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Research Article

Android based, Advanced Home Security cum Home Automation System for Blind and Differently Challenged People Especially in Developing Countries

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Abstract

In developing countries, the unemployment, excess of population and other similar socio-economic factors galvanise the crime rates in these areas. It's very easy to allude the blinded or differently challenged people. Hence the safety of this sector of the society is exacerbating. There is an ancillary problem with the differently challenged people being alone at home. They can't fully control the electrical appliances like fans, lights and other devices with easy. In this paper I try to engender a solution for both these problems by coming up with a system for the safety as well as automating the home. The above mentioned problems are predominantly present in developing countries as compared to the developed countries. And hence, a cheap security cum automating system would be an eminent solution. In this paper I would like to expound on these problems as well as similar problems faced by this sector of the society. I have been successful in developing a device for the same, and now I am working on the android software so as to ease the implementation to the next level.

Keywords: *Differently challenged people, home security system, home automation, PSoC 4, PIR sensor*

1. Introduction

About 285 million people are visually impaired worldwide: 39 million are blind and 246 million have low vision (severe or moderate visual impairment). About 90% of the world's visually impaired people live in developing countries. Hence safety of these people is a very serious issue, for which the society as well as the government, still has to find a solution to. Now let's consider a scenario in which a blind person is living all by himself at home. How would he take care about his security? Another scenario being a differently challenged person happened to be alone at his residence and wants to switch on a light or a television. The solution to these problems are tried to be dealt with in this paper. I plan to make a system which will help a differently challenged person to operate appliances at his residence and also a security system. The sensors used for home automation and security based system are Passive Infrared (PIR) and IR sensors. This will modernise the security systems for the differently challenged people. This device also encapsulates a GSM module, and a Bluetooth module. The GSM module communicates with the nearby police station and hospital. Hence this device is like a virtual assistance for differently challenged people. The device designed has a portable user control that can be attached to a wheelchair, a mechanical walker, a walking stick and for visually impaired people this user controller can be attached to their shirt, or can be worn around the neck. This device also as a central unit which controls the actions commanded by the user controller. The central unit has a peripheral device network, spread around the house and the doors. The central unit and the user controller communicate through a Bluetooth module.

2. Design

As stated earlier, this device has two major parts, the user controller and the central unit. The user controller is a handheld device whereas the central unit is a stationary device. This is a multi-level design based device.

Before I start with the extensive explanation of the device, let's look at the device architecture, which is represented by the following flowchart.

This flowchart depicts the basic design of the device made. The inputs, outputs and the communication between different modules will be delineated in the following sections.

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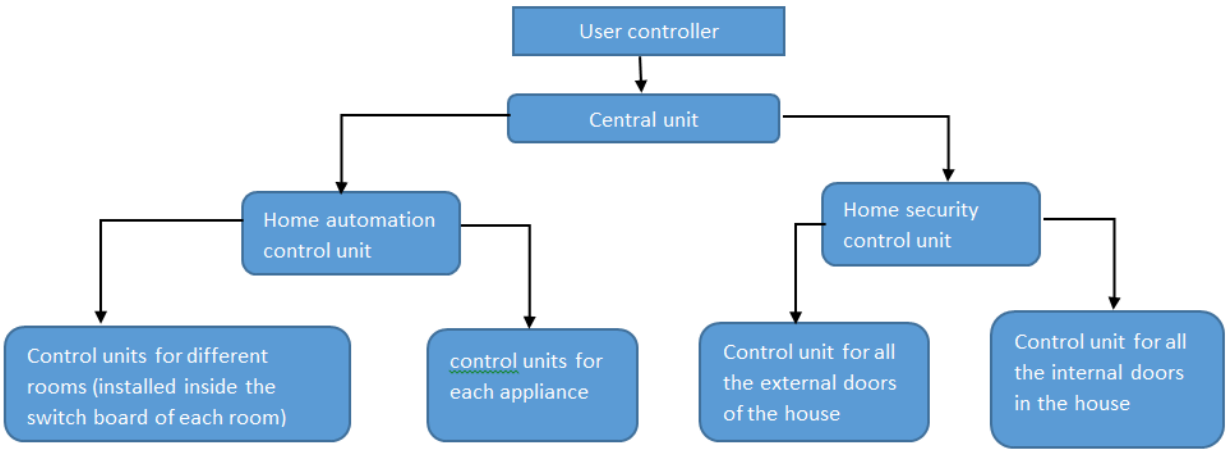

