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A Smart Assistant for Senior Citizens with Amnestic MCI (Mild Cognitive Impairment)

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ABSTRACT: Over the past two decades due to enormous advancement in medical science and improved living standards, human life expectancy has also increased, consequently, number of senior citizens (people with age 60 or above) have also increased dramatically. People of this age suffers from variety of age related ailments, among those ailments, cognitive impairments are of major concern. Cognitive impairments affect persons understanding and memory capabilities. Amnestic MCI (Mild cognitive Impairment) mainly affects memory rather than understanding, but this disease is neglected by most of the people which lead to more serious conditions such as dementia and Alzheimer's disease in 10 percent to 15 percent cases of amnestic MCI. People with these disease struggle to remember their essential things and most importantly their medicines time. This can be disastrous since failing to take medicines on time would increase the illness. People of this age greatly depend on their care giver and relatives. In this scenario we proposed a system which allows senior citizen with amnestic MCI to locate their essential things and maintains on time routine of medicine. This system will also provide assistance in case of visually impaired people for medicine recognition, thereby reducing their dependency on other people and leveraging their quality of life.

KEYWORDS: Amnestic MCI; Indoor localization; RFID; TTS; Smart assistance; OCR; Senior citizens

I. INTRODUCTION

In 2015, United Nations (UN) published the report which revealed that there were 901 million senior citizens (people aged 60 or above) in the world. These numbers would reach to 1.4 billion in 2030 and in 2050,the number of persons aged 60 years or above would approach 2.1 billion in the world. In India elderly population has increased from 77 million in 2001 to 104 million in 2011.By 2050, this would be around 300 million, means 20 percent of total Indian population. Today's young India will turn into rapidly aging society in upcoming decades.As getting older, people with this age lose their memory, visual and cognitive abilities.People of this age suffers from variety of age related ailments, among those ailments, cognitive impairments are of major concern. Cognitive impairments affect persons understanding and memory capabilities [2]. Mild Cognitive impairments are of mainly two types (i) Non-amnestic MCI and (ii) Amnestic MCI. Approximately 15 percent to 20 percent of people age 65 or older have MCI. People with MCI, especially MCI involving memory problems, are more likely to develop Alzheimer's or other dementias than people without MCI [3].

Nowadays many elders are living alone where they have to take care of themselves; these people are more vulnerable in terms of health care and daily essentialneed disturbances. Senior citizen suffers from variety of difficulties due to age related illness and other mobility and cognitive disabilities. In case of amnestic MCI, people suffers from memory loss and forget their essential daily needed things such as glasses, walking sticks, mobile phone etc. and more importantly their medication timings and other things such as exercises suggested by physiotherapist. In such scenario our system came to rescue. The propose system is able to track the essential things for elderly by indoor localisation technique. Conventionally, we have used GPS for tracking and locating objects in outdoor environment but in indoor environments GPS cannot be used due to poor signal reception, multipath fading. Radio frequency identification can be

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used in indoor environment for locating the object. This can be achieved by evaluating the received signal strength and hence can locate the particular things in the given room. When person wants a particular object such as glasses, walking stick etc. then he/she has to just click on the concerned object name on the screen then that object will start beeping and hence can be noticed by elder people.The system will maintain the schedule of medicines on android based application. This application provides capabilities which allowsenior citizens to record the medicine timings, dose and refill reminders of the medications.This information can be provided to the system by relatives or healthcare provider. Apps data can be synchronised with central server. It has ability to assist the people with visual impairment to identify the medicines by optical character recognition technology.The system data can be accessed remotely by the doctor or relative ofsuch peoples to monitor the patient'sactivities.Some elder people may have night wondering habit. In such case, if the person goes out of the home between certain timings at night then alarm will ring thereby alerting their caregivers. Hence this system will surely assist the senior citizens with variety of illnesses particularly thosewhom are suffering from amnestic MCI.

II. RELATED WORK

In [4] authors developed system named autominder, whose algorithm was based on java and LISP, deployed on mobile robot. Autominder consist of three major components (i) Plan manager (ii) client modeler (iii) Personal Cognitive orthotic. It uses a range of AI techniques to model an individual's daily plans, observe and reason about the execution of those plans, and make decisions about whether and when it is most appropriate to issue reminders. In [5] authors proposed a system for monitoring the people with cognitive impairment in homes. This system not only helps people with cognitive impairment (CI) but also their caregivers by improving caregiver's wake/sleep cycles. The main thing is bed occupancy sensor which detect whether or not patient is slept or not. When patient with CI leaves the bed then it alerts the caregiver with nonemergency signal, but when person goes out of the home then it will issue emergency signal thereby alerting the caregiver.

In [6] authors developed an android based application which obtains user's medicine prescriptions by taking its pictures. For personal preferences, the user may block time periods such as sleeping hours, religion activities time, etc. Proposed system tries not to insert in-take events into those time slots. In [9] author has discussed several technologies for indoor positioning system along with challenges of indoor environment. Each of these discussed techniques has their own merits and demerits, but RFID seems to be very practical due to its low cost (in case of passive tags), flexibility, robustness, no line of sight requirement and unsophisticated approach of implementation.

In [7] authors proposed system based on a sensing surface where entities are going to be located, a RFID reader attached to the entity that is able to read RFID tags that are part of the sensing surface, a communication system that communicates the entity with a location manager via Wi-Fi and the location manager that is in charge of mapping the tag id read by the RFID reader and show its location in the tracking map. In [10] authors proposed an innovative algorithmic approach for passive RFID localization in smart homes based on elliptical trilateration and fuzzy logic, when evaluated, proved to be quite accurate and seems robust.

