Design and Development of Smart Home Security System for Disabled and Elderly People

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***Abstract*—This paper discusses an ongoing project that serves the needs of people with disabilities and the elderly at home. It uses the WiFi technology to establish communication between a user's Smartphone and a controller board. The project uses a microcontroller to control the door lock and is equipped with a camera to identify the visitors. By connecting the servo motor and camera to the Raspberry Pi controller board, it can be controlled via WiFi to provide remote access from a smartphone.**

***Index Terms*—Application; Raspberry Pi; Raspberry Pi Camera; Servo Motor; Smart Home.**

I. INTRODUCTION

Smart home system is very popular in modern days and provides many kinds of applications that make everything simple and easy to control. In [1], modern day, home appliances are using wireless technology and can be accessed via the internet that will make the residents' lives easier and organized. The simplicity of this smart home system can be useful to disabled people and the elderly because of their physical limitation to do tasks in the house. From a security perspective, the smart home system can help those disabled and elderly people by protecting them from thieves entering the house. According to the work from [2], the security system is the door locker located at the front door and can be remotely controlled via a wireless network. The security system is convenient for the disabled and elderly to use.

According to the work presented by [3], the smart home system can increase the comforts and offer greater safety and security, as well as reduce the use of energy and other resources, and allow for significant savings. It also offers powerful means for helping and supporting the special needs of people with disabilities and, in particular, the elderly.

The main objective of this project is to develop a smart home system for disabled and elderly people by applying door security system at the front door. The function of the security system is to unlock the front door with a smartphone via a wireless connection. A camera is placed at the front door to capture the image of the visitor and send it wirelessly to the smartphone.

Figure 1 illustrates how the project works, where it was equipped with a camera installed at the front door and connected to the Raspberry Pi. The camera captured a picture of the visitor in front of the door and sent it to the application on the smartphone via a wireless connection. Through the application, the user would identify the visitor and decide whether to unlock or lock the front door.

Based on the work presented by [4] and [5], burglary cases involving the elderly and disabled are increasing because there is no proper security system for them in the house. By developing the smart home for the disabled and elderly, it will decrease the chances of burglary.

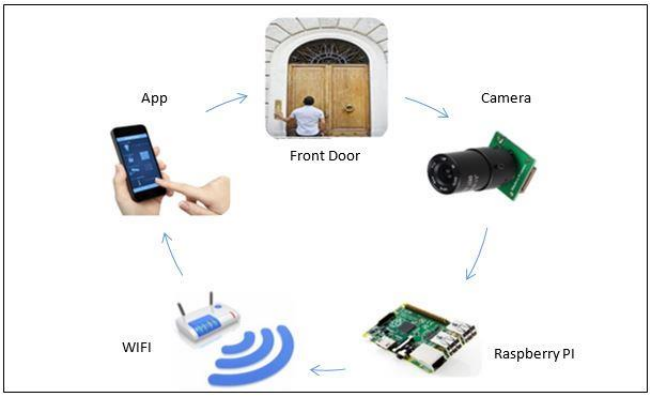

Figure 1: Smart Home project diagram

II. RELATED WORK

This section describes the related work on a smart home system which has been used in power management, smart home security for the disabled and elderly people, and the utilization of technology regarding smart home. To get an idea of the innovation of a smart home, it requires the review of the history. This chronology began with the creation of the smart home that was introduced in the early 1980s when the "intelligent building" concept was used. In the concept, the intelligent implementation of consumer electronic devices, electrical equipment, and security devices aiming for the automation of domestic tasks, easy communication, and human-friendly control, as well as safety, was proposed in [15].

A. Smart Home System

Smart homes have become a modern trend in making life easier and to create an efficient system to control electronic appliances inside the house. Residents can control the electronic devices and make sure minimal energy is used to

reduce electricity usage. Residents can also remotely control those electronics appliances from anywhere and at any time. A list of a smart home system technology is illustrated in Table 1.

