

Health Care in Home Automation Systems with Speech Recognition and Mobile Technology

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Abstract: - Home automation systems use technology to facilitate the lives of people using it, and it is especially useful for assisting the elderly and persons with special needs. These kind of systems have been a popular research subject in last few years. In this work, I present the design and development of a system that provides a life assistant service in a home environment, a smart home-based healthcare system controlled with speech recognition and mobile technology. This includes developing software with speech recognition, speech synthesis, face recognition, controls for Arduino hardware, and a smartphone application for remote controlling the system. With the developed system, elderly and persons with special needs can stay independently in their own home secure and with care facilities. This system is tailored towards the elderly and disabled, but it can also be embedded in any home and used by anybody. It provides healthcare, security, entertainment, and total local and remote control of home.

Keywords: - home automation, smart home, elderly healthcare, speech recognition, mobile technology

I. INTRODUCTION

The elderly population over the age of 65 is expected to more than double from 375 million in year 1990 to 761 million by the year 2025[1]. Health and social care systems seek ways to help this increasing number of elderly remain living independently in their own homes rather than to move them to a healthcare facility.

Home automation technology helps the user to automatically complete almost all housework or household activities, with little to no intervention from him/her. It allows an individual to control remotely all the technology that is performing the activities. The goal of this kind of automation systems is to make a home safe, easier and more enjoyable to live in[2].

Automation is critical to the healthcare industry. Smart home-based technologies allow elderly to adapt to changes of the human physical and cognitive functions and to continue to live in a familiar environment within an established social network[3].

Healthcare automation systems use much of the same technologies and equipment as home automation for entertainment, security and energy conservation but tailor them towards the elderly and disabled[4]. A smart health care system with technologies that assist elderly people would enable them to lead their life independently and away from hospitals, and also to avoid having expensive caregivers[5].

Some of the main features of a smart home are the ability to vocally command the functions of the home and its appliances, and the ability to control them from the distance using smartphone. These technologies have a key role in the development of smart homes.

Enabling the control of automated appliances and sensors via smartphones and tablets gives freedom to elderly or disabled people, in the way that they don't have to worry about or remember to turn off appliances when they go outside.

In this paper, I will present one such solution where audio-based interaction technology and mobile technology are used to control the home environment. I will present the design and development of a healthcare system that provides a life assistant service in smart home environment.

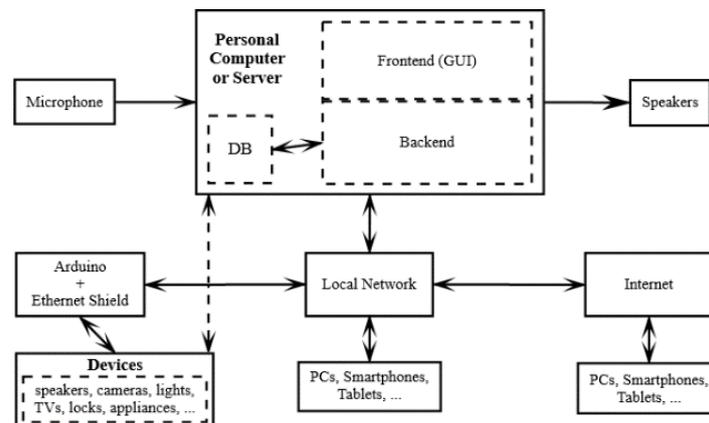
The idea of this project is to design and develop an intelligent home environment that could help the elderly and individuals with disability to live independently in their own home[6].

With regular updates using e-mail and text messages, the technology could also pave the way for elderly and people with special needs to share real-time information on their health or well-being with their absent loved ones. This way, there wouldn't be need for many doctor's visits that are difficult for the elderly and sick[7]. Another important feature of this system is scheduling reminders. It is very useful for reminding the elderly individual about important things such as appointments with doctor, taking medication, alarms, and other important dates.

This kind of system has also some other amenities. The system is designed to provide not only healthcare but also to entertain people who live alone in their home, and to provide security. Video and audio can be present in any room of the house in the form of stored or Internet media like videos, photos, music, or security cameras. The system is connected to Internet, and that gives a slew of different activities to people who enjoy being online, such as social networks, online games or other web sites.

II. METHODS

For providing the personalized healthcare life assistant service in smart home environment, it is needed to



design the healthcare system in a home environment. Fig. 1 shows the system's general architecture.

Figure 1. System's general architecture

The elements of this architecture are:

- The main part and the brain of the system is a Personal Computer or a Server, which controls all other parts of the system. It takes input from different devices connected to it, like microphones, cameras, network routers and etc. The input is then processed by the software which is installed on the PC or server. The software can process audio input with speech recognition, video input with face detection and recognition, push notifications from network, and other. After the input is processed, the system gives the desired output.
- The whole system is connected to the network for operating locally or through the internet. Other devices like PCs, smartphones and tablets, which are used to send commands to the server, must be connected to the local network, or to the internet if they are used outside of the house.
- An Arduino device with Ethernet shield is used to control electricity, home appliances and other devices. It also takes input from main machine through the network.
- And the last part of the system are all the input and output devices which enable the system to work. Microphones, which are placed in each room of the house, send audio input for speech recognition. Security cameras around the house and in front of the door send video input for face detection and recognition. Smartphones and tablets are also used to give input to the system. They give input through the network, both local and through the internet. Other sensors and home appliances also send different inputs to the system. The inputs are processed and then the output is given to the output devices. The speakers in each room give output in form of speech synthesis, music, alarms and voice calls. TVs and monitors give video output in form of real-time videos from security cameras, movies, games, video calls and etc.

