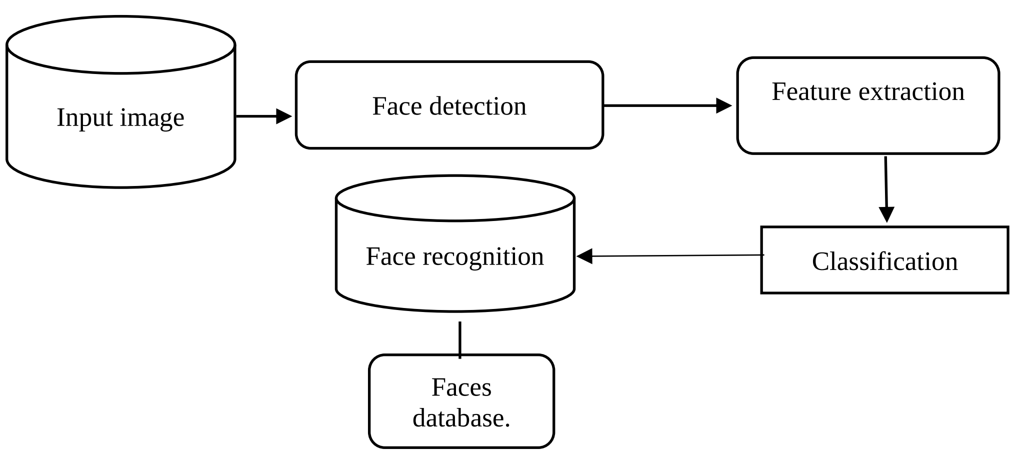

Figure 3 Face recognition process.

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Face detection is implemented as a binary pattern classification task by face detection algorithms. Each input image is segmented into blocks, each of which is then converted into a feature [14]. One of the strongest texture descriptors is the local binary pattern (LBP) operator, which has found extensive use in numerous applications. It has been demonstrated to be highly discriminative, and its main benefits are its invariant to monotonic changes in gray level and high accuracy when it is applied to challenging image analysis tasks [14]. In 2D texture test, the LBP approach is frequently employed. A non-parametric 3x3 kernel called the LBP operator characterizes the local spatial pattern of a picture.
It sets the incentive to 1 for every neighbor pixel that is better notable than or equal to the middle pixel and to 0 for all other neighbors. After that, it reads the updated pixel values, which can now be either zero or one, in a clockwise direction and constructs a twofold number [15], It then converts the twofold number into a decimal number, and that digit represents the new middle pixel calculation. Each pixel in a square receives this procedure. At that stage, each square is converted into a histogram, giving us a single histogram. Finally, it joins these square histograms to create a one-element vector for a single image that has all the intriguing details [15].

2.1.2.1 Feature extraction

Local binary pattern histogram (LBPH) feature distributions are retrieved from the face image separated into a number of regions which are radius, grade x, neighbors and grad Y [14]. After that, concatenation is used to create an upgraded feature vector. The scanning windows are divided into non-overlapping cells with the size 16×16, as the base window size to start evaluating these features in any given image [16]. A custom classifier is trained using features from the face and non-face classes. The classifier will then be able to determine whether the sample is a face or not given a fresh input image. With a Haar classifier, this can be implemented. In an identification window, a Haar include combines the pixel powers in each region and calculates the contrast between these aggregates while taking into account surrounding rectangular districts. The Haar-like classifier classifies the image in a rectangular box, making it easy to evaluate the feature in the rectangle area of the box around the face. As a result, it enables the extraction of features from the rectangles in the integral image [17].

1.3 The display unit

Face Recognition is a technique used to identify people by comparing a recognized and handled face to a database of recognized countenances. Face Recognition is the challenge of accurately recognizing a face that has already been identified and dealing with the distinctive facial traits of people [17]. Face Recognition is the challenge of accurately recognizing a face that has already been identified and dealing with the distinctive facial traits of people. The processed and detected face is compared to a database of recognized faces to determine who that person is.

In this step, the algorithm is already trained. Each histogram produced works as a representation of one of the training dataset's images. So, using the Euclidean distance to compare the histograms, we may identify the image that matches the input image by simply comparing two histograms and returning the image with the closest histogram [18]. Apply a threshold and "confidence" to determine automatically whether the algorithm correctly identified the image.
By collecting additional pictures of each individual, especially from various points of view and lighting aspects, we can increase the face recognition accuracy by using more input images—at least 30 for each participant. The implementation of the idea makes advantage of OpenCV features. OpenCV's primary benefit is that it supports multi-platform systems. The OpenCV package's algorithms are simple to comprehend and capable of producing accurate results in the given situation. [15]. Since 2002, Intel's open source framework known as OpenCV has made it possible to do facial recognition quite effectively and consistently. [15].

