HUMAN ACTIVITY RECOGNITION FOR ALZHEIMER'S PATIENTS USING MACHINE LEARNING

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Abstract— This project presents a hybrid plan recognition model, based on probabilistic description logic, which addresses the issues of recognizing the activities and the errors of Alzheimer's patients at an early stage of the disease. This model has been implemented with an embedded smart watch pair, (one on the wrist and other on the thighs for high accuracy) for patients with Alzheimer's disease which in turn offers assistance in task completion and to remind about the pending essential tasks. The patient have to wear a pair of bands(wrist & leg), from these bands accelerometer and gyroscope values are extracted and the activities like brushing, bathing, eating, going to toilet, taking medicine etc. can be tracked and reminded during right intervals. This result can be analysed through a dedicated mobile application which is under control by the bystander. The application can also remind the patients about those pending tasks which he/she haven't completed and are pending .The pending tasks are analyzed and are alerted to the bystander and also an alert is given to the patient to remind about the activity that he has forgot to do. This in turn would help to keep the activities in order and sometimes it may help to bring their memory back. The project focuses on providing complete assistance to Alzheimer's patients in their daily life.

Keywords— Machine Learning, Alzheimer's patients, Human Activity Recognition (HAR), Alzheimer's disease

I. INTRODUCTION

The widespread form of dementia causes a progressive deterioration of thinking (cognitive impairment) and memory, leading to incoherent behavior and limiting the patient's capacity to perform his tasks of everyday life (wash his hands, cook the meal, etc.) We have been exploring the process by which cognitive assistance, within a band, can be provided to an occupant suffering from Alzheimer's disease, in the performance of his Activities of Daily Living (ADL).

We propose to create a prototype aiming to actively monitor an Alzheimer's patient attempting a specific task, for instance handwashing, brushing and other activities. The proposed project addresses the issue of recognizing the activities of alzheimer's patients at an early stage of disease. Implemented with embedded smart bands (one on the wrist and one on the leg) that offers assistance in task completion and to remind the patient about their pending activities. Accelerometer has been a standard hardware. As its name suggests, an accelerometer measures the change in speed; not the speed itself. Data retrieved from the accelerometer may be processed in order to detect sudden changes in movement. Another sensor that has been used is the gyroscope which measures orientation by using gravity. Signals retrieved by gyroscope can be processed to detect position and alignment of the device. Since there is a meaningful difference of characteristics between datas retrieved from these sensors, many features could be generated from these sensor data to determine activity of the person that is carrying the device. After receiving data from users band we have a tendency to then classify the result obtained using machine learning. The rule used here is SVM. "Support Vector Machine" (SVM) may be a supervised machine learning rule which might be used for each classification or regression challenges.in this rule, we plot every data item as some extent in n-dimensional area (where n is that the range of options you have) with the worth of every Then, we perform classification by finding the hyper-plane that differentiates the two classes very well.

A major limitation of the prevailing products is to presume that the system already is aware of that activity is current, and so to suppose that it can only have task at a time. During this paper, we start to handle the limitation of recognizing an on-going ADL from discovered basic actions, that constitutes a key issue inherent in cognitive help. The complexity of this recognition method is enhanced as a result of a memory lapse will lead a patient to perform actions within the wrong order, to skip steps of his activity, or to perform actions that don't seem to be even associated with his original goal. SVM works comparatively well once there's a transparent margin of separation between categories. SVM is simpler in high dimensional areas. SVM is effective in cases wherever the amount of dimensions is bigger than the amount of samples. SVM is relatively memory efficient.