The architecture of this healthcare system is designed to be flexible and extensible, to support plug-and-play operation of new devices and components[8].

III. IMPLEMENTATION AND RESULTS

Many different approaches have been used in developed countries in considering how technology can be used in the daily life of the elderly. In some approaches the technology is used simply to monitor health and disease state, but in the others a broader view of technologies has been taken to support living at home

(healthcare; safety, security and privacy; supply of goods and services) and its surroundings (social interaction; mobility; working life; information and learning; health and wellness)[9].

The key feature of the implementation stage is the creation of an environment where data from different application areas can be integrated for delivering a richer set of smart home services. These may be application-oriented services such as comprehensive energy management. They may also be support services, such as a central point of control to define security and access control policies across multiple devices related to the home[10].

The smart home-based healthcare system that I have developed and implemented includes a wide range of information and communication technology enabled electronic assistive devices. It includes centralized control of lighting, heating, ventilation, air conditioning, appliances, security locks of gates and doors and other systems, to provide improved convenience, comfort, energy efficiency and security. Devices are connected through a home network to allow control by a personal computer. Most of devices are also connected to Arduino with relay controller, which is also connected to home network. This system also provides a remote interface to home appliances and the automation system itself, it provides control and monitoring on a smartphone or tablet.

1.1 Speech Recognition

The software that I developed for this system processes a wide range of different commands taken from input devices. The main way of communication with this system, from inside the house, is the voice recognition interface which takes inputs from microphones placed in each room. This interface works in the following manner: first, it interprets the voice commands and converts them to text. The command is then processed with a few different algorithms, and after that the required response or action is given. The interface does not necessarily need a speech to text or text to speech conversion engine. It supports and accepts both audio and text input. However for voice command recognition, the interface should be able to get audio samples as an input.

1.2 Mobile Application

The other way to give a command to the system is communication through the network. For this purpose I developed a mobile application that can be used on an Android smartphone or tablet. This application can work on both local network (inside of home) and internet. It is used to manage home appliances, set reminders and alarms, check security cameras, send notifications to user when he/she is outside of the house.

1.3 Face Recognition

The security cameras around the house and in front of the door are non-stop monitored by the system. The system takes video input from multiple cameras and processes it with face recognition and detection engine. It then gives notifications to user if there is anybody approaching the front door, and gives his name if his face is recognized. This and other kinds of notifications are given through the speakers placed in each room.

1.4 Reminders

User can set up different kinds of reminders, simply with voice commands, and at the given time the system will remind user with notification. An example of this is a medication reminder which will give notification a specified number of times daily, or reminder for appointments with doctor, and etc.

1.5 Info System

The speakers are also used to give feedback to user when some action is done. The user can also ask some questions to the system, and the system will try to find answer internally, but if answer is not found the user can search the internet. Although this option is still in early development stage, it has some very useful commands, for example: asking for current time, date, reading the recent news from given website, ask system to check your email and read it, send email, check weather forecast...

1.6 Voice and Video Calls

The system has option to receive voice and video calls. When there is an incoming call, the system asks user if he/she want to answer the call. The conversation is done without a phone, through the microphones and speakers placed in the room, and for video conference a TV is used to show the picture. For GSM calls, an activated SIM card and a special hardware (connected to the main controlling PC or server) is needed. TVs are also controlled with voice commands or smartphone. They are used for entertainment, communication and for displaying video from security cameras.

1.7 Arduino

Devices like TVs, microphones, speakers and some home appliances, are directly connected to the main machine, other devices are controlled through the network. Most of the devices and home appliances are also

connected to the Arduino hardware which is used to turn them on or off. Arduino is connected to the local network and also gets commands from the main machine.

1.8 OS control

It is also possible to control the operating system of the machine on which the automation system is installed. It can carry out any action that you can carry out on a computer including and not limited to manipulating external applications, communicating with the windows shell, and interacting with web servers and services[11]. Most of the commands work with voice recognition, but it can also be used with keyboard and mouse. User or system administrator can easily add new voice commands for OS usage through the "Commands Control Panel".

1.9 Results

The whole system is tested and is working well. The speech recognition and face recognition engines are trained and achieved high recognition accuracy. For face recognition, the user has to enter sample pictures and names of persons to be recognized. The system can also be set to automatically take picture of persons which faces are detected but not recognized, and later the user can enter corresponding names to the database.

IV. CONCLUSION

Over decades the global population of old people has increased dramatically. That affects us in various aspects, especially in healthcare where admission number and healthcare cost is rising significantly. Nowadays, advances in sensor and network technologies give us new possibilities and new models of care. Smart home is defined as a place that equipped with technologies will enable people to lead their life independently while being in charge of their own healthcare and its expenses[12].

I have designed and developed a smart home-based healthcare system controlled with speech recognition and mobile technology. Using this kind of systems and through personal connected devices and smart home technologies, people's lives can be greatly enhanced, especially those who may be physically or cognitively challenged.

While the system I have presented in this paper has the ability to assist elderly and people with special needs, it still needs to be developed and upgraded with more functionalities and new healthcare devices and sensors that will possibly move most health care tasks from hospitals and clinics to the home. In the next stage of this project, I will focus on making the system more flexible and integrable with new technologies for healthcare and automation.

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