Figure 1 Basic design of the device made

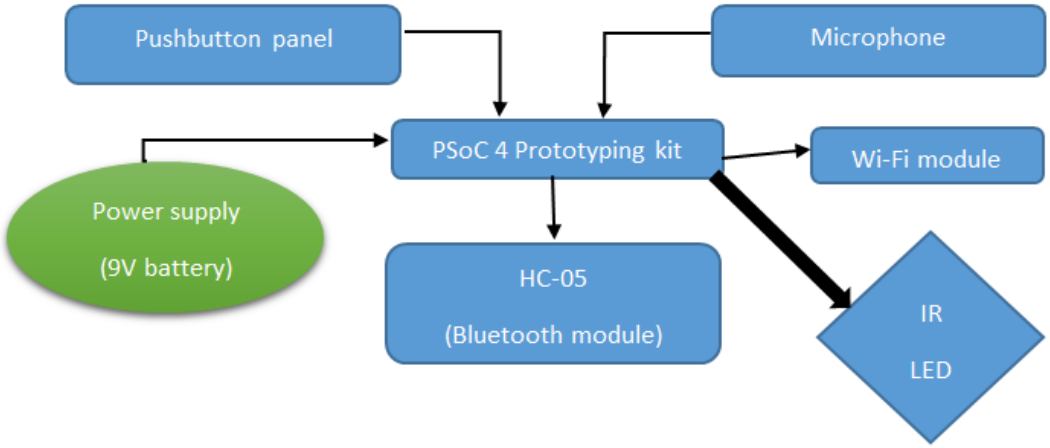

Figure 2: Block diagram of the user controller

3. **User Controller**

The user controller is a handheld device with is controlled by the differently challenged person. It takes order form the push-buttons and also from the Google's speech to text algorithm. Hence this device can also be controlled by a completely challenged (or paralytic patients). Moreover this device has a microcontroller, a Bluetooth device, a Wi-Fi module, a push button panel and a mic for audio inputs. Here, the microcontroller used is PSoC 4 prototyping kit, the Bluetooth module is HC-05, a Wi-Fi module is ESP8266 Serial WIFI Wireless Transceiver Module and the pushbutton panel is made on a PCB with the mic attached. The general block diagram of the user controller is shown in figure 2.

A. Pushbutton Panel

Here the pushbutton is a set of keys used to make a remote like device for turning on /off the security system, activating control panel of the room which one enters(manual mode), auto-sensing mode , emergency call (police station and/or hospital) , customized call (family member contact number). As it is visible that this is a multifunction portable device which can be very helpful to a blind or differently challenged person. The most innovative part of this pushbutton panel is the fact that, it has a buzzer which beeps according to the pushbutton pressed. Hence this will play a fundamental role in the usability of visually impaired patients. When the installation, first takes place the codes of each of the pushbuttons can be explained to the visually impaired person, who will, in time grasp the functionality of the handheld device.

- **Automatic Mode:** there is a switch on the pushbutton panel called automatic mode. This implies that when a person enters a room the lights and fan in that room should automatically turn on and as he leaves the room it should turn off. This is possible by using the PIR sensor, which is a motion detector. It works on the principle of change in temperature. Hence one a person enters the room the PIR sensor situated at the door (of the room), gives a signal HIGH to the control unit of the respective room. Hence turning on/off the lights and fans in the room. This functionality I coded in such a way that the lights will be turned of only once the room is empty. This is achieved by using two PIR sensors. The following diagram gives the top view of the placement of the PIR sensors about the door.

