UNIVERSITY of RWANDA

COLLEGE OF SCIENCE AND TECHNOLOGY

SCHOOL OF ENGINEERING

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

The Smart Home Technology as a Place of Control and Security.

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Undergraduate Final year Project

Bachelor of Science in Electronics and Telecommunication Engineering

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Project ID: **EEE/ETE/2021-2022/15**

Approval and Certification

We confirm that this final year project has been done at the university of Rwanda, college of science and technology, School of engineering, Department of Electrical and Electronics Engineering for the award of bachelor's degree in **Electronics and Telecommunication Engineering** under the supervision of……. we also confirm that to the best of our knowledge, it is our original work. Contributions from other sources have been properly acknowledged.

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DEDICATION

To my family and loved ones, who have always been my source of inspiration and support. Without their love and encouragement, this project would not have been possible.

To my professors and mentors, who have guided me throughout my academic journey and provided me with the knowledge and skills necessary to undertake this project.

To the developers and engineers who have created the technology that forms the foundation of this project, their contributions have been invaluable.

To the future users of this smart home automation and security system, may it bring convenience, comfort, and safety to their lives.

Finally, to anyone who has supported me in this project in any way, whether through encouragement, feedback, or assistance. Your contributions have been greatly appreciated**.**

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I would also like to thank the students who have contributed to the development of this project, their contributions have been invaluable.

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I am also grateful to my parents for their financial support and for their constant encouragement throughout this project. Their love and support have been instrumental in helping me to complete this project.

I would like to express my deep appreciation to everyone who has supported me in this project in any way, whether through encouragement, feedback, or assistance. Your contributions have been greatly appreciated.

ABSTRACT

A smart home project aims to improve control and security of a residential space using advanced technology. It includes the use of devices such as smart thermostats, lighting, and security cameras that can be controlled remotely through a smartphone or tablet app.

The project also includes the integration of a home automation system, which allows for the automation of various tasks such as adjusting temperature or turning off lights when a room is unoccupied. The goal is to increase convenience and efficiency, as well as added security for the residents. Other advanced features such as voice control and home monitoring can also be included. Smart appliances, such as refrigerators and washing machines, can be controlled remotely and set to perform certain tasks automatically.

Security is a major aspect of the project, with features such as smart locks and security cameras to protect the home and its inhabitants. The integration of these various features leads to a more convenient, efficient, and secure home environment.

Another important aspect of a smart home project is the integration of smart home systems with other technologies, such as IoT and AI. This allows for even more advanced features and capabilities, such as the ability to predict and respond to the residents' needs, and the ability to detect and respond to potential hazards or security threats. For example, an IoT-enabled smart thermostat can learn the residents' temperature preferences and automatically adjust the temperature accordingly, or an AI-enabled security camera can detect and alert the residents of potential intruders. These integrations can greatly enhance the overall smart home experience, making it even more convenient, efficient and secure.

Additionally, it also allows for the possibility of integrating with other smart devices such as smart speakers and assistants, giving the residents even more control over their home and the ability to control it with simple voice commands.

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LIST OF ABBREVIATIONS

IoT: Internet of Things

AI: Artificial Intelligence

WIFI: Wireless Fidelity

Z-Wave: Wireless communications protocol

Zigbee: Wireless communications protocol

LAN: Local Area Network

VPN: Virtual Private Network

PIR: Passive Infrared Sensor

CCTV: Closed-Circuit Television

DVR: Digital Video Recorder

IP: Internet Protocol

NFC: Near Field Communication

RFID: Radio-Frequency Identification

HVAC: Heating, Ventilation, and Air Conditioning

LBS: Location-Based Services

UAC: User Account Control

NVR: Network Video Recorder

GPS: Global Positioning System

SIP: Session Initiation Protocol

TLS: Transport Layer Security

SSL: Secure Sockets Layer

SSH: Secure Shell

PSK: Pre-Shared Key

WPA: Wi-Fi Protected Access

GPIO: General Purpose Input/output

PWM: Pulse Width Modulation

ADC: Analog-to-Digital Converter

DAC: Digital-to-Analog Converter

HS: High Speed

EDR: Enhanced Data Rate

RF: Radio Frequency

CHAPTER 1: HOME AUTOMATION SYSTEM

1.1 INTRODUCTION

Home Automation is a technology that combines the control of various systems and devices in a home to improve convenience, comfort, energy efficiency, and security. Home refers to a dwelling place used as a permanent or semi-permanent residence for individuals, families, or households. Automation, also known as automatic control, is the use of technology to monitor and control equipment and processes with minimal or reduced human intervention. The main benefit of automation is that it saves labor, but it also can save energy and materials and improve the quality, accuracy, and precision of products and services. Automation can be applied in various fields, such as machinery, factories, boilers, heat treating ovens, telephone networks, ships, aircraft, and other applications [1].

