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DESIGNING A MEMORY-AID AND REMINDER SYSTEM FOR DEMENTIA PATIENTS AND OLDER ADULTS

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Abstract. *The United Nations statistics show that our society is rapidly aging, and this has led to the surge in the development of assisted living technologies. Of note is the minimal attention given to the assisted living technologies for dementia sufferers. This research study therefore, proposes the design of an assisted living technology that could aid older adults and dementia sufferers to lead an independent life. The design incorporates speech system, schedules and task reminders, video and picture reminders of loved ones, events etc. Although there are some available systems that aid these sufferers, however, most of these systems are geared towards monitoring of patients due to accidents or sudden changes in their health conditions rather than assisting them to live an independent life. The novelty of our system provides the ability for sufferers and older adults to live an independent life while also providing a monitoring system for healthcare workers and loved ones of the patients.*

Keywords: Dementia, Older adults, Internet of Things, Memory-aid, Reminder system
JEL classification: L86, I00

1. Introduction

Dementia is a medical condition which can cause a decrease in mental abilities of the affected person and it is progressive. It spans an array of neurological disorders, and it is defined by memory loss and cognitive deterioration. It severely interferes with a person's ability to manage his/her day-to-day activities. Memory loss is one of the most serious symptoms associated with dementia. The Alzheimer's disease (AD) has been shown to be the most prevalent form of dementia, which accounts for up to 50–70% all cases [1]. Older people and patients who suffer from mental disabilities like dementia often find it hard to have good control over their lives with little assistance from others. They find it challenging performing basic chores and even interacting with assistive technologies that could aid their daily activities. Television sets have been shown to be useful as an effective assistive technology for older adults by providing reminders of their day-to-day activities including medication timings [2]. Research has shown that story-telling has proved to be an effective therapy for dementia patients [3], so story-telling through pictures can benefit the patients. It can also benefit older adults who are not proficient with technology and who live in care homes to connect with their relatives through pictures on a display screen. One of the effective ways of using assistive technology is to implement story retelling of the past via the use of visual cues, which could significantly help patients who suffer from dementia to help with memory recollection [4]. In addition, the development of assistive technologies that could remind a dementia patient of

their daily activities will help get them through with their daily activities. In this regard, technology can be used to assist dementia patients and older adults to function properly and offer some memory stimuli [5].

This paper proposes the design of a system that aids the memory of dementia patients and older adults using audio-visuals in order to connect with their loved ones. Additionally, a daily task reminder system such as when the next medication is due, doctor's appointment, appointment with friends and other loved ones amongst others. This paper is organized as follows. Section 2 discusses current technologies used in the care of dementia patients and older adults while section 3 introduces our novel design of an assistive system based on Internet of Things' concept. In section 4, we provide and our conclusion and discuss some future work to advance our system further.

2. Dementia and care for older adults

Dementia is a syndrome which is degenerative, and which affects the brain. The nerve cells miscommunicate with each other due to the dying brain cells. Early symptoms of dementia include: memory loss, mood swings and loss of logical thinking. There are many stages of dementia ranging from mild, moderate and severe dementia. Based on current studies, no known cure exits for dementia patients thus, it can only be managed. Globally, there are about 50 million dementia suffers, with 9.9 million reported cases every year [6]. This figure is expected to rise every year. Many dementia sufferers are admitted to hospitals, and this creates an uncomfortable situation for them, which in turn reduces their quality of life [7]. The authors in [8] have discussed the impact of technology on dementia care among dementia sufferers. Their study accentuates the need for improved technological advancement to help dementia sufferers.

Generally, older adults and dementia patients are usually admitted to rest homes or private homes with personal caregivers present to assist them in their day-to-day routines. However, an assistive technology can be used to help people who suffer from mild to moderate dementia. Survival without personal care is difficult in the case of severe dementia. The number of sufferers will double every twenty years as the population is increasing [9]. Assistive technologies developed for personal home care for such patients will greatly improve their quality of life. An assistive memory-aid system will provide memory stimulation to sufferers whilst the reminder system could benefit both patients and their caregivers in keeping track of their day-to-day activities and medications amongst others.

