Intruder alert system using Arduino

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Abstract— With the help of modern technology, people can secure their homes, businesses, and other properties against unauthorized visitors. In this study, a security system that includes an Arduino with a face recognition system along with a password verification system is provided to detect intruders in restricted zones and create awareness. After identifying a face, the proposed system's facial recognition system detects if there is any unknown person entered into the restricted area and then sends a signal to the microprocessor. If the person is one of the authorities they can enter the password set by admin and the facial recognition system will train itself in such a way that next time it marks this person as safe. but if the person is an intruder who should not be in this place it will alert the admin and begin buzzing the buzzer. This can decrease the possibility of an intrusion danger. The advantages of the suggested design include minimal cost and adaptable security. This proposed system has used a really simple solution so that it can be implemented on existing security systems like CCTV cameras with some simple modification using Python code running on a central CCTV control room and a microcontroller, keypad, LCD, and buzzer.

Keywords— Arduino, Security system, Intruder

I. Introduction

At the moment, security can be seen as the most important concern in our lives. A security system, also referred to as a security alarm system or home security system, is a system of linked tools and parts that are intended to secure residences, places of company, or other premises from various security risks and crises. A security system's main job is to spot possible risks such as illegal entry, fire, smoke, and more and inform people or those in charge. To improve safety and security, security systems can be implemented in homes, firms, industrial, and public facilities.

There have been different types of security systems in use for generations. Mankind has been searching for ways to maintain its property and well-being, whether it be through straightforward locks and keys or more complex mechanisms. However, security systems started to make important improvements in the 19th century, especially with the invention of electric detectors. Modern security technology was built on the foundation of these revolutionary solutions.

The development of intruder detection and alarm systems over the 20th century happened with an increase in the use of electronic technologies. These systems mainly relied on simple sensors and loud alarms. They developed throughout time to include more complicated elements like motion detectors, glass break sensors, and security cameras. In the second part of the 20th century, as the digital revolution gained momentum, computer technology started to become ever more important to security systems. The combination of computers and microprocessors made it possible for security systems to process data, communicate clearly, and adapt to changing conditions in addition to detecting threats. The fusion of computer and security technology made a great revolution in the modern times of the 20th century.

In our modern time, there are different types of security systems with different technologies with features. One of the most common and famous technologies used in the modern time is Arduino technology. This technology has both a physical circuit implementation system and a software program such as IDE which is used by the developer to write codes and upload them into the Ardino system.

In the literature, various works can be found regarding establishing security alarm systems. In 2017, *Mia Arma Desima, Pizei Ramli, Dede Feri Ramdani,*

and Saepul Rahman built an Alarm System to Detect the Location of IOT-based Public Vehicle Accidents. The main purpose of this system is to send a default text message with the location for emergency help by simply pressing a button [1]. In 2018, *N N Mahzan et al* made an Arduino-based home fire alarm system with GSM module. This work is especially made for house safety where the main point is to avoid fire accidents occurring to the residents and the properties inside the house as well [2]. Another research was done in 2018 by *R. Ram Vishnu, V. Nobin Pal, C. Narasimha Moorthy, and S. Balakrishnan* where they built an Arduino-based Smart Alarm Mobile Application System. The main objective of this system is to build a smart alarm system like the smart house technology [3]. In 2019, *Dr.Osamah Ibrahim Khalaf, Dr.Ghaida Muttashar Abdulsahib, and Noor Abdul Khaleq Zghair* created an IOT fire detection system using a sensor with Arduino technology. The main aim of this system is to design a low-cost and simple wireless protection system against fire outbreaks and provide an early danger signal to avoid serious damage due to this type of occurrence[4].

The main purpose of this study is to build a security alarm system using Arduino technology. This system has the capability to detect intruders. Using facial recognition with modern hardware is the next level of this intruder detection system.

Key-Terms— Detecting unknown faces and sending an alert message to the system. If the intruder is a new authority then the system will provide a password interface to fill up. By giving the correct password he will be known by the system for future operations.

II. Description of the proposed system

In the system, five necessary hardware components have been used. These are Arduino UNO board, a keypad, a 16x2 LCD display and a beeping buzzer.

