An Assisted Living Home for Alzheimer's Patient in Saudi Arabia, A Prototype

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Abstract. Number of patients with Alzheimer's disease (AD) is increasing every day. As it target and destroy brain cells. And in order to avoid the high cost of care institutions of Alzheimer's patients, we should provide a safe environment for them. Ambient Assisted Living (AAL) technologies can provide such environments. AAL is used to supervise and assist people with disabilities who cannot rely on themselves as patients of Alzheimer's. In this paper we present a prototype of a house that has been equipped with Arduino micro-controller to suit the Alzheimer's patients. By monitoring the behaviour of the patients, the system will interact by sending a message for the caregiver if a risk action was detected. The evaluation of the early prototype system involved evaluating the monitoring system as well as the devices.

Keywords: AAL · Alzheimer · Arduino · Physical computing

1 Introduction

In Saudi Arabia, experts have estimated that the chances of being diagnosed with Alzheimer's doubled every 5 years [1]. Though the Ministry of Health (MOH) at Saudi Arabia has no official statistics as it stated in its website, they have declared that there are at least more than 50 thousands Alzheimer's patients in Saudi Arabia, most of them are women [1]. Though this number might be insignificant, In a study that explored the Co-morbidities of patients with dementia in Saudi Arabia, The study have found that 18.2 % of sample consisted of 77 patients with dementia have presented with cardiovascular risk factors [3], This results have expanded the problem scope as World Health Organization (WHO) have reported that cardiovascular diseases are accountable for 45 % deaths in Saudi Arabia [4].

Fortunately, Ambient Assisted Living (AAL) technologies have evolved in the past two decades. These technologies aim to offer an easier lifestyle for patients having cognitive or/and physical disabilities through enhancing the quality of life as well as reducing the need for social and medical care [5]. Under this scenario, patient's treatment will take place at home by using the AAL technologies, which can be done by monitoring their daily life activities and evaluation of critical data, sending alarms and making recommendations in case of need [6].

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It is evident that deploying AAL technology will enhance the quality of life for Alzheimer's patient and it would ease the burden of responsibility of continuous monitoring felt by the caregiver. However, as stated by specialists at the Saudi Alzheimer's Association, a lot of families dealing with Alzheimer's have not deployed any technology that would help them on daily basis.

This paper deploys those technologies into customizing a house that suit Alzheimer's patient needs. Using Arduino, a physical computing sketch kit [7], a prototype of a house was built taking into consideration different aspects that may affect the design of the house; such as culture and architecture layout. Subject Matter Experts included doctors, specialists and caregivers, validated the prototype.

2 Inspiration

An assisted living home is a home that had been customized to enhance the quality of life for disabled person who live in it [8]. These homes had been equipped with technologies that contribute into discovering insights of patient behaviours. These insights have a great value for caregivers and doctors into diagnosing the patient stage of Alzheimer's and therefore adopt to more related course of treatments.

In this section, we explore the literature for implemented AAL project to introduce it in the prototype.

The In-Home Monitoring System (IMS) [9] is a sensor-based monitoring system, sensors deployed within this system varied between: pressure switch pads, temperature sensors for the stove and motion detectors. In [10] researchers have conducted a need perception study that targeted elderly who lived in a home with IMS embedded, the study have concluded a positive attitude toward smart home technologies in general.

The Aware Home Project [11] is a program within Georgia Tech Broadband Institute's Residential Laboratory. The project goal is to explore the ubiquitous computing related to elderly healthcare problems. One of the functionalities of The Aware Home it offer is to analyse the extended behaviour. As defined by researchers, an extended behaviour is 'either in time or in time and space'. Such as moving objects around the home, a stochastic context-free grammar (SCFG) technology was used in conjunction with detectors.

3 Building a Prototype

In Software Engineering field, building a prototype have been recognized to be the base of a software development model. It is since 1987 where Bullet and Brooks have highlighted that software development process will not be simplified unless it becomes visual. [15] The prototype was used by software engineers as a tool to better understand the requirements [16]. As it offers the user "functionality" of the design [15], the interactions with prototype can enable the user to grasp the dynamics of the desired system [16].

4 Methodology

This section describes the four prototyping development stages from establishing the prototype objectives to the final stage of evaluating the prototype.

4.1 Establish Prototype Objectives

Taking care of Alzheimer's patient requires high physical ability, emotional capabilities, and financial aid. The demands of day-to-day care, the change of family roles, and difficult decisions about getting external help could be difficult to handle. The main objective of this project is to raise the awareness of AAL technologies and its uses for Alzheimer's society by building a throwaway prototype that suit Alzheimer's patient needs. The aim of developing a prototype is to create an easy to evaluate model in short-time with low-cost.