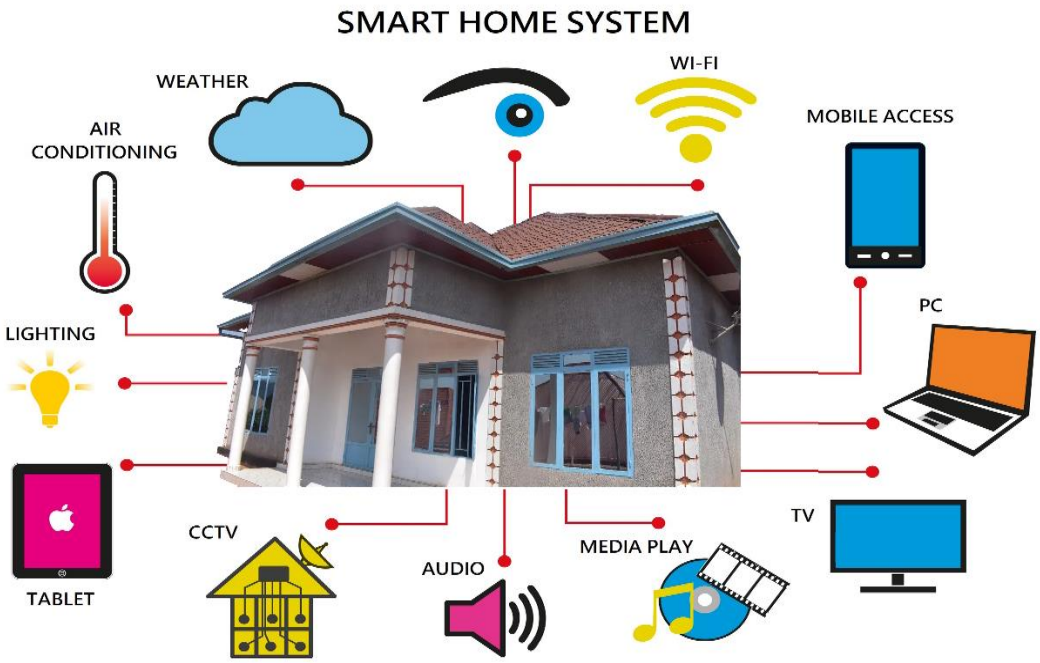


Figure 1: Home Automation System

This picture shows the future automated features of family home, including the lighting, security system, and thermostat. (Photograph by Solomon, 2023).

Home automation, also known as residential extended building automation, is a technology that automates various systems and activities in a home to improve convenience, comfort, energy efficiency and security. It can include centralized control of lighting, HVAC, appliances, security locks, and other systems. It can also provide increased quality of life for elderly and disabled individuals who may otherwise require care givers or institutional care. With the development of infrastructure and ICT, especially the advancement of the internet, the Internet of Things (IoT) has emerged as a convenient technology for connecting physical devices. However, in Africa, the lack of infrastructure and the inadequacy and mismanagement of electrical energy make it difficult for many people to adopt this technology. While it is more commonly used in urbanization and smart city building, military networks and high-level communities, home automation is an important technology that can improve the lives of individuals and communities.

Smart home technology has become a normal part of life in developed countries, offering benefits such as virtual learning with real-time communication between learners and tutors, and improved healthcare services for patients at home. However, when it comes to implementing smart home technology in low-income or developing countries, there are challenges that must be addressed such as affordability and adaptability of the technology policy to local needs. The goal is to ensure that new technologies promote the development of the region, strengthen property security in homes, and reduce spending on services for the maintenance or consumption of houses [2].

we want to achieve dream of being made in Africa in the field of Electrical and Electronics, actually it is hard to find smart home system and their applications in Africa and some of them are guided by foreigner technician. therefore, with an affordable, mainstream way to interconnect all of these devices, widespread smart home technology will be easy and not expensive to achieve. Voice-controlled temperature, lighting, appliances and others.

1.2 WHY HOME AUTOMATION

To address the potential and perceived benefits of this technology, it's important to consider both the immediate advantages that a smart home can offer its users, as well as the long-term impact that it could have on their lives and the environment. Here are several reasons why you might want to automate your home:

- **Make tasks more convenient**: Many tasks that are repetitive in nature can be accomplished automatically or with fewer steps using home automation. Instead of turning off or dimming four different lights when you want to watch a movie, home automation allows you to accomplish this task with one button led to Promote well-being of ageing and vulnerable people.

- **Financial benefit:** the long-term perspective the utilization of energy saving devices to environment sustainability while the immediate benefit could be the efficient energy consumption management in which turn off light or lower the thermostat and other devices such as smart meter, smart electric appliances automatically when you are not using them easily reduce electricity bills.