Table I.
Example of Smart Home System With Different Wireless Technologies

System	Method in Brief	Year
WiFi [9]	Smart Home Implementation Based on Internet and WIFI Technology	2015
GSM [10]	Remote Household Appliance Control System Using GSM	2011
ZigBee [14]	Modeling and Analysis of ZigBee Based Smart Home System	2014

B. Smart Home for Disabled and Elderly People

The smart home is mainly focusing on the power management and controlling household appliances in making life easier. However, there are other concerns about households that may consist of elderly or disabled people to help them in their daily chores and to ensure their safety inside the house.

Table 2
Type Of Smart Home System

System	Type of system	Year
Bluetooth [12]	Android-based Home Door Lock's Application via Bluetooth for Disabled People	2014
LAN [13]	Smart Home based using several devices via Wireless Data Exchange on LAN	2004
ZigBee [16]	Configurable ZigBee-based Control System for People with Multiple Disabilities in Smart Homes	2016
WiFi [17]	Integration of home networking in a smart environment dedicated to people with disabilities	2004

III. METHODOLOGY

There were several phases that were required in order to complete this project. These phases ensured that the project was carried out based on the objectives and the scope of the project. Standard project development methodology has been used. Phase 1 was the preliminary result that showed the progress of the project. Phase 2 was the analysis of the project that was upon the completion of the project including some requirement and analysis of the total cost and equipment The design of the prototype was performed in Phase 3 and Phase 4 was the implementation of the prototype. The outcome of Phase 4 was further analysed in Phase 5 which was the functional test to verify the expected result. Phase 6 was the documentation of the project report. The methodology of the project is illustrated in Figure 2.

A. Hardware Design

As the flow chart is illustrated in Figure 2, the hardware system began with the camera module that captured the image and then sent it to the main controller, which acts as a medium to manage all captured image from the camera to the mobile applications using WIFI. The application would then send a confirmation whether to lock or unlock the door. Raspberry Pi would process the data and decide whether to send the pulse to the servo motor to open the door or not.

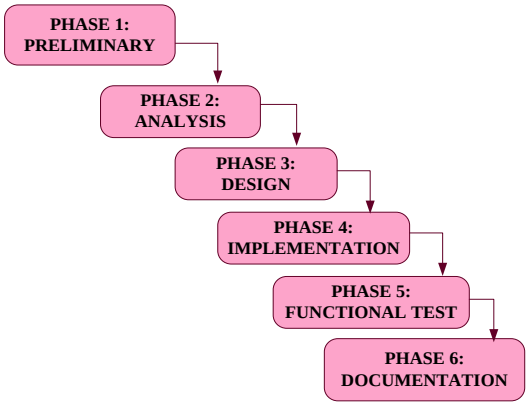

Figure 2: Project development methodology

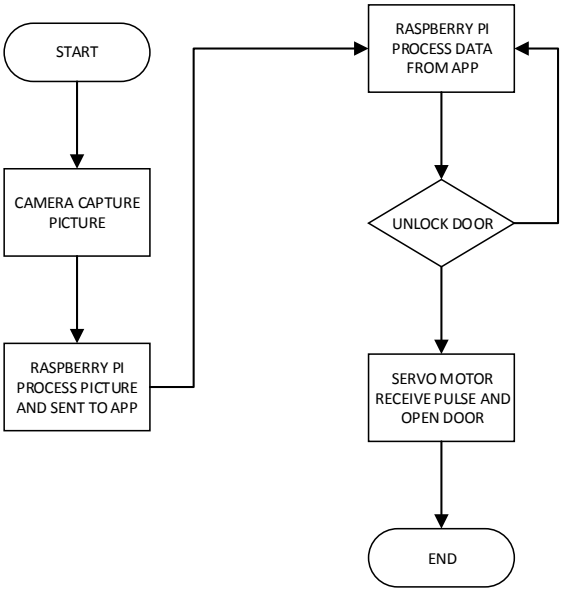

Figure 3: The system process

B. Hardware components

1) Raspberry Pi Model B+

Raspberry Pi Model B+ was chosen as the microprocessor in this project because of its capabilities as a mini computer that is convenient to develop a web server, GUI and is equipped with the latest IDE programming such as Python that is widely used in building a GUI. Besides, raspberry pi model B+ also offers 40 GPIO pins that were able to control several sensors, motors and a slot for the camera module in the raspberry pi board.