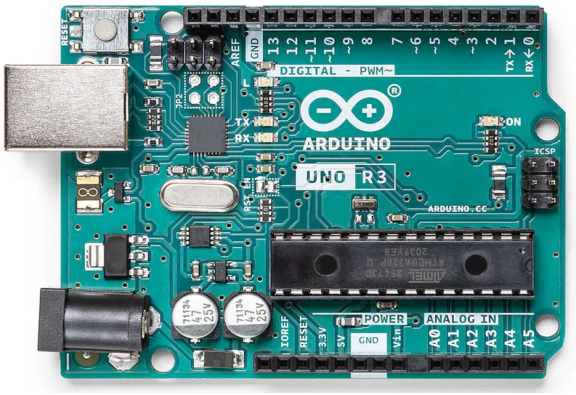

Figure 1 : Hardware of the Arduino (Type UNO)

Firstly, the Arduino shown in figure 1 is the controller unit of the system. The hardware of the Arduino is linear. It consists of an open-source board that contains 32 bits for the AVR microcontroller type. It has a software that uses a programming language compiler, where the program that is saved in the microcontroller can be executed. It receives every signal, data, input etc. and performs as it is saved by the user.

Figure 2 : Arduino 4x4 keypad

Secondly, the 4x4 keyboard shown in Figure 2 is a data inputter component to receive numbers or letters as data. It consist total of 16 data input button including the decimal values and A, B, C, and D letters with two special characters “ # ”, and “ * ”. It can be used for setting passwords, special codes, giving coded commands, etc.

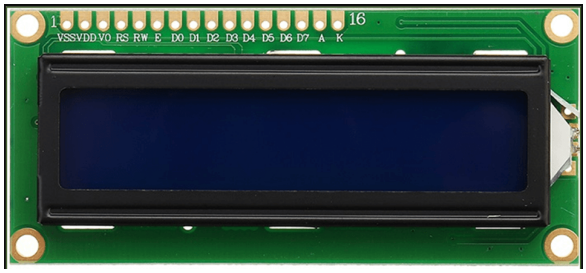

Figure 3 : 16x2 LCD display

Thirdly, a 16x2 LCD display has been used to show the working process, the received input, dialog messages, etc. It consists of a total of 16 pins including power and ground pins and other pins to get connected with the Arduino UNO controller.

Lastly, a mini Arduino buzzer has been used to alert the premises when an unknown person is detected by the system. The buzzer has positive and ground connection pins which allow it to connect with the Arduino board.

III. Methodology of the System

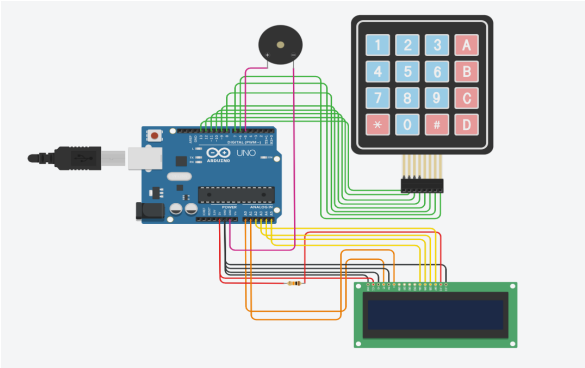

Figure 4 : The Hardware Circuit

The hardware circuit shown in Figure 4 has all the materials that are required to build the security system. The microcontroller Arduino is the main component here. It is used to process the signals that the system gets from the users. In other words, the Arduino receives signals from the laptop and button pad as the data-receiving component. Photo and password are the data here which are received by the microcontroller via pad and laptop. If the provided information is correct then the microcontroller will accept the person it will mark the user as an intruder. After catching an intruder the system will instantly send an intruder message to the admin and the buzzer will start beeping to alert the premises.