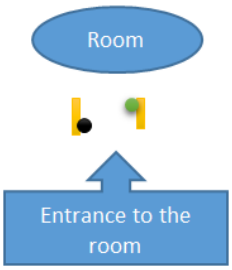

Figure 3: Top view of door and placement of the PIR sensor

Explaining the diagram: the bottom side is the outside of the room, the uppermost side is the inside of the room, and the yellow parallel plates are the top view of the door rims. The black and the green dot are the PIR sensor. This orientation is designed for a sophisticated algorithm. Suppose the differently challenged person enters the room (moves from the bottom side of the diagram to the top side of the diagram), then the black PIR sensor will output HIGH, and only after that will the green PIR sensor will turn HIGH. This condition will increment the counter of the microcontroller of the control unit of that room. The inverted case (a person leaving the room) will decrement the counter of the same microcontroller. Hence this will turn on the lights and fans in the room. Now irrespective of the number of people entering and leaving the room won't make any difference to the appliances, till the last person doesn't leave the room. Hence this is a sophisticated algorithm to help differently challenged people.

- **Manual Mode**

This mode is a button on the pushbutton keyboard. When pressed this will help the differently impaired person to make a choice, of which appliance he wishes to turn on. Hence this operation is conducted using the IR LED that communicates with the appliance.

B. Microphone and Wi-Fi module

Microphone and Wi-Fi module are used for using voice input for differently impaired people. Here we use microphone to take voice input , which is digitally cleaned using the microcontroller and audio amplifier circuit and then is sent to Google's database (via the Wi-Fi module , which connects the microcontroller to the internet.). After effectively predicting the inputted command, from the Google's speech to text algorithm, this string is sent back to the user controller device's Wi-Fi module. This string is transferred to the microcontroller which sends it over the Bluetooth to the central unit. Before sending the string received back from the Wi-Fi module to the Bluetooth module, the microcontroller activates the buzzer which beeps according to the pushbutton assignment. The user has to press the confirm button, for finally sending the string to the Bluetooth module, which will be hence be received by the central unit.

C. IR LED

To explain the functionality of this module, let's look at an example first. For example, if a differently impaired person enters a room, in which he wants to turn on the light only, or the fan only, or some other appliance. As stated earlier that the pushbutton module contains an option for, manual or automatic mode. Hence in the manual mode, when the person wants to turn on/off an appliance based on his needs, he targets the user controller device at the appliance and presses on/off button (just like a TV remote). The IR led sends a hexadecimal code to the TSOP (IR detector) connected to that device and it operates accordingly.

D. PSoC 4 prototyping kit and the Bluetooth module

The PSoC 4 is a $4 microcontroller, which is very helpful for making cost effective systems. The Bluetooth module is a serial trans-receiver used to communicate with the different Bluetooth modules of the control units of different rooms.

4. Central Unit

The central unit is a hierarchical architecture of electronics and embedded system technology. Before explaining the central unit in detail let's look at this general architectural block diagram,

Figure 4 depicts the structure of the central unit. As shown in the diagram, it consists of a microcontroller (PSoC 4), a Bluetooth module and several wires for connecting the central unit to the control units of each room. These wires are all digitally controlled by the central unit. For example, a button is pressed onto the pushbutton keypad, stating to on a fan in room no 3. Hence the central unit will send the information to the control unit of the room no.3 using this digital controlled wire. Also whenever the data is sent from the Bluetooth of the user controller, the data I relieved by the Bluetooth of this central unit. After receiving this data, the central unit takes the respective action by using the digital wires connected to the control units of the rooms. The central unit consists of two sections, the home automation system as well as the home security system. Suppose a person is at home and switches on the home security system. Anyone entering the house without prior information, will lead to an alarm which can alert the differently abled person. To explain these points in details, I have dedicated each of them with a separate unit.

