A Proposed Effective Framework for Elderly with Dementia Using Data Mining

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Abstract—**Elderly people constitute a significant percentage of the population all over the world. Patient Central Bureau of General Mobilization and Statistics (2013) reported that elderly represent 6.9% of the Egyptian population, it is estimated that the number of elderly people will be replicated in 2030. Eight percent (8%) of elders aged between 65 & 74, also about 50% aged over 80 suffer from the cognitive disease or dementia. The core of this research is to use intelligent techniques to fulfill specific needs of cognitive deficits patients and assess interaction changes based on patient's behavior in various disease stages. The aim of this paper is to provide a usable and effective framework for elderly. The proposed framework will be divided into three main phases, evaluation phase, data mining phase and assistance phase. Patient proceeds in the three stages by behavior analysis and feedback to provide interactive evaluation and assistance for him/her.**

Keywords—Dementia; Alzahimar; Elderly; Data-Mining; HCI

INTRODUCTION

Dementia is a degenerative brain disease that affects cognitive abilities of patients in general and the elderly, in specific [1] . This disease has many forms such as Alzheimer diseases (AD), Vascular dementia, Dementia with Lewy bodies (DLB), Mixed dementia, Frontal temporal lobar degeneration (FTLD). That affects cognitive abilities of patients such as memory, language, communication skills and all daily life activates [2]. Human-Computer interaction can be defined as a powerful tool used to make technologies more usable, simple and adaptive for everybody and especially with disabilities.

Human-Computer Interaction (HCI) points out the design and implementation of computer-based systems that different types of people interact with, including embedded systems in all kinds of devices, and desktop systems, as well [3]. HCI is heedful with the following:

1. The user interface between computer and user for designing of the menus and screens,

2. The dialectics for building the functionality into the system.

3. The sequent of using the system over time and its impacts on the society, group, and individual.

Assistive technologies that based on HCI models are facilitators that can be utilized to improve the quality of life for patients, disabled, and elderly. It can assist human in a more natural way to interact with his environment.

Alzheimer and other forms of dementia have many symptoms that affect cognitive abilities such as memory loss, communication, and intellectual skills, as time progress symptoms change and the disease deteriorate more brain cells through early, mid, and late stages, symptoms can vary for everyone in each stage. Until now, there is no cure for cognitive deficits, but some technologies were developed to overcome symptoms and decrease worse illness [4].

Although the research on elders' welfare is extensive, there is very little research on evaluating and dynamically adapting to user needs. Adapting to patients' behaviors, changes and communication skills is the core of our research. The system will depend on monitoring patient continuously and analyze its activities and behaviors by intelligent techniques, then offer assistance that suits his/her needs. In most systems inputs are usually provided by hardware devices such as a mouse, or a keyboard. In HCI systems inputs provided by smart devices like (GPS, Health devices, etc.) or captured from sensors in a way that permits capturing data without the user noticing (through gaming techniques) which makes interaction natural. Our main task is to make an evaluation and analysis of data in real-time and provide adaptive friendly and effective assistance for all daily activates.

In the literature, the majority of HCI systems for patients with dementia present an insufficiency [5] in analysis due to the complexity of processing different kinds of data and emotions. However, integrating elders' needs in one framework is a necessity.

The second section of this paper presents the related work. 3rd and 4th sections will present the aim of this research and the research question, respectively. The proposed framework is presented in section 5. Finally, the conclusions and future work are presented.

RELATED WORK

It's no doubt that cognitive deficits such as Alzheimer and forms of dementia are the most public health and social care challenges facing people currently and in the future and the most expensive diseases today in many countries. T.R. Reid [6] reported in a recent article in the AARP Bulletin that "the cost of caring Alzheimer and dementia patients in America exceeds the cost of treatment for heart and cancer patients. An estimated of 46 million people have Alzheimer and dementia worldwide, this number is excepted to increase 131.5 million by 2050. The symptoms of dementia disease vary from person to person. In contrast with most of diseases and disorders, dementia

diseases don't appear all at once. It starts with little symptoms and gradually increases. Most cognitive deficits patients have in common symptoms and stages, learning about diseases help in setting the stage of the patient and maintain needs accordance with this stage. There are three main stages of dementia diseases like Alzheimer (mid-early stage, Moderate stage, serve early stage) Fig. 1 illustrate brain status in the three distinct stages".
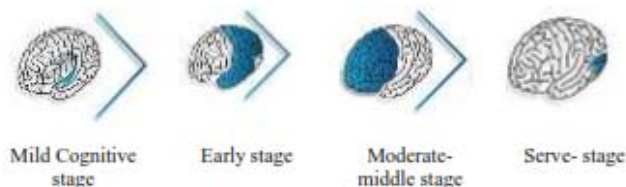