III. PROPOSED SYSTEM ARCHITECTURE

RFID system consists of three elements: radio frequency tags, at least one RF antenna and a data collection module. This system works as follows. First, the RF antenna emits a wave of radiation. Then, if a tag is located in its coverage area, the tag intercepts the signal, and its internal chip retransmits a signal to the antenna. Radio frequency tags are subdivided into three families: active, semi-active and passive. Active and semi-active tags are battery powered and often have an internal erasable memory. They use their battery to continuously communicate with the RF circuit. Passive tags have a technically unlimited lifespan and do not need external power supply. Second, we need to reduce intrusiveness and active tags are much bigger than their passive counterparts. In our system we used passive RFID tags.

It uses RFID system which consists of stationary reader and movable tag which is attached to the object which is being tracked. Raspberry Pi or Arduino Uno can be used as server which stores the object's information in database. The system can be placed or affixed at the entrance of rooms in the house. When the object moves out of the range, system initiates an alert signal by suitable mechanism to the user. When the person needs some objects such as glasses,

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walking sticks, smartphone etc. concerned person can click on the screen, and then system activates the signal, which in turn makes beeping sound indicating the absence of object within room.

Proposed system provides capabilities of daily schedules to be followed by senior citizens. System have configurable reminder cum alert or alarming mechanism, which allows caregiver to feed the medicine timings, dosage, and refill reminders. When person forget to take medicine it alert the person as well as caregiver about the concerned situation. Often elder people suffers from visual impairments, in such case system provides medicine recognition, and providing voice assistant. This functionality is achieved using optical character recognition (OCR) in conjunction with the text-to-speech converter.

A. Optical Character Recognition (OCR): It is technique of text recognition from image obtained using image sensing devices such as camera or scanner into machine encoded editable text form. There are two types of OCR: one is for recognising handwritten text and another for printed text. OCR uses template matching and structural analysis approach. We use the former approach in our system .OCR involves following steps:

- **Pre-processing:** It is necessary for improving the chances of successful character recognition. It involves de-skewing to adjust the document or image if it is tilted. De-noising removes the noise from the captured image and smooths it. Now binarization is performed, it is the process of conversion of colored image into black and white image. After binarization unnecessary lines are removed and zoning is performed. Zoning is used to detect column and paragraph in the image. Most important part of pre-processing is segmentation. It is the process of separating characters which are connected due to artifacts present in the image.
- **Character recognition:** character recognition can be done by means of template matching for structural analysis approach we focus on the template matching. Template matching involves comparing an image to a stored glyph on a pixel by pixel base is it is also known as image correlation, pattern recognition. This technique greatly depends on the input glyph being correctly isolated from rest of the image and the stored glyph should be of similar font and of same scale. It is suitable for type written text rather than handwritten text. Feature extraction generally decomposers glyph into lines, closed loops, line direction and line intersection, this provides greater accuracy in terms of character recognition.
- **Post-processing:** In order to increase accuracy of optical character recognition variety of post processing techniques can be utilised. If output of OCR algorithm restricted by a lexicon, means a list of word which would allow to occur in a particular document. As an example we can consider all words in the English language. In near-neighbour analysis approach we can make use of co-occurrence frequencies to correct errors, by noting that some words are often appear together.

B. Text-to-speech (TTS) conversion: Text-to-speech (TTS) conversion transforms linguistic information stored as data or text into speech. Grapheme to phoneme conversion modules are essential components in text-to-speech (TTS) systems. These modules operate before the phone sequence is fed into the synthesis routine [11].

Text-to-speech system is composed of two parts: a front-end and a back-end. The front-end has two major tasks. First, it converts raw text containing symbols like numbers and abbreviations into the equivalent of written-out words. This process is often called text normalization, pre-processing, or tokenization. The front-end then assigns phonetic transcriptions to each word, and divides and marks the text into prosodic units, like phrases, clauses, and sentences. The process of assigning phonetic transcriptions to words is called text-to-phoneme or grapheme-to-phoneme conversion. Phonetic transcriptions and prosody information together make up the symbolic linguistic representation that is output by the front-end. The back-end—often referred to as the synthesizer—then converts the symbolic linguistic representation into sound. In certain systems, this part includes the computation of the target prosody (pitch contour, phoneme durations), which is then imposed on the output speech [8].

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IV. ADVANTAGES

- Flexibility of configuration
- Highly portable and robust
- No direct line of sight communication required
- Interference due to obstacles such as wall furniture is comparatively very low
- It improve quality of life of senior citizens with amnestic MCI
- Reduce burden on caregivers
- Cost is comparatively low

V. APPLICATIONS

- As an indoor localization system
- As an object locator/tracker with configurable functioning
- It can be used as scheduler/reminder
- In hospitals for people with cognitive disabilities
- In old age homes for assistive daily livings
- It can be used in conjunction with Alzheimer's disease and dementia care system
- Its data can be useful for cognitive behavior therapy specialist

VI. CONCLUSION AND FUTURE WORK

The proposed system is quite effective in assisting the senior citizens suffering from cognitive impairment and memory related problems with their ambient assisted living (AAL). The system reduces their dependency on the caregivers, ensure safety, and improve their quality of life. However, the proposed the system has limited range due to use of passive tags, range of the system can be improved by use of active tags. In future, we can make it standalone, fully portable, by adding its own rechargeable batteries, and providing dedicated input mechanism and improving its user interface. The cost associated with multiple central servers can be eliminated by cloud based approach. Furthermore, we can use multi-sensory data fusion techniques to make it more accurate and robust.

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