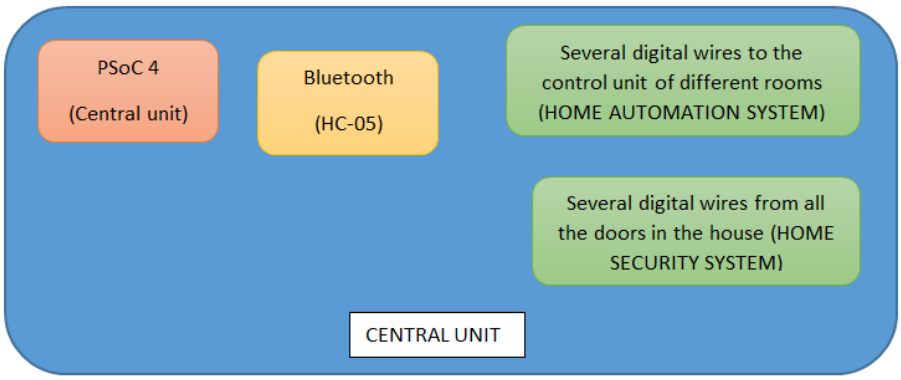

Figure 4: General block diagram of the central unit

5. Home Automation System

Home automation is a very important term in today's hyper-industrialized world. In this device, home automation forms a major sector. The central unit sends digitally controlled wires to the control units of various rooms. The control units of various rooms basically include a microcontroller and a set of relays, installed within the switchboard of the room. These relays are connected to the each and every socket and switch of the switchboard. A typical relay circuit consists of a relay, diode and transistor and a current limiting resistor. Hence, once the central unit receives a command to turn on the appliance of a particular room, it passes the command to the control unit of the respective room, and the relay corresponding to that appliance is activated (by the microcontroller of the control unit). To represent this concept diagrammatically, the following block diagram would play a fundamental role.

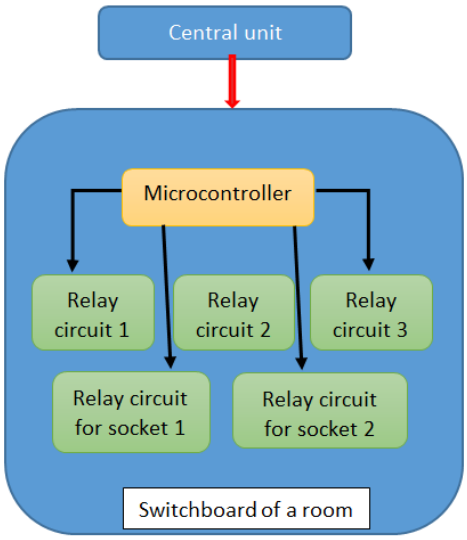

Figure 5: Structural block diagram of a control unit

Also, there is another aspect of home automation in this device. Each appliance in a room, has a TSOP (IR detector) attached near it, which connects to the control unit of the corresponding room. The control unit of a room is programmed in a way to receive a particular hexadecimal code for switching on and other for switching off it. Hence, when the user controller is pointed towards an appliance and the button is pressed to turn on or off, the particular appliance operates in the corresponding way. Finally, the home automation system of this device consists of three parts:

- **Firstly, controlled by Bluetooth**.

When a button is pressed on the pushbutton keypad, or a voice is inputted, the user controller sends the signal via the Bluetooth to the central unit. This central unit scrutinises the data, and sends the data to the corresponding room's control unit, which again scrutinises the data and turns on or off the particular appliance.

- **Secondly, controlled by the automatic mode**.

As discussed in the automatic mode section, once person enters a room the PIR sensor turns on the appliances. This is done directly controlled by the room's control unit.