1.4 the power unit

Power requirement main and direct power source: For our wearable technology its recommended to use small size, rechargeable and effective batteries, so that our selection was the $5V$ Lipo Battery $10000mah$ to get the desired voltage and current for microcontroller (Raspberry pi). So, in normal usage, this battery makes our microcontroller run for about 30 hours.

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2 Bracelet

The smooth design of the bracelet, which is made of waterproof material and is the right size to include all components with specific coin batteries to track patient location, has vital notification display, GPS tracking (Neo-6M), outdoor RFID indicator, and GSM technology embedded in it. The location is sent to the caregiver.

GPS periodically detects the patient's location's longitude and latitude and its direction and at which speed (he/she) moves, figure 4 shows the Ground Pin and needs to be connected to GND pin on the Arduino. RxD (Receiver) pin is used for serial communication. TxD (Transmitter) pin is used for serial communication. VCC supplies power for the module. The module receives power from VCC. It can be directly connected to the Arduino's 5V pin [18].

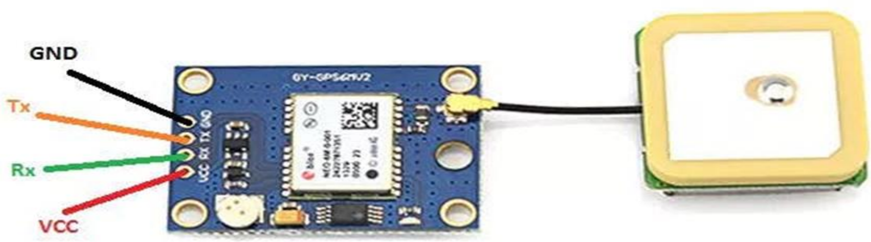

Figure 4 (Neo-6m) GPS

The name of the microcontroller used in the proposed system is, Arduino Nano 3.x(figure 5), with patch antenna having -161 dBm sensitivity [19], and a SIM800L GSM cellular chip from SimCom (figure6,7). A compact cellular module called the SIM800L supports GPRS transmission, SMS sending and receiving, and making and receiving voice calls.

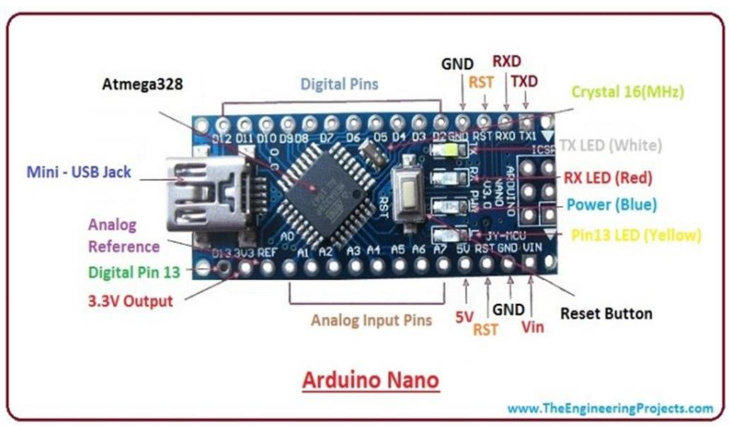

Figure 5 Arduino Nano

Figure 6 SIM800L GSM

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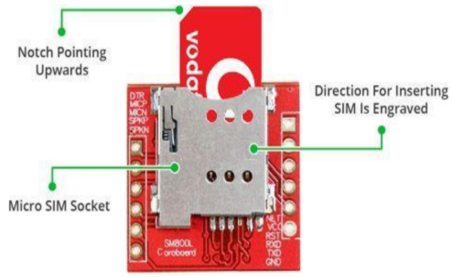

Figure 7 SIM800L Module Micro SIM Socket

Since the chip's operational voltage ranges from 3.4V to 4.4V, direct LiPo battery supply is a perfect fit for it. As a result, incorporating it into projects with limited space is an excellent choice. The implementation of the system will be made easier by IOT technology via smartphone applications, which will also provide the location of the patient in real time.

3 Results

The responsibility of caring for people with Alzheimer's disease or other forms of dementia is challenging. Our smart assistance device has made technology accessible to elders in a smart, familiar, and friendly way. The assistive device responds to a demand that was observed and supported by our ethnographic research with elders and their caretakers. We value patient satisfaction and the glass's 6 grams weight equal. Figure 8 shows 3D printing of the proposed prototype smart glass with all assistive components.

