Smart Home Security System (SHSS)

Rami Nahas

Department of Electical Engineering,

University of Business and Technology,

Jeddah, Saudi Arabia

Abstract:- **In the last few years, many people are converting their rooms into smart rooms to make their life easier. The term "Smart rooms" refers to having all the home appliances and features controlled either by the local network or the remote control. Between 1998 and the beginning of 2000 people were concerned more about making smart homes more than just smart rooms, and somehow it became more affordable for consumers. Nowadays smart homes are more about providing security and energy efficiency, and the most recent trends is having remote mobile controls and automated lights either through smart phones or sensors and having automated air conditioner and remote video surveillance. The main objective of this project is to design and implement smart homes through wireless connection using lower cost devices controlled either by smart phones or through motion detection sensors.**

I.INTRODUCTION

The world is changing, and almost everything around us is linked to the internet. Homes and cities are converting into smart cities and smart homes. In 1984, the American Association of House Builders adopted the term "smart home" and in 1990s, electronic devices became more smarter and portable, and in 1999 Microsoft introduced their vision about "smart home" where the home is powered by a pocket PC including things like smart locks, lighting, environmental controls, a CCTV home monitoring system, and even a barcode scanner to help create an online shopping list. Smart homes have increased since those years and by 2012 more than 1.5 million home automation system were installed, and it kept increasing until it reached 45 million by 2018[1]. Chan et al. wrote a survey that describe an overall review for smart homes [2].

In 2017 Saudi Arabia have launched the project Neom City which will be the first smart city in Saudi Arabia, and it is expected to be completed by the beginning of 2025. This project is part of the revolutionary 2030 vision of Saudi Arabia. Many ideas for smart home projects were presented as part of this mega project [3]. Some of these smart home ideas are controlling home features (lights, surveillance cameras, door locks, etc.) through smart phones application or by voice and motion detection sensors, and many other projects. In this paper, a project is presented in which some of these smart home ideas are combined to present an easy and affordable smart home. The project is called "SMART HOME SECURITY SYSTEM (SSHS)".

II.   OVERALL SSHS PROJECT DESCRIPTION

Sometimes many people forget to turn room lights or air conditioner when they are going out especially if they have an important appointment and they are late for it, so it is much easier to have the ability to control home features and appliance when they are away through smart phones. This project will make sure that people will be able to access their home appliance even if they are away and it's valuable for people who are busy at most of the time and they don't have the time to check their home appliances most of the time.

The target of the "Smart Home Security System (SHSS)" project is to build a miniature smart home system by interconnecting multiple deceives such room lights, door locks, surveillance camera and room temperature. The project aims to make life easier for people who want to access their home features and appliances while they are not home by controlling them through their phones. For example, when leaving r work and heading home, the system can prepare the home by having the right temperature through by turning the air conditioner of the room and having the TV on favorite channel and controlling the lights.

The SHSS project is a combination of hardware devices and a software application called Blynk that helps people to control their home appliance such as lights, air conditioner, TV from a far distance. The connection to the hardware devices can only be accessed using Wi-Fi.

To build the system, different types of technologies will be used such as:

Blynk is a platform with IOS and Android applications that can control the Arduino, Raspberry Pi and the likes over the Internet. It is a digital dashboard where we can build a graphic interface for an excellent project by simply dragging and dropping widgets [4]. it is helpful for businesses to build successful connected products.

IFTTT is both a website and a mobile app, it is a free web-based service to create chains of basic or simple conditional statements, called applets.

Applet is triggered by changes that occur within other web services such as Gmail, Facebook, Telegram, Instagram, or Pinterest.

Nodemcu basically, it is Firmware a System on a Chip or System on Chip (SoC) is an integrated circuit that integrates all components of a computer or other electronic systems.

Sender module It's a small PCB sub-assembly capable of transmitting a radio wave and modulating that wave to carry data. Transmitter modules are usually implemented alongside a micro controller which will provide data to the module which can be transmitted. RF transmitters are usually subject to regulatory requirements which dictate the maximum allowable transmitter power output, harmonics, and band edge requirements.

Relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays.

Arduino IDE: Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board.

Arducam ArduCAM is an open-source project for Arduino camera since back to 2012. It is the world's first SPI camera

Receiver module It's a (radio frequency module) is a (usually) small electronic device used to receive radio signals between two devices. In an embedded system it is often desirable to communicate with another device wirelessly.

for Arduino and fills the gap of missing camera support in Arduino ecosystem. It supports wide variety of camera modules from 0.3 ~ 5MP with JPEG, RGB, YUV, RAW format, taking still images and even taking short movie clips. Moreover, you can plug multiple ArduCAM SPI cameras to a single Arduino UNO board at the same time.