- **Finally, when a particular device is turned on using a IR led**

When the user controller is pointed towards a particular appliance, and the turning on/off button is pressed or spoken by the user, the TSOP of that appliance sends the data to the microcontroller of the control unit of that room, which turns on the relay pertaining to that appliance and hence turning it on or off.

6. Home Security

Home security is a very sensitive topic now a days. The rate of robbery is increasing at an exponential rate. Hence it becomes mandatory to include this in our support device for the differently challenged people. Here all the doors have a pair of PIR sensors attached, as well as a pair of IR leds and TSOPs.

This is a very sophisticated system design for the advance security for the people. Each side of door rim, consists of one IR led and one TSOP. To elucidate this idea lets first look at the orientation of the IR leds, TSOPs and the PIR sensors.

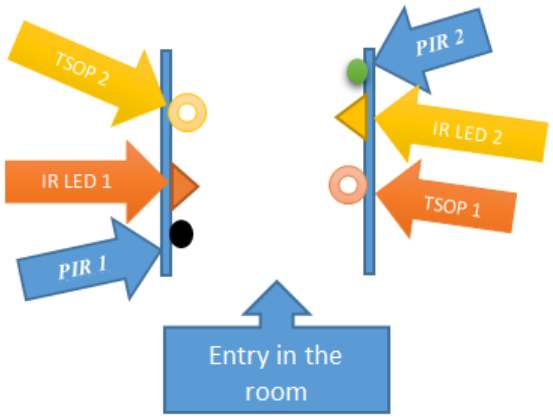

Figure 6: Orientation of sensors on a door rim

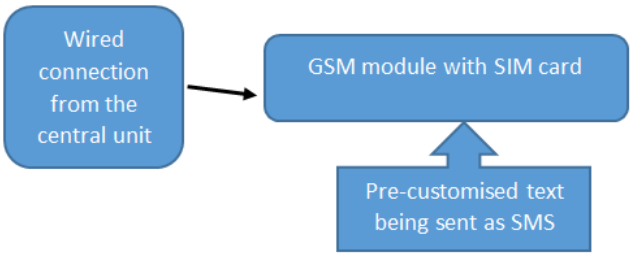

Figure7: Block diagram of home security section

The working of the PIR sensors have been already taken place in the discussion above. Here we will discuss this peculiar arrangement of IR leds and the TSOPs. The IR leds are continuously on and hence the value of the TSOPs are continuously high. Now suppose someone enters the room, firstly the orange (IR LED 1 and TSOP 1) circuit will break followed by the yellow (IR LED 2 and TSOP 2). When the security button is pressed on the pushbutton keypad, and when the circuit breaks in the manner stated above, the user controller vibrates, alerting the person. He then has an option of pressing the button to call any of the emergency numbers.

In this way this device helps the visually impaired person to take care of himself. Now, when the person presses an emergency call button, the data is sent via the Bluetooth (of the user controller) to the central unit's home security sector. This home security section contains a GMS module with a SIM card attached. Hence the SMS or missed call is sent to the emergency contact. Here is the block diagram of the home security portion of the central unit.

Future Scope

I plan to incubate an android software which will directly call the emergency number and play a pre-recorded message in case or emergency. Also this application will, let the relatives of the differently challenged people know, which appliance is on and in which room the person is. One of the most important things, which I plan to include in this device is a fall detector. This will inform the neighbours that the differently abled person has fallen and will give access to them to enter the house without keys and help them. This will idealise the home-care system for such people.

Conclusion

This is pure research paper, written based on the works that I'm carrying out. Hence the list of the references is shockingly small. This system will revolutionize the differently challenged people's lifestyle. This device will help the relatives of the differently abled people to carry on with their daily routine without being stressed out about them. Also with the fall detector, I plan to launch the first handheld device to detect and call for help, once a differently challenged person falls.

References

http://www.iapb.org/vision-2020/global-facts