2) Servo Motor

A servomotor is a rotary actuator that allows for precise control of angular position, velocity and acceleration. Servos are widely used in robotics, creating a humanoid robot, biologically inspired robot, and robotic arm. This is because of its abilities to rotate and maintain certain locations, positions or angles according to the control pulses from a single wire.

3) Camera Module

The Raspberry Pi camera module can be used to take high-definition videos, as well as stills photographs and it is suitable for this project. The camera works with all models of Raspberry Pi 1 and 2. The camera module has numerous third-party libraries built in it, including the Picamera Python library.

C. Software

Based on the flowchart illustrated in Figure 4, the software system began by receiving a picture from the raspberry pi and displayed it on the application. The user would make the decision whether to unlock or lock the door upon viewing the picture received from the raspberry pi. The application would then send the confirmation whether to lock or unlock the door.

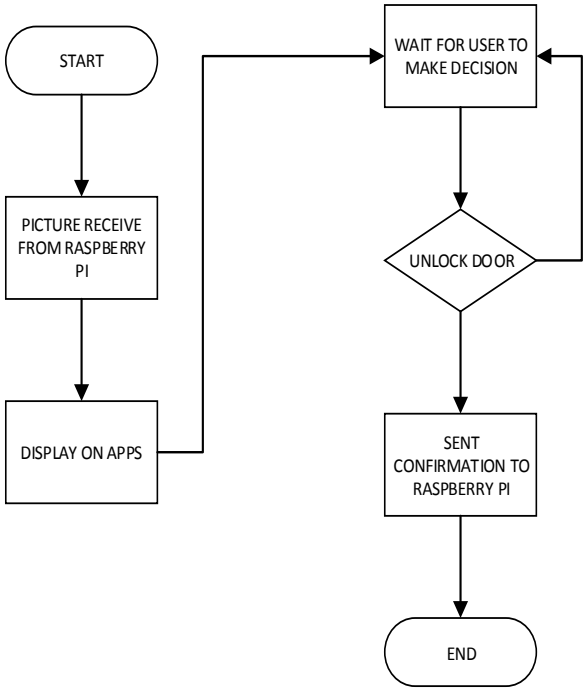

Figure 4: The flow of the system

D. Software Components

1) Web server

Apache supports a variety of features that act as compiled modules which extend the core functionality. These can range from server-side programming language support to authentication schemes. Some common language interfaces support Perl, Python, Tcl, and PHP. The languages that are widely used on Apache are Python and PHP because the languages are easy to use.

2) Library

WiringPi is a GPIO access library written in C for the BCM2835 used in the Raspberry Pi. It is released under the GNU LGPLv3 license and is usable from C to C++ and many other languages. WiringPi includes a command-line utility GPIO which can be used to program and set up the GPIO pins. WiringPi supports analogue reading and writing, and there is no native analogue hardware on a Pi by default.

3) Pi-Blaster

Pi-Blaster is an upgraded work from servoblaster, initiated by Richard Hirst that enables users to control servo motor freely without having difficulty in setting up that motor by programming. Pi-Blaster enables PWM on the GPIO pins you request of a Raspberry Pi. The technique used is extremely efficient; it does not use the CPU and gives very stable pulses.

IV. DESIGN AND DEVELOPMENT

This section focuses on the development of the prototype. The Raspberry Pi was able to control the servo motor as expected. The servo motor movements from 0º to 180º and vice versa were able to unlock and lock the door.