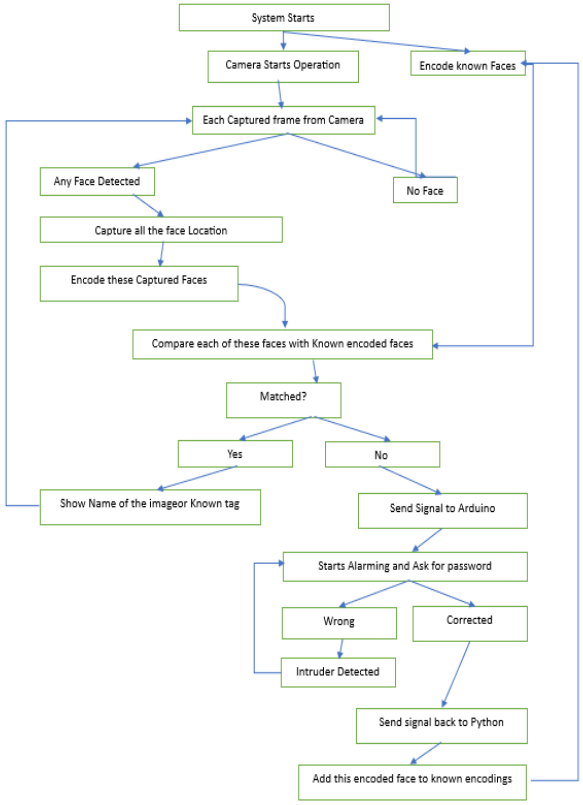

Figure 5 : .The main flowchart of the Security system

As we see in the flow chart, it is a combination of 2 parallelly running systems. They will not work properly independently. After the system starts it encodes all the image files stored in the Images Directory and stores

them inside memory to do this it uses Python dlib and OpenCV library. Then it starts capturing video frames. In each frame, there can be multiple people's faces. It will keep track of every face and encode them then store them in an array. Now each of these faces will be compared with all of the known face encodings. So that if one of them is matched it's a known face. but if after comparing with all the faces it doesn't match to any known encoding then probably it's an intruder. So to verify this, we give a chance to the user to enter the admin password, if the password is wrong the system will recognize him as an intruder, but if the password is correct Arduino will send a return signal, the password is correct, so it must be of the authorities, so the system add the encoding face into known face encodings. Before getting a response from Arduino, this server will not move to the next frame.

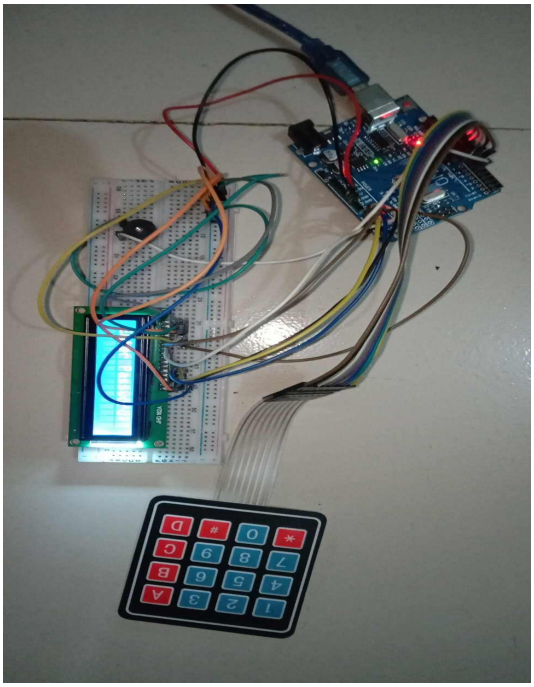

Figure 6 : The circuit of the system

In the Hardware section, we can see that Arduino is connected to an LCD, keypad, and buzzer. The Arduino microcontroller is also connected to the Python server via a computer. There is a serial Data communication between Arduino and Python, So If Python needs to send data it sends it via Serial data communication, and It also receives data from Arduino, Serial data transmission sends and receives data bit by bit, in our case we are sending and receiving one bit and only 1 digit at a time which is either 0 or 1. To make sure serial communication is established, we need to ensure that they are connected in the right port and no other device is connected using serial communication otherwise it will not be able to connect with the Arduino.

Now to connect the display we need to follow table 1 given below, this is a 16x2 LCD that has 16 columns and 2 rows and to write on each row and column we need to set the cursor there, by Arduino code. The pin diagram of this display is already listed here. From this, we see that there are LED+ and LED- which are connected to 5v and GND. The data passing will work correctly without them, but these 2 are backlight control and contrast. without them, there won't be any light to see the text. An Arduino has a useful library tool to work with this display. By using the library we can easily configure the pins.