Figure 8 3D printing and design of the smart glass

This remarkable "Open-Source Computer Vision Library" was used for this project. The programs, which are implemented in Python as shown in figure 9, With sub-windows in the rectangular boxes, faces could well be automatically detected, and their features identified. The technique is evaluated using the OpenCV package on both a normal picture database and live images.

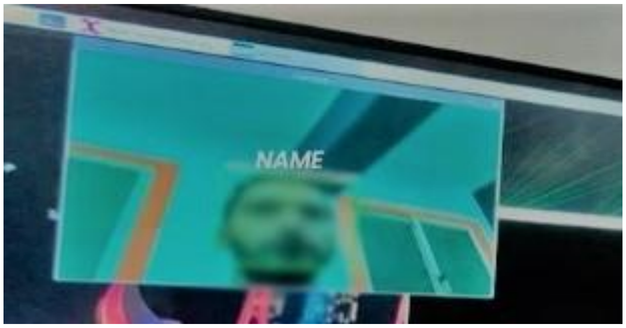

Figure 9 The camera recognizes the face and display the name of that person correctly.

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All the parts for the proposed bracelet, including the GPS, GSM, Sim card, and battery, were gathered (figure 10). Outdoor monitoring was used to run the test, and the reading from it revealed the system's actual location (figure 11,12).

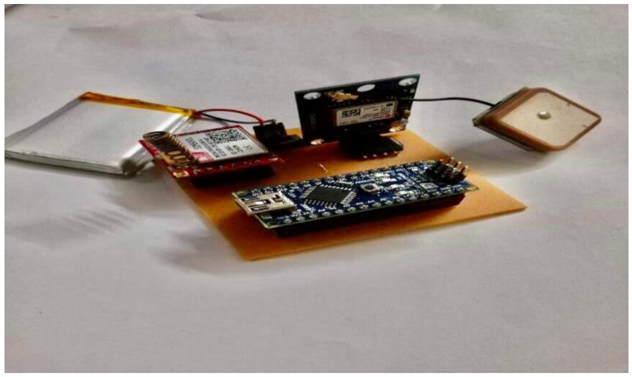

Figure 10 all components of the bracelet.

Figure 11 Patient location from GPS module

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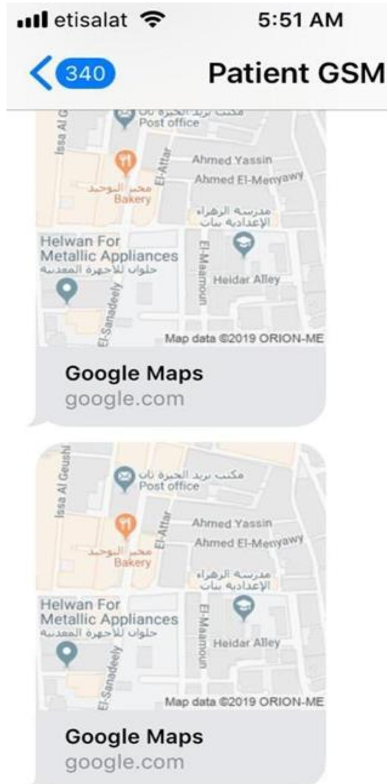

Figure 12 Patient location from GSM module

It is now possible to help Alzheimer's and dementia patients in a more practical, effective, and productive way.

4 Conclusion

Alzheimer's disease (AD) that is diagnosed in a timely manner, when a patient first comes to the notice of a clinician due to concerns about changes in cognition, behavior, or functioning and is still mentally good and functionally independent. Health care is a vital aspect of life. An assistive wearable glass for Alzheimer patients can use in an easy way, light weight, low cost to help AD patients to easily remember his/her family. Contain Wi-Fi connectivity as well, which will aid the caregiver in tracking the patient's condition and finding the patient's location for outdoor monitoring. Our assistive technology is designed to help people with chronic illnesses manage their condition and its emotional effects while also contributing as active a life as possible. However, in order to support the growing populations of people with dementia and cognitive impairment effectively, it is important to comprehend their needs.

A (GPS) module demonstrates its dependability and precision in providing location data. Face recognition correctly recognizes the patient's family members' faces and speaks their names. The device's functionality in relation to its price enables us to conclude that it performs the function for which it was designed by being simple to use, affordable, lightweight, and accessible to a large number of people.

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