- **Home security:** using face recognition home automation may provide access control to buildings even to airports/seaports, ATM machines and border checkpoints; computer/network security; email authentication on multimedia workstations.

- **Environmental Benefits**: effective smart homes provide benefits in reduction and monitoring of energy usage within a residential setting. Emerging threats such as climate change, global warming and volatility in energy prices have fueled the interest in smart systems. The greater control over energy usage can eliminate carbon emissions and lead the way to a transformation of the traditional energy systems into renewable sources of electricity generation.

- **Peace of mind**: Never again worry about your home while you're away. Using home video cameras and an Internet connection, you can check on the status of your home or kids from anywhere in the world using a PC or web-enabled phone.

- **Increased home safety**: Many accidents happen in the home because of poor lighting. Home automation can automatically turn lights on in closets, stairways, and other dark places when you enter and decrease the chance of accidentally tripping or running into things [3].

1.3 LITERATURE REVIEW

Smart homes have gained significant attention due to their potential to provide a more comfortable and secure living environment. In the context of control and security, smart homes are becoming increasingly popular as they enable residents to remotely manage their home environment, monitor security, and control appliances through internet-enabled devices. This section provides an overview of the literature related to smart homes as a place of control and security.

Several studies have explored the benefits of smart homes in terms of control and security. One study found that smart home technology allows residents to remotely control and manage their home environment, including heating, lighting, and security systems, through a smartphone app (Malkawi et al., 2019). This enhances residents' comfort, convenience, and sense of control, as they can manage their home environment from anywhere, at any time [4].

In terms of security, smart home technology provides several features that enhance home security. For example, smart door locks enable residents to remotely lock and unlock their doors, while smart cameras allow residents to monitor their homes and receive alerts when suspicious activity is detected (Ghaffari et al., 2020). [5] Additionally, smart smoke detectors can detect fires and alert residents through their smartphones, enabling them to respond quickly to potential emergencies (Li et al., 2020) [6].

However, some studies have also highlighted potential privacy and security concerns associated with smart home technology. For example, smart home devices can collect personal information about residents, including their daily routines, preferences, and habits, which can be used for targeted advertising or other purposes (Monteiro et al., 2020). Additionally, smart home devices may be vulnerable to hacking, which can compromise residents' privacy and security (Chen et al., 2020) [7].

In conclusion, smart homes have the potential to provide a comfortable and secure living environment through the use of internet-enabled devices that enable residents to control their home environment and monitor security remotely. However, it is important to address privacy and security concerns associated with smart home technology to ensure that residents' personal information and security are protected.

CHAPTER 2: THEME OF SMART HOME AUTOMATION

2.1 BACKGROUNG

Home automation systems allow users to manage and control electric appliances in their homes. They aim to provide efficient, convenient, and safe ways for people to access their homes. These systems have been around for some time and have evolved to incorporate new technologies. However, many existing systems still rely on old technologies like wired communication, which can be costly and unreliable for retrofitting into existing buildings. Wireless systems like Bluetooth, Wi-Fi, and IOT-based systems have emerged as a more cost-effective and reliable solution. In developing countries, the lack of infrastructure and affordable materials is an additional barrier to the adoption of home automation systems. Engineers need to address these barriers by promoting locally made solutions and addressing the concerns of financial, ethical, and legal issues related to new technology, as well as the knowledge gap and psychological resistance that can slow the acceptance and adoption of home automation systems.

2.1.1 Technological barriers

There are existing smart home devices which seems complex to use which leads to refusal the adoption to it. The technology fit should be important factor to consider when extending the smart home and address user perception of the compatibility and the reliable system to enhance the usefulness of smart home technology. We need to focus on the technology features that could potentially mitigate the threats to the users and influence the perception behavior of the technology. User's expectations are a smart home recognize their needs and provide fitted assistance. therefore, it is essential to implement the reliable system providing safe and secure services to potential users.

2.1.2 Financial, Ethical and Legal issues

Due to financial as well as ethical and legal issues, particularly in developing countries leads to refusal of acceptance of the smart home technology. The financial factors include the cost of installation and maintenance, which could be the reason discouraging the user from adopt the new technology. It can be the lack of understanding regarding to moral issues of how smart home could help them saving money and mistrust towards technology.

The low rate of adoption and perceived usefulness of smart homes, the research indicates various reasons such lack of knowledge, trust to embrace the benefits of smart home technology, people are not fully aware of their functions. The role of government policy and engineers is needed to overcome this barrier and that is why we committed to introduce the smart home products could feature software systems that are adjustable, flexible and meet to user's perception [8].