II. LITERATURE REVIEW

2.1. FITBIT

American company their product square measure activity trackers, wireless-enabled wearable technology devices that live information like the amount of steps walked, heart rate, quality of sleep, steps climbed, and alternative personal metrics concerned in fitness aboard the activity trackers, Fitbit offers a website and mobile app for iOS, android and Windows ten Mobile. The trackers may be synced to devices like mobile phones via Bluetooth, or to a Bluetooth-equipped laptop running Windows or MacOS. Users have the power to log their food, activities, and weight, to trace over time and may set daily and weekly goals for themselves for steps, calories burned and Calories in versus calories out square measure additional accurately measured once app users keep their huntsman on. However, the app may be used while not a huntsman to live calories on a life-style app. The app offers a community page wherever users will challenge themselves and vie against alternative users. Fitbit proclaimed Fitbit OS three.0 - a version with an extended on-device dashboard, on-device fast work for weight and water intake, and goal-based exercise mode. The new extended on-device dashboard (FitBit Today) can embrace a lot of stats and information relating to sleep, water intake and weight. The new Fitbit OS 3.0 conjointly includes Fitbit watch versions of fitness-related apps that square measure widespread on platforms like Apple's iPhone and Google's android. Fitbit conjointly proclaimed that 10 new partner apps square measure being side to the Fitbit App Gallery. Couch to 5K, Achu health, My Swim Pro, and Genius articulation radiocarpea square measure side. As Fitbit Pay uses NFC to transmit card technology, the users haven't got to demonstrate via chip or pin. Developers to make apps in an exceedingly a lot of economical. On December twenty, 2018, Fitbit proclaimed that it's adding a Run find feature, enabling auto-pause and auto-stop.

2.2. TRAX

Trax is touted as the world's smallest and lightest live GPS hunter. The device sends position, speed, and direction through the cellular network on to your app on a smartphone. Trax Geofences don't have any size

limit, caregivers will produce as several fence areas PRN, and may schedule once those virtual fences are in impact. Trax operates mistreatment GPS Satellites and cellular networks. Once the Trax device has calculated its position with the assistance of the satellites, the situation knowledge is distributed to the Trax App by cellular network.

Feature:

- Real time locating system
- Augmented Reality Tracking
- Geofences & Alerts
- Scheduling
- Proximity alerts

Real-time locating systems (RTLS) square measure wont to mechanically determine and track the placement of objects or individuals in real time, sometimes among a building or alternative contained space. Wireless RTLS tags square measure connected to things or worn by individuals, and in most RTLS, mounted reference points receive wireless signals from tags to see their location.[1] samples of period of time locating systems embrace pursuit cars through an production line, locating pallets of merchandise in a very warehouse, or finding medical instrumentation in a very hospital. The physical layer of RTLS technology is sometimes some form of radio frequency (RF) communication, however some systems use optical (usually infrared) or acoustic (usually ultrasound) technology rather than or Tags and fixed reference points are often transmitters, receivers, or both, possibly various possible technology combinations. RTLS are a variety of native positioning systems, and don't typically ask GPS or to mobile phone following Location info typically doesn't include speed, direction, or abstraction orientation.

Augmented reality (AR) is associate degree interactive expertise of a real-world setting wherever the objects that reside within the world are enhanced by computer-generated perceptual info, generally across multiple sensory modalities, as well as visual, auditory, haptic, sensory system and exteroception.AR are often outlined as a system that fulfils 3 basic features: a mix of real and virtual worlds, period of time interaction, and correct 3D registration of virtual and real objects. The overlaid sensory info are often constructive (i.e. additive to the natural environment), or harmful (i.e. masking of the natural environment).This expertise is seamlessly complex with the physical world specified as an associate degree immersive side of the real setting. during this means, increased reality alters one's current perception of a real-world setting, whereas a computer game utterly replaces the user's real-world setting with a simulated one. Trax Geofences haven't any size limit and you'll be able to produce as several as you wish. Set individual schedules for geofence alerts that reflect your routines. you'll be able to customize every geofence to send notifications on bound days and hours. Proximity sensors square measure unremarkably used on mobile devices. Once the device has awoken from sleep mode, if the proximity sensor's target continues to be for an extended amount of your time, the device can then ignore it, and therefore the device can eventually revert into sleep mode. For instance, throughout a telephony, proximity sensors play a job in detecting (and skipping) accidental bit screen faucets once mobiles square measure control to the ear. Proximity sensors are used to recognise air gestures and hover-manipulations.an array of proximity sensing parts will replace vision-camera or depth camera based mostly solutions for the hand gesture detection.

