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# Design and development of Personal Assistive Device for Elderly

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***Abstract*—Smart home technology for aging people is coming up increasingly as elderly people require living at home with assistive devices. With aging comes associated health problems like mobility impairment and memory related diseases like amnesia, Alzheimer's, etc., They face difficulty in keeping their essential things safely and keeping up schedules. The work aims to develop an assistive device to elderly people and people with memory disabilities to keep their essential things safely using smart health care system. The system maintains a list of objects/things necessary to be remembered at different occasions based on user preferences. This system is customizable and enables locating misplaced things using alarm signaling, reminds periodic and important schedules for the day using easy and effective user interface. The tracking range can be extended by integrating two or more Pi's to create a distributed environment. The system also reports the name of tablets given the image of the tablet sheet to overcome reading difficulties.**

***Keywords—Assistive device, Raspberry Pi, RFID tags, OCR, smart home. smart healthcare.***

## I. INTRODUCTION

The Radio frequency identification (RFID) uses electromagnetic fields to keep in track of the objects to which it has been attached. It is used in various real-time applications, like tracking pets, acquire access through office buildings, keeping track of children by working parents and speeding on toll collection on roadways. RFID is used to identify people, objects, and animals automatically using short range radio technology to communicate digital information between a stationary location (reader) and a movable object (tag). People with disabilities need an assistive mechanism to remind things, schedules and assist in medicine identification. RFID enabled Raspberry Pi assistive device is designed to give a reminder everyday at a particular time for the user to update their schedule for the day. In addition, it also reminds the schedule to the user before an hour in addition to medicine name identification.

## II. RELATED WORKS

In [1] the authors used weight sensors to track the state changes of medicine bottles. With the help of the state changes observed, the system will decide whether to alarm the patient or not. The system consists of two steps. First is detecting the state changes of medicine bottle. Second is raising an alarm based on the observation made in the previous step.

RFID plays the most important role to track and localize the objects or things in Smart Home systems attracted by its flexibility, low cost and robustness. In [2], the author devices a system in which the user can search for the lost object, the user has the RFID reader with the smart phone and can make use of this with the help of the PLSM (Personal Localized System for Misplaced Object) web application through the application developed on the phone.

In [3], the authors proposed a hybrid system that combines WSN and RFID technology to get the location of indoor objects, by updating the position information of the lost object into the system. WSN nodes leverage on a common set of protocols and algorithms to automatically setup an ad-hoc network which is utilized to transfer data between central nodes called "sink nodes", which in turn provides the internet connectivity.

Patients' health can be monitored using smart environment. In [4], the device developed is used to monitor the patient's blood pressure. One solution is combining the architecture of GSM and GPRS for monitoring the health in real time. The Sensors attached to the system compares the recorded values with threshold values and alerts the doctor in case of emergency situations where the GSM infrastructure is used to track the location using GPS attached to system.

Elderly patients face various challenges that to leading an independent life is difficult for them. Ambient-assisted living (AAL) technologies is a popular research filed that is aimed to develop a smart home that satisfies the user's needs. Smart homes can be made more effective by combing it with the Cloud based systems. In [5], the authors built an architecture based on the necessary requirements and standards quoted by ITU-T and Continua Alliance.

Smart home has sensors to monitor the health of the patients and to provide effective treatment in case of emergency. In [6], the system alerts in case of any problem or emergency and this technology requires low cost. The design and characterization of a biosensor designed in [7] for direct integration into smart phone and wearable technologies to enable remote and accurate personal health monitoring is proposed.

In [8], the authors presented an assistive mobility device for the elderly people who have mobility disabilities to help them in doing their work independently with the training given by the mobility device and to monitor the elderly from the remote place.

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The six-axis force sensor handlebar will convert the force applied by the people to relative speed and turns the device with the help of the motors to the respective angles. For the monitoring the patients remotely, the device is installed with sensors to detect the vital signs of the elderly such as body temperature and heart rate and to find the location of the device.

