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Alzheimer's Patients' Assistance Models

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***Abstract:** Alzheimer's is a neurodegenerative disease which primarily effects the neurons in the human brain. The severity gradually increases over time, considered as the main cause for cognitive impairment in elderly people. Alzheimer's Disease has a long incubation period before clinical symptoms emerge, the available treatment can only delay the disease but not the progression. Hence the patients need assistance for their day to day activities. There are few neuropsychological tests like mini-mental state examination to determine the need and way of diagnosis and few systems have been proposed to help such patients. It is necessary to study the available systems for their efficiency, feasibility, speed and other factors necessary for comparison in order to understand the work done so far which will open ways for further research and improvisation of existing models and approaches. Therefore, in this paper we will review some of the devices, approaches and systems designed in order to help the Alzheimer's Patients' with their daily activities.*

***Keywords :** Alzheimer, Cognitive, Personal Assistant, Alzheimer disease, Probability*

I. INTRODUCTION

Alzheimer's is a chronic disease which primarily effects the neurons in the human brain. This disease will start slowly and increases its severity gradually over time. Aging is one of the prime factors for the occurrence of this disease. There is no complete cure for this disease as such but proper care may temporarily improve the symptoms. This disease will reduce the life span of the effected person and if it is severe it may lead to the death of the patient. The causes of this disease are not well understood but the causes may be head injury or hypertension or it may be inherited by parents. The most common symptoms of Alzheimer's are not remembering recent activities in early stages and as the severity increases the symptoms would be problem with languages, getting lost easily, issues with behaviour, loss of motivation, losing interest over self-care and facing difficulty in doing familiar tasks.

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The diagnosis for this disease will be based on the person's medical history, relative's history and behavioural history of the person. There are few neuropsychological tests like mini-mental state examination to determine the need and way of diagnosis. There is no particular measure that is effective in preventing the Alzheimer's disease because of inconsistent results. The number of people getting effected by this disease are increasing day by day and only 25% of them will get diagnosed. Approximately 44 million people are affected by this disease worldwide according to reports and at least 4 million people from India are affected by this disease. According to a report by National Institute of Aging, it says that the commonness of this disease is getting doubled every five years beyond the age of 65 years. This disease will have impact on economic growth. It is estimated that around $605 billion is the cost of this disease which is almost one percent of the world's gross domestic product. The technical assistance of the Alzheimer's patients with their everyday life activities under surveillance is termed as smart homes. The very first challenge encountered in this system is the recognition of their daily chores and this gainsay involves knowing a modicum number of those activities which are rudimentary yet important. The course encounters rejecting many hypotheses that might lead to overfitting the data. Nonetheless, only few works addressed all those aspects relating the objects and the environment [1],[2].

II. LITERATURE REVIEW

A. Novel Recognition Model

In reference [3] one novel recognition model has been proposed that utilizes the most important qualitative spatial reasoning approach to differentiate among the activities. Adding to which, it validates through substantial testing of realistic scenarios based on clinical trials conducted at their workspace under supervision. The system consisting of subjects that are normal as well as impaired. However, the discrimination through variant hypothesis without considering other factors such as the distance of objects, their weight etc. resulted in an obscure differentiation. The speed at which the algorithm can recognize efficiently is measured by EDR (early detection rate) metric measures. The reduction in such a percentage obtained as a result implies a better system. Meanwhile, the proposed algorithm notably enhances the acknowledgement process, which is a good sign in terms of learning model. However, the exclusion of direction and orientation details, gives rise to confusion with respect to the task details [4]. The first among the constraint classification system uphold the logical and mathematical constraints. Despite the development of various theories and working on their computational efficiency, drawbacks evidently telltale the erroneous plans not being defined. The lack of testing in real world and not laboratorial smart homes, make them only theoretically functional and hence requires more pragmatic steps. The assumptions made also talks about the already available library of activity sets which again is not consistent [5],[6].

B. Bayesian/ Markovian Model

The theories designed over the concept of probability such as Bayesian networks and Markovian models assigns a set of probability score to the hypotheses and the one with the highest score is considered as the plan about to be executed. The experiments conducted by Patterson to recognize 14 different ADLs and a recognition rate of 88% was obtained but required the glove to remain worn which serves as an antenna that is developed based on the Radio Frequency Identification (RFID) technology. The probability scores assigned to activities break also generates a well-defined set of phases that include details like the objects involved and the duration of the task. All this information is processed to be converted into another set of Dynamic Bayesian Network (DBN) [7].