2.3. ANGELSENSE

AngelSense is specifically designed for special desires and with advanced GPS tracking technology, distinctive safety options, and well-being monitors to keep your dearest safe. This one of the most reliable personal location tracking technology thus folks will realize a runner as quickly as potential. Additionally significantly, our iAlerts area unit designed to proactively observe unsafe things to forestall emergencies. AngelSense helps you discover them asap, will stop older abuse, and ensures they get to and from activities safely. Unlike the other tracker, AngelSense was designed to produce more protection for those with special desires and insanity. It's necessary to

keep in mind that watches, tiles, bracelets, etc. aren't created to forestall wandering Associate in Nursing area units restricted in their ability to assist throughout an emergency once each second counts.

III.PROPOSED SYSTEM AND ARCHITECTURE

The proposed system consists of 2 bands, one on the wrist and the other on the leg. The system provides an eminent accuracy in classifying tasks since we take the values in two perspective. We extract the accelerometer and gyroscope values from the smart bands using MPU6050(gyro+accel).These values are analysed and classified in order to recognize each essential activity like brushing, bathing, taking medicine, fooding, fall down alert, washroom reminder etc based on 3 main Machine Learning algorithms. We analyze and compare the values using SVM, Random Forest, Deep Learning and take the best out of it that provides the maximum accuracy in classifying the right task. Human Activity Recognition (HAR) is achieved by use of MPU to extract the values. Human Activity Recognition (HAR) is classifying activity of a person using responsive sensors that are affected by human movement.
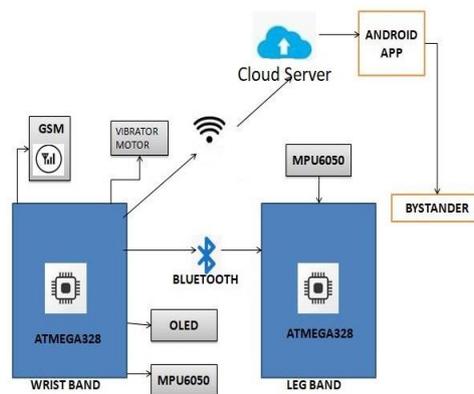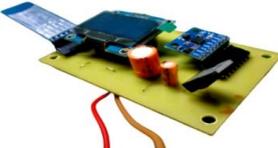

Fig 3.1 Proposed Architecture

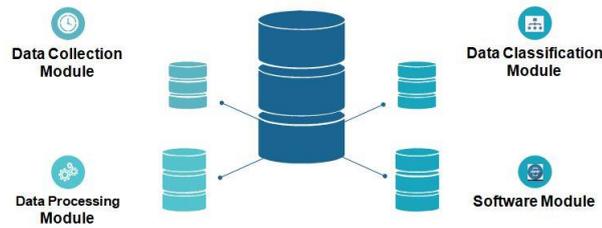Fig 3.2 Project Components

3.1. MODULE DESCRIPTION

Fig.3.3 Module Description

3.1.1. DATA COLLECTION MODULE

3.1.1.1. MPU6050

The MPU-6050™ components are the world's 1st Motion Tracking devices designed for the low power, low cost, and high-performance necessities of smartphones, tablets and wearable sensors. The MPU-6050 incorporates InvenSense's MotionFusion™ and run-time activity firmware that permits makers to eliminate the pricey and complex choice, qualification, and system level integration of separate devices in motion-enabled products, guaranteeing that sensing element fusion algorithms and calibration procedures deliver optimum performance for consumers.

The MPU-6050 devices mix a 3-axis gyroscope and a 3-axis accelerometer on the same silicon die, at the side of an onboard Digital Motion Processor™ (DMP™), that processes advanced 6-axis Motion Fusion algorithms. The device will access external magnetometers or alternative sensors through an auxiliary master I²C bus, permitting the devices to assemble a full set of device knowledge while not intervention from the system processor. The devices are offered in a four mm x four mm x zero.9 mm QFN package.

3.1.2. DATA PROCESSING AND CLASSIFYING MODULE

- Synchronization of 2 watches is achieved using bluetooth module

- We take coinciding values from each watch (wrist & leg) to the info classification module(Raspberry Pi) for any process.

- We take the values to a cloud and process them to classify them into some activities like Brushing, Bathing, Fooding etc and checks for the forthcoming routine activities that an individual should do.