The proposed system consists of a set of robots having different task spaces, cloud computing techniques to improve the capabilities of the system, unification with home infrastructure, and compatibility with smart mobile technologies and devices. In [9], a Smart Assistive Navigation System for Blind and Visually Impaired Individuals is proposed to provide them a safe, secure and independent navigation. The navigation systems can be implemented with sensors and a processing unit to manipulate the data from the sensors. The advantage of the system is the mobile application, which cannot be found in most of the other systems. The disadvantage is that the credibility of the system when measured in real world reduces from the actual result.

In [10], a systematic mapping study of assistive technologies for people suffering from dementia is presented. The percentage of world's population for ageing people is increasing in all countries. Assistive devices are used for helping people with dementia to lead an independent life which is otherwise not possible with other's help. The activities and the daily routines of the people with dementia are loaded into the assistive device and based on the mapping with the patients who logs in the assistive suggestion are given to the patients. The research indicates that the existing assistive technologies can be classified into five major categories: robotics, health monitoring, prompts and reminders, communication and software.

The most important thing to decide is that which technology is best suitable for the current situation. The decision of such technology is very important because, the accuracy of these devices are very important and building those devices is also very expensive. In [11] a model by considering the computational methods was used and identifying the limited and reduced set of relevant features to help the doctors to make decisions on whether to suggest the technology is built. The models were evaluated in terms of accuracy in prediction, robustness etc. The advantage is that the system has the ability to differentiate between adopters and non-adopters with the accuracy of 99.42%. The disadvantage is it may be expensive to collect feature and it is time consuming. Therefore, it is necessary to reduce the size of the feature set but the prediction accuracy should be high.

Assist-Me, a smart system for assisting elderly people in case of emergency was discussed in [12]. The purpose of the system is to enhance the independence and autonomy of elderly people in indoor and outdoor environments, by offering faster assistance in emergency situations through services offered by volunteers. This system includes two applications: one with the elderly people who require emergency assistance and the second with the volunteers who receive the request from the elderly. Fuzzy-logic is used to automatically select appropriate volunteers to manage the emergency situations.

In [13], the authors proposed a Non-contact elderly body temperature tele-monitoring system that uses XBee wireless protocol and helps in checking the body temperature of the aged people to provide necessary treatments. Doctors can monitor the complete state of the patient's health from remote location and can suggest some suitable medications. The main advantage of this kind of assistive technologies is, that the elderly can lead an independent life and they can also enjoy a better quality of life. The disadvantage lies in the fact that collecting information is difficult and the accurate results are not obtained. In [14], a software application which is used to convey a dialog between disabled patients and clinicians is presented. The patient may not be able to speak properly, but he can convey his need by moving a finger which can be captured by the mobile phones and can be converted into the appropriate message.

The authors of [15], discussed about the assistive devices for encouraging the people to do physical and mental exercise for those affected by diseases like Alzheimer's. This system consists of a movable mini stationary bike and an interactive multiple choice question game. Physical exercise is given by the bike while the game concentrates areas such as memory, prediction, problem solving capability, recollecting information, and matching.The drawback in this system is that it is used only to assist the health of the patients by using the machines but the location of the patient and other things cannot be tracked using this system.

Paper [16] listed the various tracking devices that can be in many forms and some of the proposed forms are: A wearable memory aid and a reminder system in the form of eyeglasses, were used which have significant effect in managing anomia and certain forms of agnosias. A memory aid, can be clipped to the clothing in the form of a badge, combines task information with time, location and context. Cognitive–navigational tool is one of our proposed ideas where a different technology is used for navigating things. The design consists of two sections; one is the tag which transmits the signal and the other reader which reads the signal transmitted by the tag. These two sections helps in the library system to know when the book is taken and it is done with the help of the alarm system.