C. Hierarchical Hidden Markov Machine (HHMM)

A Hierarchical Hidden Markov Machine (HHMM)that establishes the initial probability values based on supervised learning of the model given certain conditions was implemented. The usage of camera-based system helped recognize the patterns. The obtained results were impressive with a 100 % recognition rate and a correct duration rate of 73.5 % on a set of 45 tests. However, the system has quite a few pain points. First being, it works on sensors, cameras also known as invasive sensors, which outputs complex data and are not commonly accepted by majority of the older generation. Machine learning algorithms require such sensors and at the same time has a lot of advantages, although, it must not be used as a solo recognition model, but instead be subsumed in other precedent algorithms. HHMM may provide precise results but their complexities, even for minute tasks are relatively high. Adding to this, the amount of training the model has to undergo for ideal output is not precise. This approach also does not address the positional, directional, orientational and dimensional problems that arise while working with models in a wide range of distance with possibility of movement in every possible direction with varying speed and obstacles. [8].

D. Autonomous Agent for monitoring Alzheimer Patients (AGALZ)

The paper in reference [9] presents a scintillating model which is solely created for the purpose of observing Patients with Alzheimer's in health care centers. The AGALZ (Autonomous agent for monitoring Alzheimer patients) that is used in geriatric residences, takes independent considerate case-oriented steps which is developed to schedule the nurses' active working hours while dynamically managing the reports about their activities. Adding to this, the most important motive is to assure the patient receives the right care. This agent is interconnected with multiple other agents in a multi-agent system and also works on all wireless devices, known as ALZ-MAS (Alzheimer Multi-Agent System), which has the potential of indulging and integrating with the environment. The paper aims at demonstrating how its concept of planning enhances visiting schedules which further helps medical assisted geriatric residences. The agents provide all the data in accordance with the patient's history and present updated information which facilitates the work of nurses and doctors [10]. The elucidation, the inter-agent relationship and initial results of the advanced multi-agent system prototype, The AGALZ, in an environment similar to the real world is portrayed [11].

Jeffrey and Meunier [12] put forth the concept of functional programming paradigm which is used by virtual machines that bolster mobile software agents. With this, the application developer is able to build varied mobile application agents in a platform which is robust and rich. This particularly aims to target distributed image processing and distributed medical information. This extremely interesting idea and proposal encountered quite a few security issues which affected mobile agents and hence, is considered unviable. An alternate for scheduling strategies pinpointing the location of the patient has not been proposed as of now.

In [13] there is a unification between AGALZ agents and ALZ-MAS which is a multi-agent system where it uses a dynamic system for administrating the various situations of the geriatric centre. The Radio Frequency Identification technology (RFID) is used by the system for finding out patient's location concerning to improve the safety of the patient or to set up medical staff plans. The advancement in this multi-agent system is inspired by one of the many peculiar characteristics of geriatric or Alzheimer residences, which happens to be their dynamism, in a manner that the patients will change very frequently, the new patients will arrive and the old patients will pass away. In this scenario, the staff should change their patients frequently which increases the relativity of staff rotation. ALZ-MAS will provide the personnel of the residence with all the required and updated information about the patients, about the centre, about the working plan, about possible problems and it will record their actions and movements within the centre. This technology will prove that the dynamic problems will require dynamic solutions. In the user's point of view, the complication of the solution is decreased by taking the help of user-friendly interfaces and potential and easy to use multi-agent system. ALZ-MAS will mount microchips on the patient's bracelets or ornament which they will wear it to their wrists or ankles and the protected zones are installed by sensors all over with a capture range up to 2 meters which is also adjustable. A 125kHz signal will be used by these microchips to help in locating the patients which can be determined by consulting the AGLAZ agents.

E. Cognitive Aids

In reference [14] Cognitive aids which help the patients with reduced memory issues, due to Alzheimer's Disease or related disorders, improve their problem-solving ability as well as memory are mentioned. These active aids are provided by Assisted Cognition systems. Two such systems are developed which stand to be exemplary examples of Assisted Cognition systems.