2.2 TRADATIONAL SYSTEMS AT HOMES

Rwanda is a beautiful place for settlements, but for middle class families, it may be difficult to fully enjoy life due to financial constraints. Despite everyone wanting appropriate technology to improve their living conditions, it may be limited by the inadequate source of income. After a long day of work, people want to relax and take their mind off the day's stresses and responsibilities when they finally reach home, but tasks such as cooking, cleaning, and other household chores can be tiring and make it difficult to fully unwind. Imagine the impact on someone who lives alone and has to do everything manually. Smart home technology can help to improve the quality of life for these individuals by automating various tasks and making them more efficient, giving them more time to relax and enjoy their hobbies.

Figure 2: Traditional system used at home

This picture shows the old manual features of my family home, including the switches and domestic equipment. (Designed by Innocent, 2023).

Another job fields where you need to switch on the lights first, then start the fan and adjust its speed manually, unlock inside door, go to kitchen and make a cup of coffee for you. And also if you want to a shower you have to go in the bathroom and switch on their equipment like Geyser. Then after the work is still coming you would need to hear songs, so you have to go and switch on the Audio Console and search for a favorite track. Again, if you have a desire to watch what is going on TV then you will need to search for remote control which seems to be a very hard task.

Large number of people not only in Rwanda but around all developing countries are experiencing in this field. So the overall experience as engineer made us feel to think something we can do to overcome from all this. Nothing may come up in our mind but the idea which should mitigate effectively and we proposed that earlier in the introduction part as the solution of affordable cost. to make people understand and enhance the acceptance and adoption of smart home technology. Everybody love appropriate things, so we just want to comfort at least in our own apartment and different places. It is right for everyone nothing limits us to have it [9].

2.3 CHALLENGES IN HOME AUTOMATION SYSTEM

There are several challenges that need to be addressed in the development and deployment of home automation systems. Some of the key challenges are:

- **Internet connectivity:** One of the main challenges for home automation systems is related to internet connectivity, which is critical for enabling devices to communicate with each other and with cloud-based services. This challenge includes ensuring a stable and reliable internet connection, sufficient bandwidth for proper functioning of the system, strong security measures to prevent hacking and data breaches, compatibility with different types of internet connections, finding ways to make devices affordable for consumers while still providing reliable internet connectivity, and optimizing devices for low-latency environments to avoid delays in device response times.

- **Interoperability**: Home automation systems are typically composed of multiple devices and components from different manufacturers. Ensuring interoperability between these devices can be challenging, especially if they use different communication protocols.

- **User Experience**: Home automation systems should be intuitive and easy to use. The user interface should be designed with the end-user in mind, and should provide clear feedback and guidance.

- **Scalability**: Home automation systems should be able to scale to accommodate additional devices and services as they become available.

- **Cost**: Home automation systems can be expensive, which can limit their adoption. Manufacturers need to find ways to reduce costs and make home automation systems more affordable for consumers.

- **Power Consumption**: Home automation systems require a constant source of power. Manufacturers need to ensure that their devices are energy efficient and don't consume too much power, which can increase electricity bills and negatively impact the environment.

- **Privacy**: As home automation systems collect and store data about users, there is a risk that this data could be misused or stolen. Manufacturers need to implement strong privacy protections to prevent data breaches and ensure that users' personal information is kept secure [10].

2.4 THE OBJECTIVES OF THE PROJECT

Smart home technology has become increasingly popular due to its ability to enhance the comfort, convenience, and security of our homes. In this project, we aim to develop a comprehensive smart home system that seamlessly integrates control and security features to improve the quality of life for users and address modern security concerns.

Our project's primary objective is to create a smart home system that seamlessly integrates control and security features, leveraging advanced technologies such as sensors, cameras, and control systems to provide users with a secure and convenient living environment. Our goal is to offer an easy-to-use, highly effective system for managing and securing homes.

Our second objective is to promote the adoption of locally made smart home solutions by addressing financial, ethical, and legal concerns to foster trust and confidence. We aim to showcase the benefits of these systems for control and security to further encourage adoption and long-term success.

Our project takes a comprehensive approach to smart home technology by addressing technical and social aspects. We aim to provide an integrated control and security solution that offers convenience and peace of mind, promote locally made solutions, and address financial, ethical, and legal concerns to foster widespread adoption and success.

In conclusion, our project seeks to make a positive impact on people's lives by creating a safer and more comfortable home environment. We are committed to developing innovative solutions that address both technical and social aspects of smart home technology. By promoting the adoption of locally made solutions and addressing concerns related to financial, ethical, and legal issues, we aim to foster trust and confidence in these systems, promoting widespread adoption and long-term success.