The drawback in [17], is that the tags and other things that are attached to track the patients might get lost. So the patient's location cannot be tracked. To overcome this we started using mobile device for tracking the patients and if the patients go out of the room without the mobile device then it would alarm indicating that they left their mobile phone inside the room.

The features of the system, "Alzheimer Disease Pocketcard" proposed in [18] are as follows: 1) Displays latest improvements on detection, diagnosis and management of Alzheimer's disease. 2) Interactive tools are attached that helps to assess cognition and function.3) Education/support PDF's are generated and are mailed

to patients and caregiver. Drawbacks of this system are as follows: 1) There is no progress reports to get the progress of cognitive functioning of the system. 2) The user interface might be difficult of the Alzheimer patients to use. 3) The patient's location cannot be tracked.

Classical Radio Frequency Identification (RFID) schemes such as frame slotted ALOHA (FSA) can be used for eliminating the collision of tag responses. The proposed scheme in [19] exploits collisions in the acquisition phase, which is enabled by compressed sensing techniques. All activates tags are designed to select a signature randomly from a huge set of signature pool and the tags transmit the signature simultaneously from the reader.

In paper [20], a comparison between morphology operation and template matching for recognizing defects in tablets is done. Experiments have been conducted using both of these image recognition techniques and results show that template matching is a much simpler option. Since drugs are very essential entities, it is essential to produce them without any defects. Other image recognition techniques maybe used to find the tablet given its image as input. The tablets are being recognized based on a set of features such as the size, color, appearance and weight in [21]. This is a computer-vision based pill recognition system on mobile phones.

## III. PROPOSED WORK

The proposed work is to develop a system that assists the elderly to keep track of their objects with ease. The system employs an RFID reader to read the objects that are affixed with the RFID tags. A Raspberry Pi is used which acts as the server to store and maintains the database of the connected devices. The Raspberry Pi (or the Pi) is a single-board computer that enables easy portability. A passive RFID reader is used to minimize the cost. The read range of the reader is up to 3 feet. Thus, each Pi is placed at the entrance of different rooms in a house. When an object moves out of range, it updates in its database. A centralized database is being used. When the object goes out of the house, where the main Pi is placed, an alarm is raised with a voice note of which object is taken outside. This way it enables the user to track the object within their homes.

The challenge is to integrate the various Pi's and instill a centralized control. The device also provides a reminder wherein the user can feed their everyday schedule into the device, which raises an alarm with a voice note at the time of the event. The system is implemented in python along with some libraries for serial port connection, text to speech and event handler. Integration of Raspberry Pi's is done to extend the range of the pi to a wider scope pertaining to a distributed environment. The name of the tablet is reported as an audio message given the image of the tablet sheet as shown in Fig. 1.

Configuration of the Raspberry Pi involves setting up a VNC server and putty thus booting the Pi and pairing of eight female wires with a MFRC-522 EM Reader in order to read a tag. Once the setup is done, programming the Pi using python is carried out.