Arduino and 16x2 LCD display connection table

LCD	Arduino
VSS	GND
VCC	5V
VEE	GND
RS	A0
RW	GND
E	A1
D4	A5
D5	A4
D6	A3
D7	A2
LED+	5V
LED-	GND

Table 1 : Display connection pin table

And for connecting the keypad we will simply follow table 2 given below. But we have the freedom to choose which pins we will use. And after that, we need to change the Arduino configuration code. Without proper configuration, the keypad won't function properly and to do that Arduino has provided a keypad library so we can easily set it up. As we can see our selected keypad is 4x4, so it has 4 rows and 4 columns, so the data cable is also 8, first 4 of them are for rows and the next 4 of them are for columns. After connecting the wires we need to tell the Arduino which pins are connected with which data line of the keypad.

On 4x4 keypad LeftMost is 1 and RightMost is 8 number pin (First 4 of them are Row next 4 of them are Column:

Arduino	Keypad
D-13	1
D-12	2
D-11	3
D-10	4
D-9	5
D-8	6
D-7	7
D-6	8

Table 2 : Keypad connecting table

And finally, we have connected the buzzer with pin D5, and when we need to start the alarm we just need to make sure that Arduino is sending voltage HIGH on this digital pin 5.

IV. Result

The design was built by using Arduino UNO, Buzzer, 16x2 LCD and laptop as a detection device.

After powering up the Arduino, the laptop sends an image as a signal to the microcontroller for processing as if it is a known face or an intruder. If the system found an intruder it would simply send a message to the admin panel which we can see in the figure 7. Also, the system will start beeping the buzzer.

Figure 7 : Getting message in the panel

The system has a password system which allows the person to give a password. If the password is incorrect then the system keep beeping the buzzer and also shows an "Intruder" message in the display as we can see below,

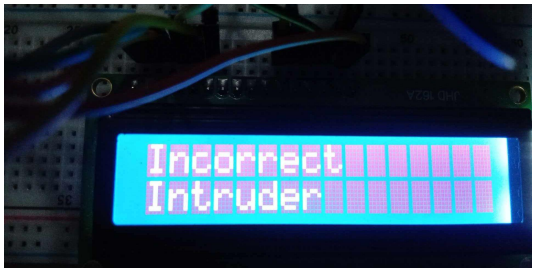

Figure 8 : Intruder detected message

The beeping buzzer will keep beeping till the system gets the correct password. When the correct password is inserted, the system will stop beeping the buzzer, save the face as known and will show a "Access Granted" message in the display which we can see below,

Figure 9 : Access Granted message

V. Discussion

Firstly we thought that we would only detect unknown faces and as a result of getting unknown faces we would start the buzzer, Then we realized that It would not be a complete system where the user can not control anything at all. So we need to give some control over to the user so that if anything goes wrong they can manage it. So we added a keypad and to see the result we added an LCD. Then we could understand that when getting signals from Python code and interacting with Arduino, they are simultaneously running loops. So there was a high chance we would lose an important signal and there would be no delay between them. And what if the system python sends the wrong signal how will we verify it, so we add a password system with it? But even after getting the wrong person safe, as the Python server does not have the information of this new user, it could send an unknown signal to Arduino in the

next second. So we faced a new problem which is, how we let the system learn that the password-entered person is the authority. So we captured and encoded the face of this new person, who was previously unknown but as he entered the password and the password is correct, the system should recognize him as a known face. So we added this encoding face to our known face encodings list. The new user becomes one of the authorities who have access to this area. And that's how we discovered new ideas and implemented them into our project.

VI. Future Work

Even after this project comes this far, there is tons of work left to do. Many important features need to be included. Someone may try to break into the system using a known person's image or video. Even there is existing technology of using silicon masks for a person. On image and video, we need to ensure liveness on the face and detect if the user is trying to spoof the system by tracking facial movements and other liveness detection algorithms. We also need to ensure the retina scan of a person to further secure the system. We also need to further work on a stronger locking system so that it becomes harder to break in. As no system is perfect there will be a scope to work with it in the future.

VII. Conclusion

In the proposed system, a CCTV camera that is already attached to restricted zones ensures a more secure environment. Based on our research we can conclude that this system can be implemented with low price and maintenance cost and easily fixable. During this research we came across many difficulties which made us change many of our ideas and this is the final product of that journey.

Reference

[Source codeDrive link]

https://drive.google.com/drive/folders/17ypN1zMqG4gcUrYE7vxKKZSr5ErYECNw?usp=sharing

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