They are, The Activity Compass and the ADL Prompter. The first system helps the patient through their day by prompting them to perform multi-step everyday routine whereas, the second system is a literal guide for such patients helping them get through each day through steps of "Activity daily living" (ADL). The information required to run these systems are obtained from the home environment. This home environment will have a network of sensors embedded in them. The information gleaned from these sensors along with a rich probabilistic model of how the patient performs activities are integrated and are further used to predict the patients next move or a series of activities the patient might perform. Multiple sensors are made use of. Some being, Motion detecting sensors, Sound or noise detection sensors, Sensors which detect the position of objects or swinging of doors or even operation of equipment etc. One example we can consider is, a patient enters a dining hall during lunch time to serve food. Then the system notes the time he goes and predicts he might be serving his food. However, if there is a delay and the patient is motionless, the system reminds the patient by intervening and verbally assists the patient by prompting him on the task at hand. These prompts are not given until and unless it is absolutely necessary inorder to avoid any further confusion that would arise and the necessary computation required to produce and perecept the same. The Activity compass is meant to guide the patient in accordance to the environment. Hence, we can note that these prompts are no preprogrammed or set for a particular time. This Activity Compass works on the fundamental principle of client/server architecture where server controls and stores sensor readings, constructed models and background information whereas the client handles the communication between the user and the server. The client of the Activity Compass presently is a GPS and wireless-enabled Palm PDA.

The Assisted Cognition varies from the Activity Compass in several critical aspects. Some are as follows. First, the destination of the user is predicted by having prior knowledge of the patients' movements and obtains a pattern through learning these movements. Second being, the system is able to engage the patient dynamically: for example, if it corroborates that the patient has lost his way and meanders for a longer period than usual, it advices the patient to return home through a vocal/audio prompt or a graphic display giving him the appropriate directions to his house. The Assisted Cognition system has the ability to link present data about the movement of the user with the external surrounding that helps achieve the user goals. For example, we have the metros. consider the following scenario, 1. Gary walks to the metro station. 2. The system takes note of this time. And how frequently Gary takes the metro. 3. Real time metro information depicts the metro departs in 5 minutes and the next one is in 2 hours. 4. The system predicts Gary might miss the metro because he isn't moving fast enough. 5. The system then intervenes and requests Gary to move faster [15].

III. COMPARISON OF DIFFERENT ALZHEIMER'S PATIENTS' ASSISTANCE MODELS

The Table I, gives a clear picture about the various models available for assisting the Alzheimer's patients using various technologies.

Table-I: Comparison of Different Alzheimer's patients' Assistance Models

Sl. No.	Model	Methods	Learning Time	Speed & Efficiency	Result
1	Novel recognition model	Uses qualitative spatial reasoning approach by observing normal and affected individuals	The time taken to learn is quite long as it needs to observe every activity and classify them.	Measure by EDR and there is a reduction in percentage of the rate meaning it is "fast" method.	Only works well in laboratories which makes it theoretically functional. Quite inconsistent.
2	Bayesian/ Markovian model	Sets probability score to hypothesis and chooses one with greatest probability	Takes a long time to determine the probabilities in learning stages and the related information such as the duration and objects involved that to be converted to Dynamic Bayesian network(DBN).	It is quite fast and can work in multiple situations and varies as the strength of the signal perceived from the RFID gloves	Accuracy was about 88% when conditions were right however conversions of networks in case of redundant data reduces efficiency.
3	Hierarchical Hidden Markov Machine (HHMM)	Establishes initial probability values based on supervised learning	Since it is supervised learning it takes shorter period of time. However, does not address distance and direction problems.	The output is complex data and hence it takes time so it is not very fast.	Accuracy was around 100% for 45 tests with duration of 73.5%

4	Autonomous agent for monitoring Alzheimer patients (AGALZ)	Takes case-oriented steps to dynamically manage reporting activities of nurses	Learning time takes long because it is unsupervised and the environment is practical	Once it learns it is able to dynamically update data and works at great speeds	It is quite efficient because once it learns it is bale to update data for new patients as well
5	Cognitive aids	Improves problem solving abilities and memory retention.	Takes a long time to learn as it works in a real environment with sensors	It adapts very fast and hence the speed is great	Efficiency is very good since it helps the patient individually and works quite well

IV. METHODOLOGY

A. Glint – An Alzheimer's Patients' Personal Assistant

The proposed system Glint is an Alzheimer's patients' personal assistant system that helps remind the tasks to the patients such as taking medicines on time, going for a walk or other daily chores. In this model, a questionnaire on a timely basis will be asked to the patients to check the state of the patient and then provide services which can be customized based on the severity. For instance, if the disease condition is severe then the questionnaire is not feasible. The model has a wearable device that interacts with the database that stores relevant data of the required individuals and can be retrieved on request and the activity related information that is retrieved automatically. It has a facial/object recognition system to help provide security for the personalized data. The GPS coordinates and the Bluetooth connectivity with the speaker system helps keep track of the patient's location. The hassle free management of the device is password free unlike smartphones.