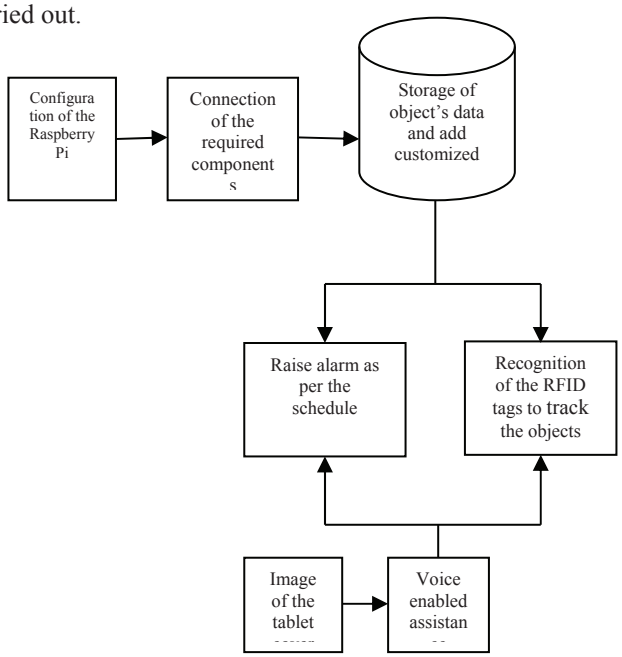


Fig. 1. Architecture of the proposed system

Storing of objects and adding customized schedule is programmed using python. Adding of customized schedule is further divided into tracking of the objects and to raise alarm as per the schedule, where voice assistance and image to text conversion of the tablet are added features of the assistive system.

The proposed system accommodates the feature of identifying the name of the tablet given its cover image. This is carried out by using the Optical Character Recognition (OCR) technique in MATLAB. The image is converted to text and a set of tablet names are stored in the database. Using regular expressions, the name of the tablet is searched in the text (converted from the input image) and given out as an audio. In comparison with the existing system as discussed in paper [22], the proposed system is very simple. The former uses computer vision with many attributes and also a set of tablets along with its features saved in a database, while our system doesn't involve complex artificial intelligence techniques to output the same. Moreover, the proposed system does not have to store the attributes of the tablets in a database.

### *A. Algorithm For Tablet Identification*

1. Input the image of tablet's cover

2. Use OCR to identify the text in the image and store it in results

3. Define regular expressions for tablet manes

4. Match results against regular expressions defined

5. Provide the tablet name as anvoice output.

## IV. EXPERIMENTAL SETUP AND RESULTS

The RFID reader is connected to the Pi using 8 female to female pins and pin connections are listed in fig.2

| RFID | Raspberry Pi | GPIO phys pin |
|---|---|---|
| SDA/SS* | CE0 | 24 |
| SCK | SCLK | 23 |
| MOSI | SPI MOSI | 19 |
| MISO | SPI MISO | 21 |
| IRQ | N/C | N/C |
| Gnd | Gnd | 6 |
| RST | GPIO 25 | 22 |
| 3.3V | 3.3V | 1 |

Fig. 2. Pin Connections

The Pi has to be connected to a constant power source. The Pi is connected serially to the computer using the Ethernet cable. This way, the screen of the laptop can be used as the display of the Raspberry Pi. The Pi is manipulated by connecting through the putty emulator as shown in fig 3 and VNC server is started as captured in fig 4.

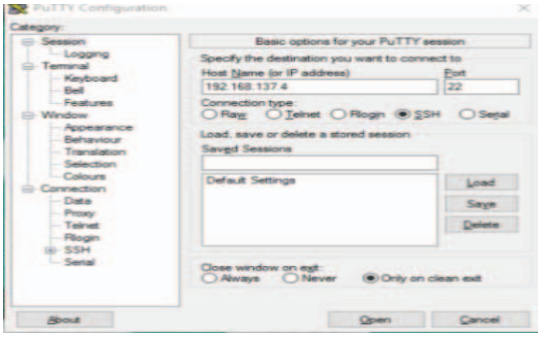


Fig. 3. Setting up of emulator

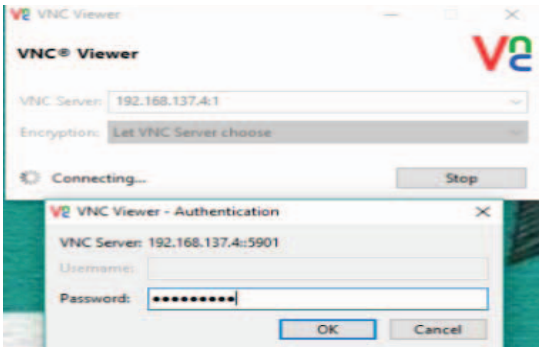


Fig. 4. Starting VNC Server

The GUI for the Pi is obtained through the VNC server which uses the Remote Frame Buffer protocol (RFB) to remotely control another computer as depicted in fig 5. Putty is setup in order to boot the Raspberry Pi Once this is completed the login setup is carried out