PIR sensor (Passive InfraRed sensor) A device used to detect motion by receiving infrared radiation. When a person walks past the sensor, it detects a rapid change of infrared energy and sends a signal. PIR sensors are used for applications such as automatically turning on lights when someone enters a room or causing a video camera to begin operating.

III.PROJECT FUNCTIONS

The main objective of Smart Home Security System (SHSS) project is to provide a flexible access to the home appliances through an internet connection, and the project functions are (Fig. 1):

Accessing room lights using Blynk application software.
Accessing room lights using voice.
Accessing room air conditioner using smart phone.
Using sensors to detect the motion of a person entering or leaving the room.
Sending a notification email to inform if the light is turned on.
Using surveillance camera to monitor rooms.
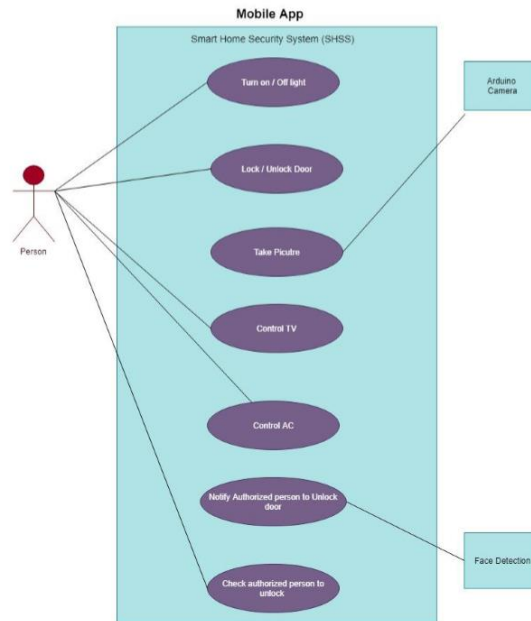Using smart phone to control door lock.

Figure 1 Use case diagram for the presented system

IV.SYSTEM CONSTRAINTS AND LIMITATION

But To achieve all the above previous functions points , the Smart Home Security System (SHSS) project requires a wireless internet connection must be provided in the home to enable the communication between all the devices and controlling device like smart phone. The wireless connection is required to connect the Nodemcu with smart phone application and the WIFI network credentials will be included while uploading the code to the Nodemcu.

Another technical constraint is that the Nodemcu can operate on an external supply of 6 to 12 volts. If using more than 12V, the voltage regulator may overheat and damage the device. The recommended range is 7 to 12 volts.

For the face detection system feature, one needs to firstly run an external python program to allow the camera to capture and detect face since Arduino IDE does not support the python programming language.

Finally, all codes will be uploaded to the Nodemcu using the Arduino IDE since it is only supporting the Arduino components.

V.PROPOSED SYSTEM

In this system, a relay switch is used to control lights, lock door, or any other electronic devices by connecting or cutting the power to them via a remote control. A relay switch is a tool used to open and close circuits electronically. Each relay comes with its own remote control. The remote control represents the sender module which sends RF signal, and the relay switch itself contains a receiver module inside that receives the signal which is sent by the remote-control sender. Depending on the received signal, the relay connects or cuts the power. The project idea in this section is to use mobile application (SHSS App) instead of using a remote control to turn on/off lights or to lock/unlock a door. To do that, there is a need to decrypt the signal that is sent by the sender module and convert it to a binary number which will be sent by using a specific Arduino program that is uploaded to NodeMCU board. The mobile application (SHSS App) can also be used to control TV or AC instead of using a remote control.

SHSS App Light Section: the program interface of the light section contains three buttons as shown if Fig 2. The purpose of the buttons is to turn on/off the lights of a living room, bedroom, and kitchen. The following describes the procedure for lights control:
• Each button is connected to a specific function on Arduino program.
• If a button is clicked, the related function will be run.
• The related function sends a specific signal through the RF sender that is wired to the NodeMCU board.
• The RF receiver of the light receives the sent signal and then turns on/off the light.

Figure 2 Light Section

SSHS App Door Section: the program interface of the door section contains two buttons as shown if Fig 3. The purpose of the buttons is to lock/unlock the doors of apartment or the rooms. The procedure is as follows:
• Each button is connected to a specific function on Arduino program.