2.5 PRICE OF SYSTEM PROJECT

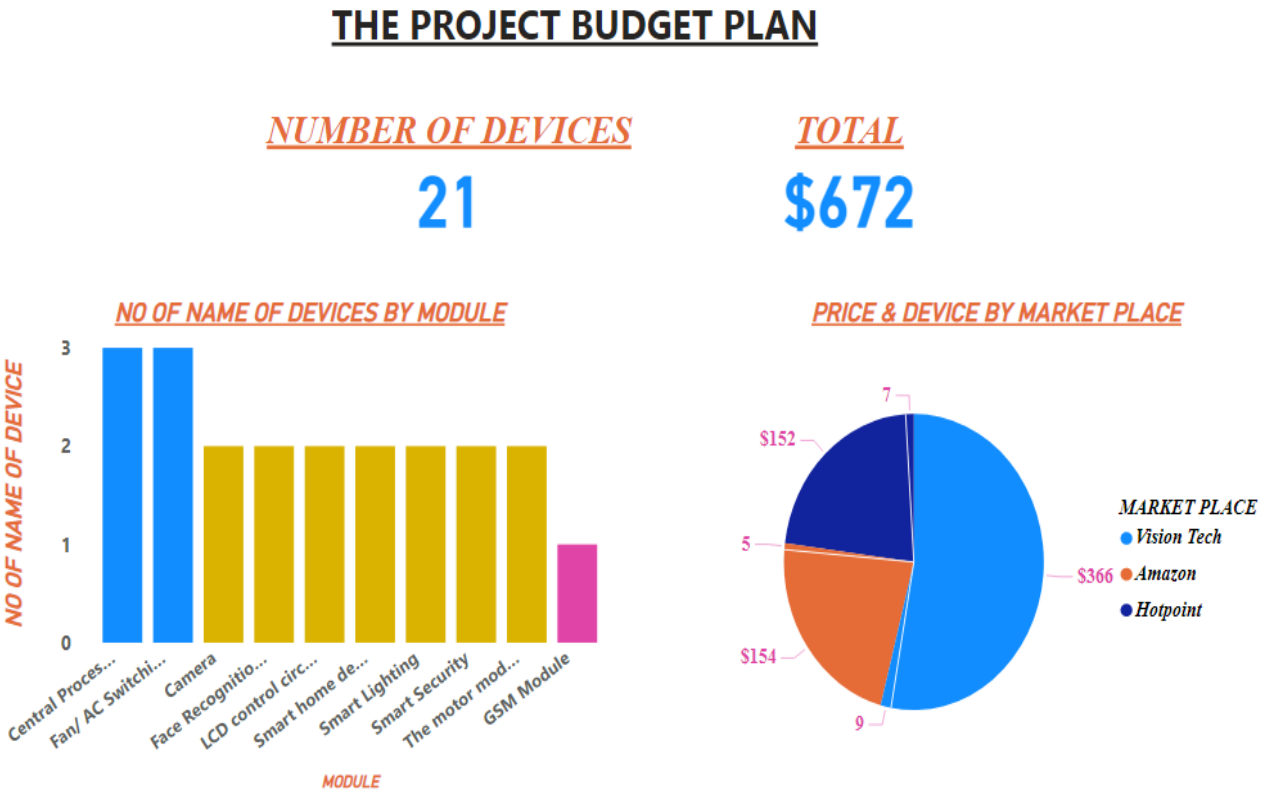


Figure 3: visualize data

This picture shows visualization data of price of the project (designed using power BI by Jean de Dieu, 2023).

Table 1:Source of data

No	NAME OF DEVICE	MODULE	MARKET PLACE	PRICE
1	Raspberry Pi 3	Central Processing Unit (CPU)	Hotpoint	$35
2	Arduino UNO	Central Processing Unit (CPU)	Hotpoint	$24
3	Philips Hue Starter Kit	Smart Lighting	Vision Tech	$25
4	Lutron Caseta Wireless Smart Lighting Starter Kit	Smart Lighting	Vision Tech	$15
5	Ring Alarm Security Kit	Smart Security	Vision Tech	$25
6	Nest Cam IQ Outdoor Security Camera	Smart Security	Vision Tech	$26
7	NVIDIA Jetson Nano	Central Processing Unit (CPU)	Hotpoint	$22
8	Raspberry Pi Camera	Camera	Hotpoint	$26
9	Logitech BRIO Ultra HD Webcam	Camera	Vision Tech	$45
10	OpenCV Face Recognition module	Face Recognition Algorithm	Amazon	$0
11	Amazon Rekognition	Face Recognition Algorithm	Amazon	$1
12	Insteon FanLinc	Fan/ AC Switching	Vision Tech	$30
13	BroadLink RM4 Pro	Fan/ AC Switching	Vision Tech	$35
14	Axial fan YWF4E-300S	Fan/ AC Switching	Vision Tech	$120
15	Samsung SmartThings Motion Sensor	Smart home detectors and sensors	Amazon	$24
16	Samsung SmartThings Water Leak Sensor	Smart home detectors and sensors	Amazon	$39
17	Somfy Universal RTS Interface II	The motor module	Amazon	$90
18	Chamberlain MyQ Smart Garage Door Opener	The motor module	Vision Tech	$45
19	SIM900A	GSM Module	Hotpoint	$20
20	Raspberry Pi 16x2 LCD Display	LCD control circuit	Hotpoint	$15
21	Arduino LCD Keypad Shield	LCD control circuit	Hotpoint	$10
	Total			$672

Those devices are available from different companies in Kigali city, such as Vision Technologies Company and Hotpoint, as well as online shops like Amazon (Vision Technologies Company [11]; Hotpoint [12]; Amazon [13]).