Fig. 1. Distinct Stages of Alzheimer

TABLE I. STAGE DURATION, SYMPTOMS, AND REQUIREMENTS

Stage	Duration	Symptoms	Requirements
Mild-cognitive	7 years	Diseases begins in medial temporal lobe	- Short-term memory loss
Early-stage	2 years	Diseases spread to lateral temporal & parietal	- Previous stage problems - Reading problems - Poor object recognition - Poor direction sense
Moderate-stage	2 years	Disease spread to frontal lobe	- Previous stage problems - Poor judgment - Impulsivity - Short attention
Serve-stage	3 years	Disease spread to occipital lobe	- Previous stage problems - Visual problems

As mentioned above in table 1 dementia diseases don't appear all at once, but they start with little symptoms and gradually increase. The speed of symptoms increasing inversely proportional to brain actives like memory training, short and long activities for attention and concentration which help in increasing cognitive abilities. We aim in this research to stand against and delay degenerative brain and memory loss with cognitive brain activities. Cognitive deficits such as Alzheimer and dementia are the most common diseases that affect cognitive abilities for elders. As these diseases advances, more symptoms appear which negatively affect memory, language, and communication skill. It also causes depression and sleep disorders. Until now there is no cure for cognitive deficits that lead to functions loss and ultimately death. Current solutions only help in living with symptoms and decrease the speed of function loss [7].

HCI in assistive technology for special diseases (disabled, elderly) aims to understand and facilitate the needs of patients and their communities (caregivers, doctors, patients). Complete HCI system for Alzheimer's patients (AD) developed by D. Mandiliotis et al. [7] which make an integrated system that fulfill patient's needs in adaptive way, system provide facilities to caregivers and doctors to monitor patient and deal with his needs (symbio music, symbio games, symbio organizer... etc.). Authors of [8] provide prototype for smart environment for Alzheimer's patient this project aims to depend on monitor patient and immediately help when error has been happened by sending text message to caregivers, this home prototype proposed built-in sensors for oven, refrigerator, sink to reduce risks and allow caregivers to monitor and follow patient actions, authors. This paper demonstrates, in theory, how HCI can be achieved in a smart environment for Alzheimer patients. Others [9] provide multimedia story include (images, videos, music) which allow patient to interact with multimedia, this interaction adaptive dynamically according to the state of the diseases, it will help in the mid stage of cognitive deficits.

Some studies try to interact with patients according to sensors, [4] try to extract emotions in three levels arousal valence and dominance dimensions VAD levels developed HCI system to understand and classify human emotions through VAD levels, physiological features used from DEAP dataset to analysis and extract features for emotional patterns. Extreme machine learning (ELM) used to predict emotions. Others [10] (as shown in Fig. 2.) depend on speech and gesture as input for developing HCI System, gesture input is provided through a computer mouse (instead of a pen), speech recognition made using the open source software Pocket Sphinx. Screen recording and camera recording used as inputs datasets another type of interaction by hand gesture [11].

Healthcare industry nowadays produces big dataset about patients, disease recognition and diagnosis etc. The massive amount of data is the core of analyzing and extracting knowledge that helps in efficient decision making and cost saving. Healthcare application depends on data mining in diagnosis, treatment and enhancing healthcare resource management etc. Using data mining and machine learning in health care would save various manual process that leads to improving patient care, data mining provides several types of processes that extract valuable information that help doctors and caregivers in taking the right decision in patient diagnosis and treatment. Machine learning in healthcare recently made huge improvements, Google developed machine learning algorithm that made diagnosis cancerous tumors based on mammograms[12]. It also reported high results in skin cancer using deep neural network [13]. Diabetic retinopathy in retinal images also diagnosed using deep machine learning algorithm [14]. Ilayaraja et al [15] proposed data mining technique to predict the patient under risk based on some chosen features and the level of risk. This method was applied over 1000 record of heart disease patient who suffer from several heart diseases it depends on, discarding the unnecessary item set which does not satisfy the support value, this method increases efficiency and save execution time.
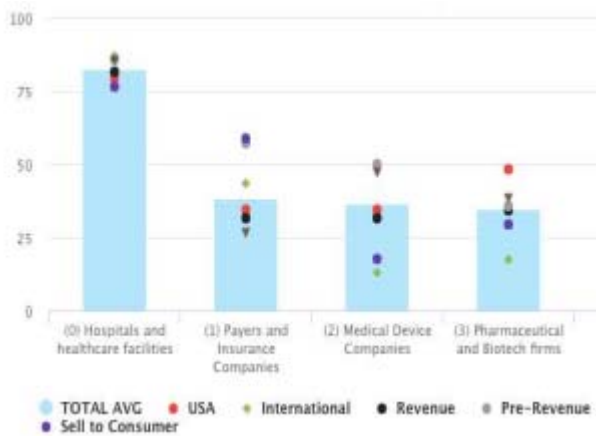
Fig. 2.   How Data Mining Affect In Healthcare Side World Side and in USA [10]