2.1 Current technological solutions for older adults and dementia patients

With the improvement in the standard of living, there has been a rise in the quality life style among older adults, and one of the major reasons for this is the technological improvements in recent years. There are various assistive technologies which are available to help older adults and dementia sufferers. In the past, safety and security were the primary use of ICT when dealing with older adults and dementia patients, but today, the focus has shifted in providing not only security and safety, but also the use of the ICT industry to promote quality of life style for older adults and dementia sufferers [10]. We review below some typical smart technologies that have been developed and deployed for older adults and dementia sufferers.

2.1.1 Basis B1 smartwatch

The Basis B1 smartwatch is a plug and play device which does not require the user to interact with the device. The device only needs to be charged once every 3 days. The data from the smartwatch can be easily uploaded to a laptop or similar device. The state of the user is recorded by the watch without the input of the user to change the state by pressing any button [11]. It

tracks the heart rate, steps, perspiration, temperature, and calories. The advanced data aggregation function is used to combine data in the form of biosignals for health analytics. The device can be used to monitor the health of dementia patients by tracking their sleep, heart rate and stress levels.

2.1.2 Computerized help and information project (CHIIP)

CHIIP is a system which can be used both indoors and outdoors and across various demographics of people. The system consists of a near field communication (NFC) tag and an android app, and various reminders can be set by the patient's caregiver or the patient, which makes it particularly beneficial for dementia sufferers. The phone however, needs to be close to an NFC tag to initiate a reminder action [12].
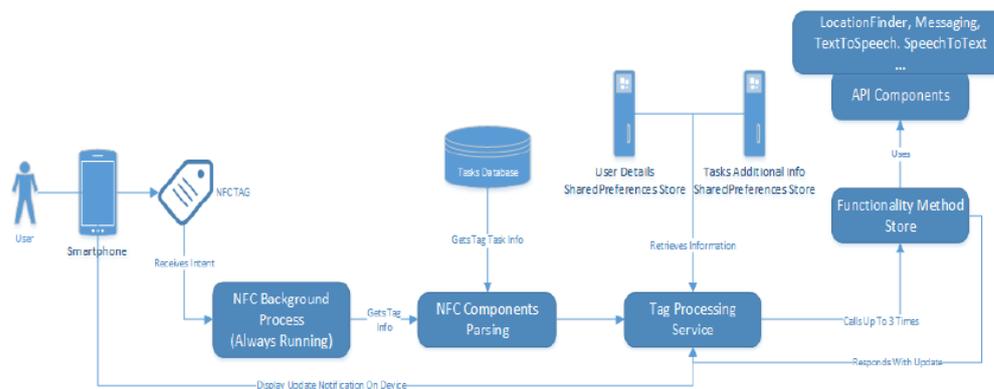

Figure 1. The schematic flow diagram of CHIPP [12]

The flow diagram in Figure 1 shows how the CHIPP process works. The tags need to be scanned by the user for a process to be activated. The application then checks the tasks assigned to the tag using the database. There are various scenarios in which the tags could be utilized. Tags can be placed on doors which could generate a voice reminder to close the door when exiting. It can also be placed in a car which could open navigation system while tags on the wrist could be used to call emergency services.

2.1.3 Tech@home

The Tech@home is another smart system that helps monitor dementia patients by notifying their caregivers or loved ones of any suspicious situation monitored. The system works by using magnetic sensors to monitor the environment in which a patient is domiciled. If the room floods due to an unclosed water outlet, the monitoring system notifies the emergency contacts listed. Bed sensors are also used to monitor the time spent in bed while magnetic contacts are used to monitor whether the fridge is left opened by the patient. Figure 2 shows the physical setup of the monitoring kit. If the caregiver could not be reached, the kit will try to notify the all secondary emergency contacts listed in their order of listing [13]. A fundamental weakness with this system arises when a patient wanders off from home, it is unable to report this scenario.