CHAPTER 3: SCIENCE BEHIND THE PROJECT

3.1 TECHNICAL APPROACH

Home automation is a new concept in the Rwandan market but becoming more popular as technology advances. There are different home automation devices available on the market which are based on microcontrollers like 8051, At mega or discrete components like capacitors, resistors, and inductors. The project we are working on is different as it uses the latest microcontroller, Raspberry Pi 3 which is more user-friendly and easier to understand than previous microcontrollers, also it is more powerful than Arduino. The difference between using a Raspberry Pi and an Arduino in a big project is their capabilities and intended use. Raspberry Pi is a small computer that runs on a Linux operating system and is suitable for projects that require more processing power and software functionality, such as home media centers, servers, and other complex projects. While an Arduino is designed for simple, single-purpose projects and typically used for projects that involve controlling physical devices, such as motors, sensors, and LEDs [14].

3.1.1 Hardware Components

Raspberry Pi: This will serve as the main controller for the smart home system. It can be used to run the face recognition software and control other devices in the system.

Camera: A camera, such as a Raspberry Pi camera or a USB webcam, can be used to capture images of people in the home. This camera will be connected to the Raspberry Pi.

Relays or actuators: These devices can be used to control different appliances and lights in the home. For example, a relay can be used to turn a light on or off.

Power supply: A power supply, such as a USB power bank, can be used to provide power to the Raspberry Pi and other components.

3.1.2 Software Components

Face recognition software: The Raspberry Pi can run a face recognition software such as OpenCV. This software can be used to detect and recognize faces in the images captured by the camera.

Database: A database, such as MySQL, can be used to store information about the people in the home. This database can be used to store information such as the names of the people in the home, their images, and their access levels.

Control logic: The Raspberry Pi can run a control logic that can be used to control different appliances and lights in the home based on the face recognition results. For example, if the face recognition software recognizes a specific person, the control logic can turn on the lights in the room.

Communication protocol: A communication protocol such as MQTT, can be used for communication between the different components of the smart home system.

3.2 RASPBERRY PI 3

Raspberry Pi 3 is a small, single-board computer that runs on a Linux operating system. It is a more powerful and versatile version of the Raspberry Pi, with a 1.2GHz 64-bit quad-core ARM Cortex-A53 CPU, 1GB of RAM, built-in Wi-Fi and Bluetooth, and 40 GPIO pins for connecting to sensors and other devices. It also has 4 USB ports, an Ethernet port, a HDMI port, and a 3.5mm audio jack. The Raspberry Pi 3 is capable of running a wide range of software and programming languages such as Python, C++, and Java, which makes it a suitable choice for various projects such as home media centers, servers, and other complex projects.

Like the Arduino, the Raspberry Pi is an open-source platform and the development environment for writing software for the board is available for free. It can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. However, the Raspberry Pi is more powerful than the Arduino and can run more complex programs and projects.

The Raspberry Pi 3 has a large and active community of developers who have created a wide range of ready-to-use modules such as GSM module, Bluetooth module, ZigBee module, and IP module that can be used to turn creative ideas into reality. The Raspberry Pi 3 also has an inbuilt burner which is helpful to program the board as per the requirements of the project.

In summary, the Raspberry Pi 3 is a more powerful and versatile version of the Raspberry Pi, with a more powerful processor, more RAM, and built-in Wi-Fi and Bluetooth. It can run a wide range of software and programming languages and is suitable for more complex projects, while the Arduino is a microcontroller board designed for simpler, single-purpose projects [15].

Figure 4: Raspberry pi 3 board

This picture shows the Raspberry Pi. Raspberry Pi The Complete Manual (Andrews, 2016, p.2) [16]**.**

3.3 ARDUINO

Arduino is a popular open-source microcontroller platform that enables people to create interactive physical devices that can sense and control the world around them. It is based on a simple microcontroller board, and comes with a development environment that makes it easy to write and upload code to the board. This makes it easy for people of all skill levels to start creating their own projects and devices, whether they're stand-alone or communicating with a computer.

One of the advantages of the Arduino is its flexibility, it can be used to control a wide range of devices and appliances, and it can be easily integrated into existing systems. It's open-source nature has led to a large community of developers creating and sharing libraries, tutorials and sample code for a wide range of applications, making it easy for people to find support for their projects. Additionally, the ready-to-use modules such as GSM, Bluetooth, ZigBee, IP makes it easy to expand the capabilities of the Arduino and allows for wide range of connectivity options.