MOTIVATIONS

It is clear that a limited number of devices and assistive software are developed for elders in technology industries. In spite of the fact that the number of elder people with cognitive deficits is significant, it's clear that Alzheimer Disease International (ADI) [16] has reported that there are 44 million people with AD around the world and 83 million people that suffer from cognitive deficits This number is expected that this number will triple by 2050.

Designing technology system for elders allows them to stay in their home longer and safer. For example shopping systems, emails, security system and games will increase the sense of dependable and well-being, as T.cohne [9] reported that speed of memory and functions loss will decrease with daily activities.Therefore the present study aims to understand and interact with AD patients, develop an application with simple and accessible interface could effectively adapt with patient requirements and, predict patient needs and increase cognitive abilities through daily life activities.

RESEARCH QUESTION, OBJECTIVES

This study aims to understand the needs of patients with cognitive deficits; the main goal of this study is to answer some question,

- How can human-computer interaction help elderly in their daily activities in the efficient and friendly way?

- How can the research of this dissertation help in increasing the cognitive ability of elders?

- What kind of data mining techniques and dataset will help in diagnosis and assist elders?

- Will this kind of smart interface will encourage elders to change the way they convince about technology systems?

THE PROPOSED FRAMEWORK

The aim of the study is to explore needs of patients with cognitive deficits and understand the need to help in patient's daily activities. Our research focuses on help facility that assists patients with cognitive deficits using intelligent techniques. Proposed system aims to monitor patient activities, evaluate interactions and adjust the

system to suit patient needs. Various kinds of data are needed to simulate human- computer interactions for elderly. These data could be structured or unstructured. Table 3 will list various types of human data that could be captured from different sensors according to literature.

One of the main contributions of our research is to enhance prediction of emotion and needs of the patient based on data mining. TABLE 2 AND TABLE 3 summarizes an overview of data mining techniques according to the literature review. Proposed framework will be divided into three main phases as shown in Fig. 3. Framework phases will be discussed in the following section.

TABLE II.   TYPES OF HUMAN DATA

Data	Reference number(s)
Vital signs	[7], [17], [18]
EEG signals	[7], [19], [20], [17]
Eye gaze	[21], [22]
Speech	[10], [23]
Emotion	[4], [7]

TABLE III.   DATA MINING TECHNIQUES

Classification techniques	Reference number(s)
Neural Networks	[12], [13]
Extreme Machine Learning (ELM)	[4]
Wavelet transform	[4]
Bayesian network	[24], [18]
Rule-based tree	[24], [25]

A. Phase 1: Evaluation phases and Acronyms

This phase will focus on the evaluation of cognitive abilities using games and tests that evaluate short-term memory, attention, and concentration, the proposed test will focus in the evaluation of memory functions which related to recent events and conversations. J.M. Montenegro ...et al [21] proposed cognitive evaluation test based on turning test and virtual environment tests. This stage will be considered as an input to the third stage. System in the third stage will vary and dynamically change according to cognitive abilities.

B. Phase 2: Data mining phase

In this phase, the system will try to capture data from patient sensors and analyze it in the real time with the clinical and the in a middle data mining layer. Physiological and vital data will be analyzed, and key features will be extracted using feature selection techniques, then training and on time classification. This stage has a great importance in understanding and developing of usable and accessible HCI interface that will assist in improving cognitive abilities of the patient.

C. Phase 3: Assistance phase

This phase is the most important phase of our proposed system. It provides the following possibilities:

- Use data mining from the previous step to predict patient needs.

- Provide mental activities to develop awareness and recognition.

- Make periodically assessment to the patient.

- Provide feedback and automatically adapt system according to patient status.

Fig. 3.   The Proposed Framework

CONCLUSION AND FUTURE WORK

This paper reports an ongoing research project of for elder people. The core of this research is to apply intelligent techniques to meet particular needs of cognitive deficits patients and assess interplay adjustments based totally on his or her behavior in diverse disease stages. The aim of this paper is to provide an effective and usable framework for elderly; the proposed framework is divided into three main phases, evaluation phase, data mining phase and assistance phase. Patient proceeds in the three stages by behavior analysis and feedback to provide interactive evaluation and assistance for him/her.

After implementing this framework, authors will apply it for elderly and will try to improve it after recording the results.

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