A. Circuit

Figure 5 shows the connection between the servo motor and Raspberry Pi. The Figure shows that the servo motor needed an external power supply because the Raspberry Pi board could not supply enough power to switch on the servo motor. The servo motor needed 5 volts to switch on and for the current progress, the servo motor depended on four AA batteries to switch on.

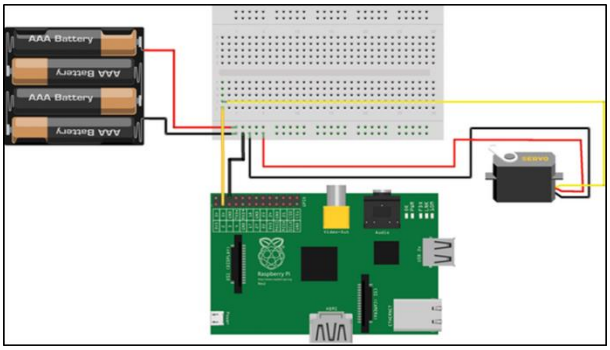

Figure 5: Device connection

As shown in Figure 6, a real circuit was constructed according to the circuit diagram. The servo motor was tested to rotate to certain angles and the servo rotated accordingly. This test was conducted to verify the capability of the servo motor to unlock or lock the door.

Figure 7 shows the servo positions at angle 0º, angle 90º and angle 180º. Each angle was pointed out by the blue dot to represent the servo specific angle. These positions were set up by using the program written in C.

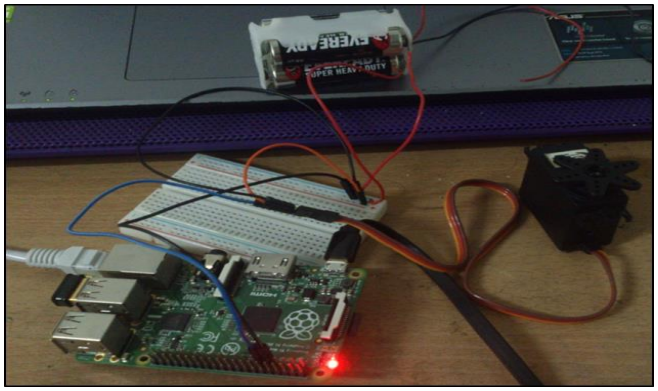

Figure 6. Prototype

V. CONCLUSION

In this paper, we proposed a solution to develop an efficient smart home security for disabled and elderly people with the application of Raspberry Pi. This project consists of two parts which are the hardware and software that were developed to ensure that the door can be locked and unlocked by using the application. These are the objectives and scope of the project that need to be achieved

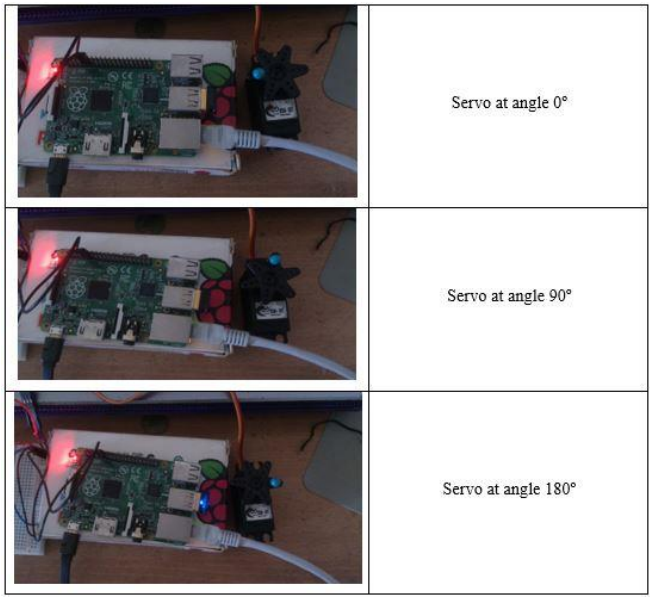

Figure 7. Servo motor position

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