- Also constant alerting is enabled to the bystander once a patient falls down or moves out of a such boundary.

3.1.3. SOFTWARE MODULE

Software module constitutes the mobile application which is used as a 24*7 assistant for the bystander to track & and analyze the routines of the patient. The application is designed to work well on android platforms. Application Features:
- Login/Registration
- Pending Task/Current Activities
- Live Location Tracking
- Pop Up Alert
- Report

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IV.PROPOSED ALGORITHMS
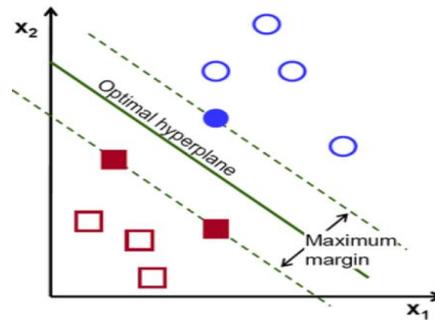
4.1. SUPPORT VECTOR MACHINE ALGORITHM

Fig.4.1 SVM

- The objective of SVM is to find an hyperplane in N dimensional space.

- To separate the two classes of data points, there are many possible hyperplanes that could be chosen.

- Our objective is to find a plane that has the maximum margin, i.e the maximum distance between data points of both classes.

The followings are important concepts in SVM −
Support Vectors − Data Points that are closest to the hyperplane is called support vectors. Separating lines will be defined with the help of these data points.
Hyperplane − As we can see in the above diagram, it is a decision plane or space which is divided between a set of objects having different classes.
Margin − It may be defined as the gap between two lines on the closet data points of different classes. It can be calculated as the perpendicular distance from the line to the support vectors. Large margin is considered as a good margin and small margin is considered as a bad margin.
The main goal of SVM is to divide the datasets into classes to find a maximum marginal hyperplane (MMH) and it can be done in the following two steps −
First, SVM will generate hyperplanes iteratively that segregates the classes in the best way.
Then, it will choose the hyperplane that separates the classes correctly.

4.1.1. IMPLEMENTING SVM IN PYTHON
For implementing SVM in Python − We will start with the standard libraries import as follows −

4.1.1.1. SVM KERNELS
In practice, an SVM algorithm is implemented with a kernel that transforms an input data space into the required form. SVM uses a technique called the kernel trick in which the kernel takes a low dimensional input space and transforms it into a higher dimensional space. In simple words, the kernel converts non-separable problems into separable problems by adding more dimensions to it. It makes SVM more powerful, flexible and accurate. The following are some of the types of kernels used by SVM.

4.1.1.2. LINEAR KERNEL
It can be used as a dot product between any two observations. The formula of linear kernel is as below −
$K(x,xi)=sum(x*xi)$
$K(x,xi)=sum(x*xi)$
From the above formula, we can see that the product between two vectors say x & xi is the sum of the multiplication of each pair of input values.

4.1.1.3. POLYNOMIAL KERNEL
It is a more generalized form of linear kernel and distinguishes curved or nonlinear input space. Following is the formula for polynomial kernel −
$k(X,Xi)=1+sum(X*Xi)^d$

k(X,Xi)=1+sum(X∗Xi)^d

Here d is the degree of polynomial, which we need to specify manually in the learning algorithm.
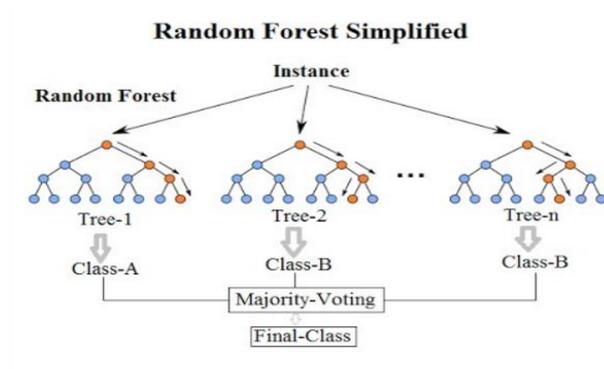
4.2. RANDOM FOREST ALGORITHM

Fig 4.2 Random Forest

Random Forest algorithm is a supervised classification algorithm. It creates many decision trees and uses a tree-like graph to show the possible consequences. If you input a training dataset with features into the decision tree, it will formulate some set of rules. These rules can be used to perform predictions

The Working process can be explained in the below steps and diagram:

Step-1: Select random K data points from the training set.