2.2 Advancing care for older adults and dementia patients through the Internet of Things

Degenerative diseases and the ageing population are on the rise in many countries, so the need for advanced medical care for the ageing population is also increasing. The good news is, the
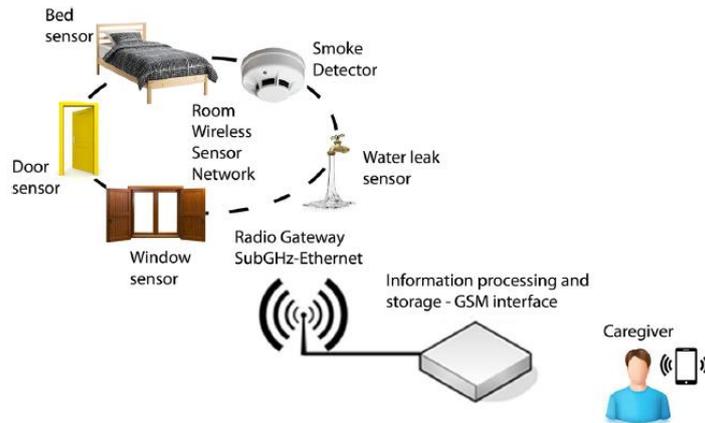
Figure 2. The Tech@home monitoring system [13]

advancements in wireless computing and sensor miniaturization have allowed technologies to be developed that can be used to monitor the health of individuals. The Internet of Things (IoT) – the pervasive interconnectivity of smart networked objects is being used in healthcare for real-time patient monitoring, treatments and medication dispensing. IoT can assist in the management of chronic health conditions for all patients especially for older adults and dementia sufferers. IoT based wireless sensor networks can reduce the workload of caregivers and doctors as IoT sensor systems can be used to monitor the condition of patients [15]. As life expectancy is on the rise due to better medical care globally, older adults are now forced to live on their own. Furthermore, many older adults also prefer to live an independent life that requires little or no help from their care-givers and/or loved ones [14]. In addition to the aforementioned, today, there is a huge interest globally on technologies that could assist patients, older adults and disabled people to have an independent life [14]. These assistive technologies can decrease the pressure and cost of healthcare systems for governments and also give patients their freedom to be away from the hospital [15]. Of particular importance is the elimination of data entry errors from healthcare staff that could result due to work fatigue or large number of patients.

3. The Memory-Aid and Reminder System: Design and Functionality
We propose a Memory-Aid and Reminder System for dementia patients and older adults to assist and help them carry on with an independent life style while providing healthcare workers with a good monitoring system for their patients. The design schema presented in figure 3 displays a simplified representation of the different components of the system interconnecting and interacting with each other. In our design (figure 3), a loved one with appropriate permission could upload videos and pictures to the cloud to help as a memory recollection for the patient. A doctor or a nurse from a patient's hospital could upload detailed prescribed medication which is synced to the cloud while the patient gets reminders when they need to take their medication. Furthermore, in the system (figure 3), magnetic door sensors (exits) serve to alert the system of a patient's absence from the house. This helps monitor when a patient is either at home or away from home. The system uses this feature to determine a patient's availability in order to know when to display the memory pictures, audio-visuals, and even remind them of their appointments and/or medications amongst other activities.
From the figure 3, audios, videos, patient's activities, appointments are synced to the cloud. This provides a repository to maintain a patient's detailed activities and keep track of all reminders and memories they have cherished, which hitherto the patient could have forgotten.
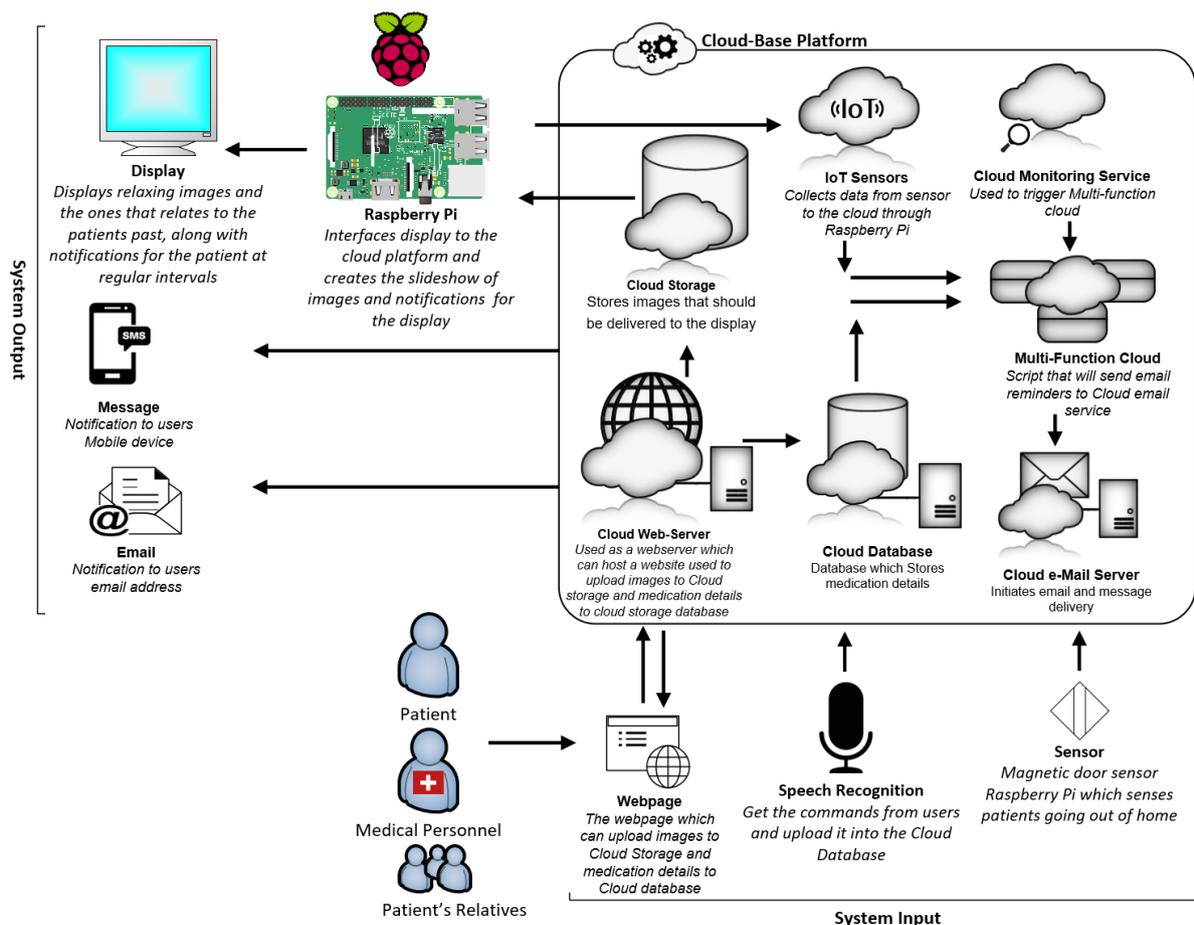
Figure 3. Schematic design of the Memory-aid and Reminder System