4.2 Define Prototype Functionality

This project depends on monitoring and detecting patient activities. The system will assist the patient immediately once an error activity has been accrued. Interactively, this system would send text messages to the caregiver or/and taking an immediate action. Figure 1 shows the context diagram of Alzheimer's patient home prototype. In this prototype, sensors have been built in the oven, sink, refrigerator, bedroom and on the main door intended to detect and prevent dangerous situations. The functionality of the prototype has been determined by Alzheimer's patient caregivers as well as knowledge shared by Saudi Alzheimer Disease Association.

The key stakeholders of this house are Alzheimer's patient, the caregivers, and the health care provider. Using AAL technology will allow caregivers to monitor the patient actions from remote location. Caregiver's concentration and physical pressure will be reduced by reducing the number of working hours. Furthermore, the caregiver and the health care provider will take the advantages of the system through receiving different kinds of reports about patient's behaviour (Table 1).

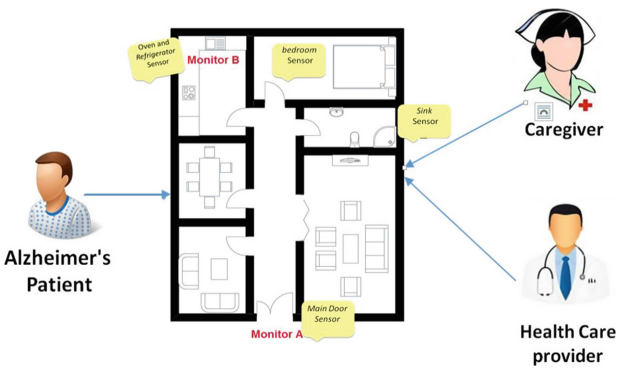

Fig. 1. Context diagram of Alzheimer's patient home

Table 1. Prototype functionality

Sensors	Patient action	System response	Notification
Sink	Left the water tap open for a specific period	Close the water tap	Sending SMS message to the caregiver
Oven	Forgot the stove on without usage for a specific period	Switch off the stove	
Refrigerator	Left the refrigerator door open without usage for a certain time	Close the refrigerator door	
Bedroom	Fell out of bed	No action	
Main door	Open the main door	No action	

4.3 Develop Prototype

Our prototype simulate the functionality of two parts namely, the main door and the oven sensors. In the early stage having fewer parts in a prototype is almost better as stated by Yang, "Prototypes with fewer parts correlate with better design outcome, as do prototypes that have fewer parts added to them over the course of development. Also committing more time to a project is not necessarily associated with a successful design outcome." [12]. To build this prototype we use Arduino Uno microcontroller since it has huge market and open source [7], in addition we use various sensors to monitor the house. Global System for Mobile communications (GSM)[1] shield has been bulged in the Arduino board with a Subscriber Identity Module (SIM) card in order to send notification messages. Figures 2 and 3 show the main door and the oven that have been developed in the prototype including the Arduino, sensors and other components.

4.4 Evaluation Prototype

The evaluation of the early prototype system involved evaluating the monitoring system as well as the devices. In this phase the components of the system will be tested individually. The aim of this process is to insure that the system is well working according to the specifications and achieving the desired goals.

5 Limitations and Future Work

Due to the constraints of sensors availability and time limitation part of the prototype functionality will be considered as a future work. These functions include refrigerator, sink and bedroom.

[1] http://arduino.cc/en/Reference/GSM.

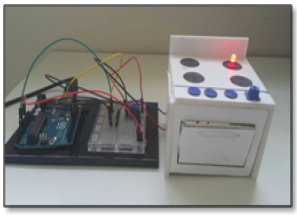

Fig. 2. Oven prototype

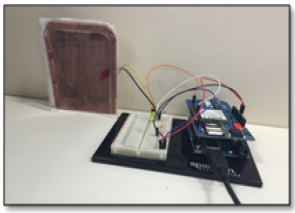

Fig. 3. Main door prototype

6 Conclusion

Ambient Assisted Living AAL experiencing significant development in the last decade. Using AAL technologies, we can control and reduce the risks that may surround a patient of Alzheimer's because these technologies provide the ability to monitor the health and safety of the patients. Using AAL, we developed a prototype of a house for an Alzheimer's patients. We identified and monitored several locations at the house to assist the patient. Using Arduino, we monitored these locations, send a message for the caregiver if a risk action was detected, and also sometimes an action is performed to reduce the danger that might result from forgetting some of the devices such as the oven. Consequently, we tried to minimize the risk that might surrounds the patient.

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