Fig. 5. User Interface

Fig.5 displays the user interface with two options namely set alarm with snooze feature and also to read a tag. The set alarm feature helps the user by reminding the customized schedule and the snooze option available is an added advantage. Fig.6 shows the notification message when all items customized are present. The user this way can be informed in case any object is missing

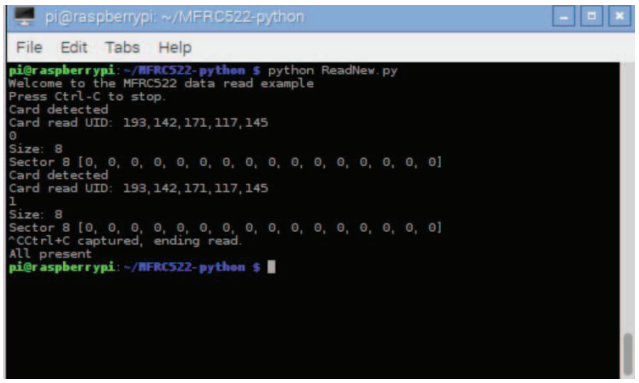


Fig. 6. Scenario when all objects are present

Users can identify if all items are present and will be notified in case any item is missing which is depicted as in Fig.7. Snooze feature provided to the user is depicted in fig.8. When the user misses any item that is customized, the user is notified by the name of the missing object. The voice assistance available provides the user with the tablet name when required thus enabling effective and easy use.

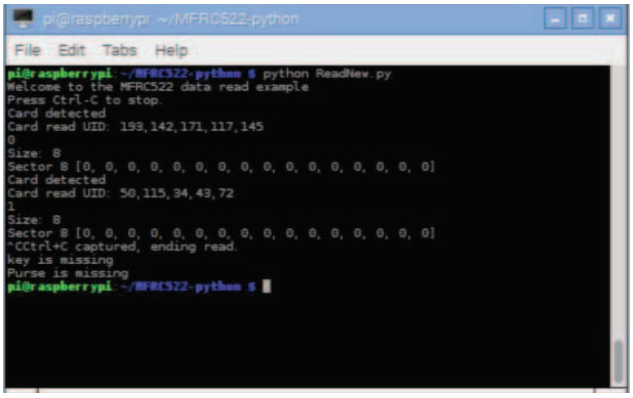


Fig. 7. Notification for missing object

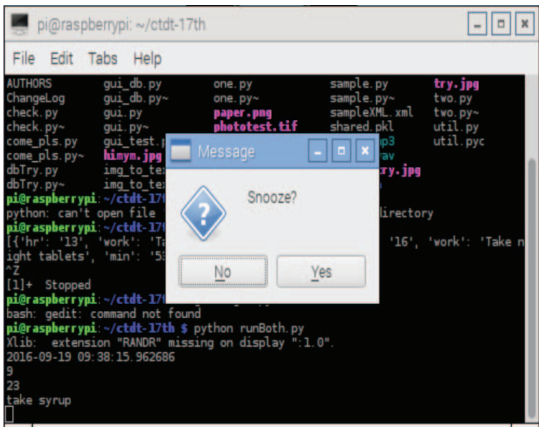


Fig. 8. Snooze feature

## V. CONCLUSION AND FUTURE WORK

The proposed system is affordable and is easy to install and use with less maintenance and cost. The proposed device is portable and can be customized. The challenge arises when multiple devices are to be integrated in a centralized environment. The future work may include extending this concept as a mobile app that enables even lesser cost. People face numerous challenges such as memory disorders and with age they also tend to face sight loss and hearing loss. Technology can help the people with above challenges to meet out some of them and allow them to lead an active and independent life.

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