• If a button is clicked, the related function will be run.
• The related function sends a specific signal through the RF sender that is wired to the NodeMCU board.
• The RF receiver of the lock door receives the sent signal and then lock/unlock the door.

Figure 3 Door Section

SSHS App Television (TV) Section: the program interface of the TV section contains buttons that send specific IR signal when they are clicked as shown in Fig 4.
• Turn On/Off TV button.
• Turn On/off channel receiver button.

• Menu button
• Volume UP, Volume DOWN, and Mute buttons.
• Changing to next or previous channels buttons.
• Moving UP, DOWN, Exit buttons.

Figure 4 TV Section

Air Condition (AC) Section: the program interface of the AC section contains buttons that send specific IR signal when they are clicked as shown if Fig 5.
• Turn On/Off AC button.

• Increase temperature degree button.
• Decrease temperature degree button.
• Changing the mode of AC to fan mode.

Figure 5 AC section

Monitoring Section: the program interface of the monitoring section displays a stream (live) video from a camera. It helps to monitor rooms when away from home for more security as shown in Fig 6. To monitor room, a monitor device is required. Arducam is a good one to use.

Figure 6 Monitoring section

Face Recognition section: the purpose of this section to turn on/off lights and lock/unlock door by using face recognition program as shown in Fig 7. This section contains two programs, which are:
1. Camera system: a program in Arduino used to capture a picture for people by using camera hardware called ArduCam.
2. Face Recognition system: a program in python used to test the captured picture to decide if the person is authorized (could recognize him) or not.

The Procedure of this section is as follows:
• Run the face recognition program through Python.
• The python (face recognition) program connects automatically with the Camera program in Arduino.
• The system waits until a picture is captured.
• Picture is captured by using a push button.
• After a user push the button, the camera will capture a picture of the user.
• The picture will be saved at PC.
• The python (face recognition) program will detect the face (Check if the picture has a face, if not, then system returns

"Picture is not for a human", if the picture has a face, then the program continues.

• After detecting the face, the python program compares the face with people pictures that are saved in the library of the system as "Authorized people"

• If the program could recognize the face, then it prints "Authorized person" and turn on/off the light/lock door.

• If not, then it will print "Unauthorized person"

Figure 7 Face Recognition section

Problem: How system would know that nobody is inside the room, so light is turned off?

• Everyone enters or leaves the room must use the camera to capture a picture of himself so system can know how many people in the room now.

• When running the face recognition program for the first time, the python program creates an empty list [ ] called "People inside the room"

• After every successful face recognition, the name of the person will be added to the list.

• The light/lock door will turn on only if the list has only one name.

• Only one name in the list means he is the first person enters the room and for that reason light/lock door must turn on.

• If a second/third/forth/...etc. person enters the room, his name will be added to the list, but no function will be run because it already executed with the first person.

• If someone's name already in the list, and then he uses the camera again, that means he is leaving the room. so, his name must be removed from the list.

• If all the names are removed from the list (which means all the people left the room), then the light will turn off and the door will lock.

CONCLUSION

Technology is improving every day; it can be either useful or sometimes it can be harmful. The presented Smart Home Security System (SHSS) project will make life easier and will help homeowner to control appliances in homes remotely. It is a security system that enables the homeowner to control the electronic devices in his/her home remotely while away, and it also provides a face recognition detection system which provides authorization to access the system.

As it was provided in the paper the system was build and it was functioning. The system with the use of face recognition increased the security and gave more information about the home and the surroundings.

REFRENCES

[1] Caccavale, Michael. "Council Post: The Impact Of The Digital Revolution On The Smart Home Industry." Forbes, Forbes Magazine, 24 Sept. 2018, www.forbes.com/sites/forbesagencycouncil/2018/09/24/the-impact-of-the-digital-revolution-on-the-smart-home-industry/.

[2] M. Chan, D. Estève , C. Escriba and E. Campo, "A review of smart homes-Present state and future challenges", Computer Methods and Programs in Biomedicine , vol. 91 , pp.55-81, Jul. 2008.

[3] Cms.law. 2020. Case Study: Neom, A New Future Infrastructure Index 2019. [online] Available at: <https://cms.law/en/ken/publication/bridging-continents-infrastructure-index-2019/middle-east-smart-cities-shaping-the-future/case-study-neom-a-new-future>.

[4] "Blynk for NodeMC-Introduction." Https://Roboindia.Com/, roboindia.com/tutorials/blynk-introduction nodemcu/#:~:text=Blynk%20is%20a%20Platform%20with,simply%20dragging%20and%20dropping%20widgets.