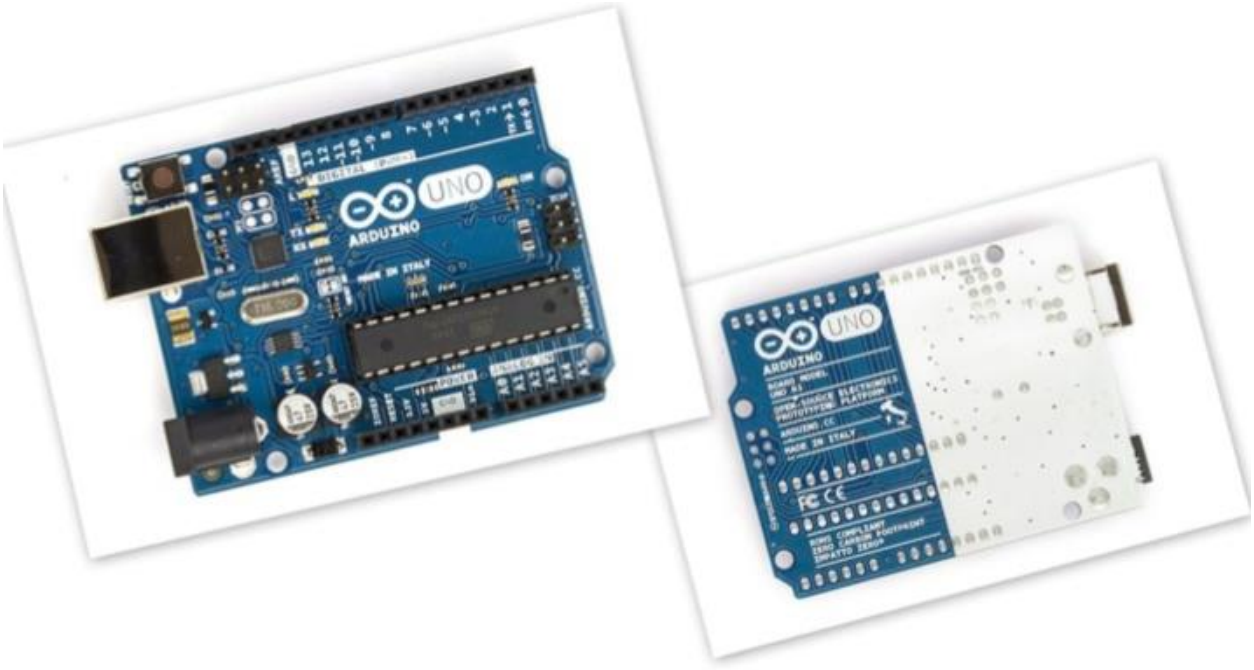


Figure 5:Arduino UNO board

This picture shows the Arduino UNO board. Fig 1-2. Building Arduino PLC (Seneviratne, 2017, p.5) [17]**.**

The Arduino Uno is a type of microcontroller board that is built using the ATmega328 microcontroller. It has a variety of input and output pins that can be used for a wide range of applications. Specifically, it has 14 digital pins which can be used as inputs to read sensors or as outputs to control devices such as LEDs and motors, 6 of them can be used as PWM outputs, also it contains 6 analog input pins which can read sensors that outputs analog signals. It also has a built-in clock crystal with a frequency of 16 MHz, a USB connector to connect it to a computer, a power jack to supply power, a programming header, and a reset button. This board comes with everything you need to get started with the microcontroller, all you need is to connect it to a computer with a USB cable or power it with an external adapter or battery.

The Arduino Uno is a microcontroller board based on the ATmega328 microcontroller. It has several input and output pins that can be used for a variety of purposes. It has 14 digital input/output pins, 6 of which can be used as PWM outputs and 6 analog inputs. It operates on a voltage of 5V and can be powered by an external source with a voltage range of 7-12V or 6-20V. The board also has a built-in clock crystal with a frequency of 16 MHz, a USB connector for connecting to a computer, a power jack for external power supply, a programming header, and a reset button.

The revision 2 of the Uno board has a resistor that connects the 8U2 HWB line to ground, making it easier to put into DFU mode. Revision 3 has the following improvements: a stronger RESET circuit, the Atmega16U2 replaces the 8U2, more robust power supply and protection.

The name "Uno" means one in Italian and was chosen to mark the upcoming release of Arduino 1.0, which is the reference version of Arduino. It's the latest board in a series of USB Arduino boards and the reference model for the Arduino platform. This board has a total of 32KB of flash memory, 2KB of SRAM, and 1KB of EEPROM. Additionally, its dimension is 68.6mm x 53.4mm and weighs 25g [18].