Step-2: Build the decision trees associated with the selected data points (Subsets).

Step-3: Choose the number N for decision trees that you want to build.

Step-4: Repeat Step 1 & 2.

Step-5: For new data points, find the predictions of each decision tree, and assign the new data points to the category that wins the majority votes.

V. HARDWARE REQUIREMENTS

5.1. RASPBERRY PI

The Raspberry Pi 3 Model B+ is the latest product in the Raspberry Pi 3 range, boasting a 64-bit quad core processor running at 1.4GHz, dual-band 2.4GHz and 5GHz wireless LAN, Bluetooth 4.2/BLE, faster Ethernet, and PoE capability via a separate PoE HAT The dual-band wireless LAN comes with modular compliance certification, allowing the board to be designed into end products with significantly reduced wireless LAN compliance testing, improving both cost and time to market. The Raspberry Pi 3 Model B+ maintains the same mechanical footprint as both the Raspberry Pi 2 Model B and the Raspberry Pi 3 Model B.

5.2. BLUETOOTH MODULE(HC05)

The Bluetooth module HC-05 can be a MASTER / SLAVE module. By default, the plant setting is SLAVE. entirely AT COMMANDS can put along the role of the module (Master or Slave). The slave modules cannot initiate an affiliation to a distinct Bluetooth device, but can settle for connections. The Master module will initiate AN affiliation to totally different devices.

5.3. VIBRATOR MOTOR(ERM)

An eccentric rotating mass motor acts sort of a normal DC electrical motor— it transforms the flow of electrical current right into a mechanical pressure that turns the motor. not like loads of DC motors, the ERM motor to boot has AN non concentric mass. Because of the actual fact that the turning of the non concentric mass produces AN uneven force, a non-zero force is created once the motor turns. As long as the motor runs at a high style of turnings every minute, the constant variation of the pressure generates a perceivable facet vibration.

5.4. ATMEGA 328

ATmega 328 has 1KB Electrically exterminable Programmable browse alone Memory (EEPROM). This property shows if the electrical provider equipped with the microcontroller is removed, even then it will store the data and may provide results once providing it with the electrical provider. ATmega-328 has a 2 KB Static Random Access Memory (SRAM). Different characteristics are going to be explained later. ATmega 328 has many totally different options that build it the foremost widespread device in today's market. These choices include advanced computer architecture design, sensible performance, low power consumption, real timer counter having separate generator, 6 PWM pins, programmable Serial USART, programming lock for software system security, output up to twenty units of measurement etc. ATmega-328 is sometimes used in Arduino.

5.5. GSM MODULE

GSM could be a mobile communication modem; it stands for international system for mobile communication (GSM). The thought of GSM was developed at Bell Laboratories in 1970. it's a widely used mobile communication system within the world. GSM is AN open and digital cellular technology used for transmittal mobile voice and knowledge services operates at the 850MHz, 900MHz, 1800MHz and 1900MHz frequency bands. GSM system was developed as a digital system victimization time division multiple access (TDMA) technique for communication purposes. A GSM digitizes and reduces the information, then sends it down through a channel with 2 totally different streams of shopper knowledge, every in its own specific time interval. The digital system has a capability to hold 64 kbps to an extent of 120 Mbps of information rates.

5.6. OLED DISPLAY

An Organic lightweight Emitting Diode(OLED) could be a show device that has self light-emitting technology composed of a skinny, multi-layered organic film placed between AN anode and cathode.
The OLED show uses AN I2C bus to speak with the Arduino. The I2C bus will support multiple devices and every device on the I2C bus incorporates a distinctive address. The Arduino code uses this address to speak with the OLED show and sets its internal registers and memory to show knowledge on the screen.For making communication between Arduino and OLED, the pins area unit connected as follows:

- SCL to A5
- SDA to A4
- Vcc to 5V
- Gnd to Gnd

VI.RESULT AND ANALYSIS

ACTIVITY	SVM	RANDOM FOREST
BRUSHING	89%	85%
EATING	96%	94%
STANDING	95%	95%
SITTING	98%	96%
WALKING	96%	96%
JOGGING	87%	85%
MEDICINE INTAKE	80%	79%
FALL DOWN	82%	79%

RANDOM FOREST ACCURACY

Fig 6.1 Random Forest Accuracy

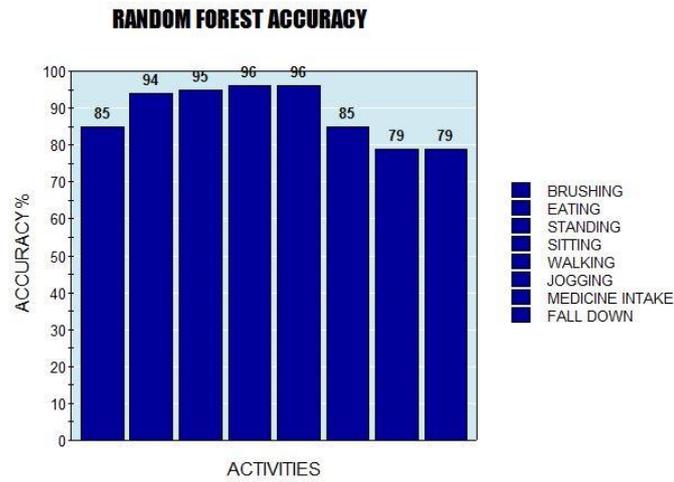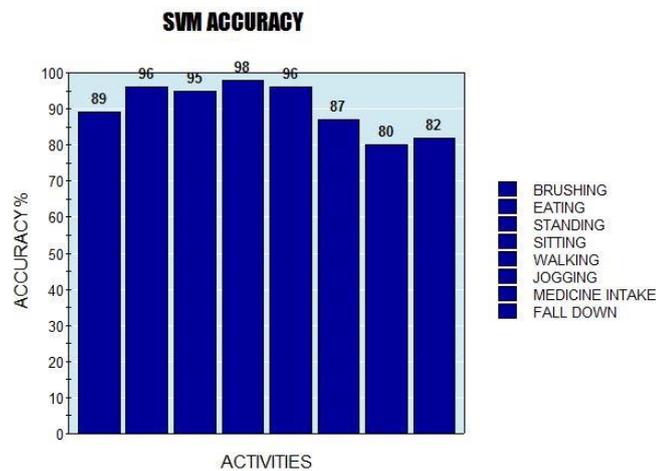**SVM ACCURACY**

Fig 6.2 SVM Accuracy

VII.   CONCLUSION

Alzheimer's disease is a progressive disorder that causes brain cells to waste away (degenerate) and die. Alzheimer's disease is the most common cause of dementia — a continuous decline in thinking, behavioral and social skills that disrupts a person's ability to function independently. Taking care of the patients with AD can be both physically and mentally demanding. At the same time, it is also important to allow the patients to live an independent life. To help the AD patients, we have designed and developed a healthcare device, to provide help to the patients for important activities and report emergency situations to their relatives and/or caregivers immediately. This can minimize the potential risks on the users and proper actions can be taken promptly. By checking the activity list tracked in this device, we can assess the self-caring abilities of the users and their normal activity habit (NAH). These information can be used as references in assessing the users and determining the activities that may be allowed to be handled by the users. Note that allowing the AD patients to perform simple living activities is highly important both to reduce the degeneration rate of their memories and improve the stability of their mood. Our proposed system   records and reminds an Alzheimer's patient's daily routines and activities. The main advantage our system is that the bystander can analyse the recorded data. We can extend the system with deep learning (ANN Technique) by using more data sets for activities like going to the toilet and taking medicine etc. 3D printing can be used to develop the band as an compact device More activities can be incorporated Raspberry PI processing can be done with the aid of a cloud server, which will help make the watch smaller and more portable. The app can also be extended for the Alzheimer patient with some more features A photo gallery feature to recollect things Small puzzle games to train the memory

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Jigsaw puzzles, playing cards, dice, and word puzzles are simple games that can be easily adapted as Alzheimer's recreational activities for the person in your care.

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