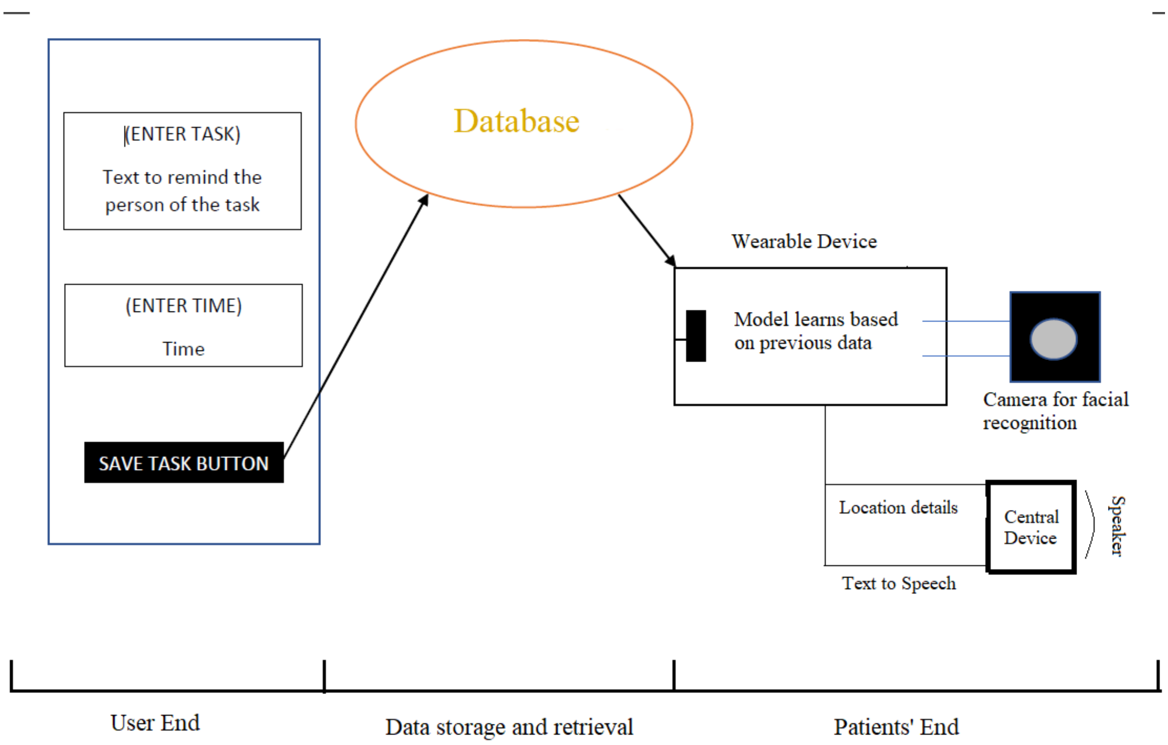

Fig. 1. Glint – System Design

Steps in Operation :

1. This consists of an user end application that enables the user to input data about the task as a reminder to help the patient.
2. The data is stored in a database that can be retrieved later on the patients' side
3. The data from the database is retrieved by the wearable device on the patients' end and processed to remind about the tasks.
4. The model has a central device with the speaker connected via Bluetooth to communicate the instructions. Also, the GPS coordinates help keep track of the patient's location in sync with the central device.
5. A camera module helps in facial and object recognition that in turn converted to speech.
6. The Machine Learning model is based on previous patient specific data and automate the reminder process until there are changes in the prescription.

V. CONCLUSION

Alzheimer's patients need full-time assistance and many systems have been proposed that can provide the required help and assistance up to a certain level. However, the dependability, accuracy, user interface, portability, speed and feasibility etc., are some of the factors to be considered in proposing a new system or improvising the existing ones. Theoretical ideas mentioned above may provide accurate results in simulation and laboratory constraints. However, they require pragmatic implementation in order to be proved as a reliable solution considering the factors listed. Therefore, more research needs to be done in gleaning the data related to the patients, understanding patients' specific requirements, working on the ability of the system that can be adapted and customized accordingly followed by implementing such systems that work well in the real-world environment.

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