Reminders for the mobile device can be received in the form of emails or text messages, which can be achieved using a cloud-based e-mail server. A cloud-based subscription system is setup to generate notifications, which can be used as a reminder for appointments, time to take medication etc. The cloud email server can publish messages to the topic at regular intervals using multi-function cloud such as AWS Lambda in AWS (Amazon) platform.

The system can be implemented using an audio-visual display which is connected to a Raspberry Pi system. The Pi is in turn connected to a cloud-based platform like Amazon AWS or Google Cloud, although different cloud services could be used to implement the system design. The Pi storage is synchronized with recent audio visuals uploaded to the cloud storage. This helps to provide some recent audio-visuals when there is possibly loss of internet connectivity. However, due to the limit of the local storage on the Pi, the audio-visuals will be constantly replaced with newer memories from the cloud storage, but as soon as the connectivity is restored the patient is connected to the entire repository of memories and full functionalities. Furthermore, an easy-to-upload interface is provided for relatives and medical professionals to upload inputs. A cloud web-server could be used to host the website that can be used to upload inputs like appointments, medications, visuals, audios. A voice module is also provided to allow healthcare workers to create voice recordings of medication intake (type and amount of medication to take and when), or loved ones sending messages.

The outputs include: emails, text messages and audio-visual displays that will facilitate appointments reminders and memory recollection in addition to other specified functionalities.

4. Conclusions

Older adults and dementia patients are normally admitted to rest homes or private homes with personal caregivers present to assist them in their daily living. However, these older adults and dementia patients who desire independence in their day-to-day living can with the help of our proposed system achieve this aim. The proposed system aids users with task reminders, video and picture remembrance of loved ones and appointments amongst others. In our future work, a testbed implementation of the proposed design will be trialed with patients to ascertain its impact in assisting older adults and dementia sufferers in leading independent life style based on the functionalities of our system.

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