3.4 CONNECTING MEDIUM

3.4.1 ANDROID SMARTPHONE

Android is a mobile operating system that is widely used on smartphones and other mobile devices. It is based on the Linux kernel and is developed by Google. The user interface of Android is designed to be easy to use and intuitive, with a focus on direct manipulation of the on-screen elements. Android is also used on other devices such as televisions, cars, and watches. In our project, we are using an Android smartphone to display information from sensors and send instructions to a microcontroller via Bluetooth. This allows us to control devices connected to the microcontroller, such as those connected to an Arduino board. There are many apps available on the Android app store that can be used for automation purposes, such as controlling home appliances or monitoring sensor data.

3.4.2 BLUETOOTH

Bluetooth is a wireless communication technology that allows devices to connect and exchange data over short distances. It uses radio waves in the ISM frequency band to establish connections between devices and create personal area networks (PANs). The technology was invented by Ericsson in 1994 and it was initially designed as a wireless alternative to RS-232 data cables. Bluetooth allows multiple devices to connect to each other simultaneously and eliminates the need for synchronization. The Bluetooth Special Interest Group (SIG) manages the development and standardization of the technology and maintains a qualification program for manufacturers to ensure their products meet the Bluetooth standards. Additionally, a network of patents applies to the technology, which are licensed to individual devices that meet the requirements.

3.4.2.1 Implementation

Bluetooth is a wireless communication technology that operates in the unlicensed 2.4 GHz frequency band and uses a technique called frequency-hopping spread spectrum to transmit data. It divides data into packets and transmits them over designated channels, with a bandwidth of 1 MHz with the introduction of Bluetooth 4.0, the spacing between channels increased to 2 MHz, and the technology started to use Adaptive Frequency-Hopping (AFH) to optimize communication. Additionally, different modulation schemes like Gaussian frequency-shift keying (GFSK) and π/4-DQPSK are used to transmit data at different speeds. Bluetooth uses a master-slave structure, where the master device can communicate with up to seven slave devices, and all devices share the master's clock. The packet exchange is based on a basic clock set by the master, with packets being 1, 3 or 5 slots long. However, Bluetooth Low Energy (BLE) operates differently in the same spectrum.

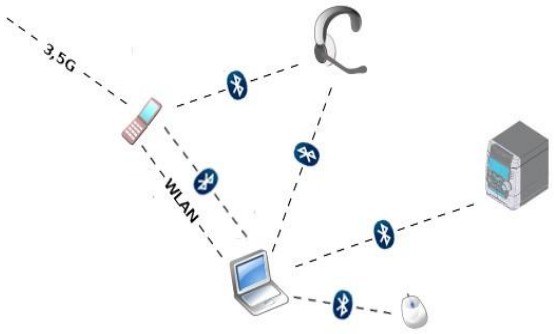


Figure 6: Bluetooth Network

This is picture of how to saturate a network of Bluetooth devices [19]**.**

3.4.2.2 COMMUNICATION AND CONNECTION

In a piconet (a network using Bluetooth technology), a master device can communicate with up to seven other devices, but not all devices reach this maximum. The devices can switch roles, and the slave can become the master. Two or more piconets can also connect to form a scatternet, where some devices play the role of master in one piconet and slave in another. Data can be transferred between the master and one other device at a time, and the master chooses which device to address, usually switching rapidly between them in a round-robin fashion. Being a master of multiple slaves is possible, but being a slave of multiple masters is difficult. The Bluetooth specification is not specific about required behavior in scatternets.

3.4.2.3 USES OF BLUETOOTH

Bluetooth is a wireless communication protocol designed for low-power consumption and short-range communication. It uses radio waves to transmit data between devices, which do not need to be in line of sight, but must have a clear wireless path between them. The range of Bluetooth communication varies by the class of radio being used. Class 3 radios have a range of 1 meter, Class 2 radios commonly found in mobile devices have a range of 10 meters, and Class 1 radios primarily used in industrial settings have a range of 100 meters. However, these ranges can vary in practice due to factors such as propagation conditions, material coverage, and battery conditions. Most Bluetooth applications are intended for indoor use and have a much shorter range than the specified line-of-sight ranges. The range can be extended by connecting a Class 2 device to a Class 1 transceiver with higher sensitivity and transmission power, or by connecting two Class 1 devices with both high sensitivity and high power. Depending on the throughput required by the application, the range can be far in excess of 100 meters.

The Bluetooth Core Specification sets a minimum range for Bluetooth communication at 10 meters; however, it does not set a maximum range and manufacturers have the flexibility to adjust the range of their devices for specific applications. The actual range of Bluetooth communication can vary depending on the devices used and their configuration.

Table 2. Bluetooth Core Specifications

Class	Max. permitted power	Type of range	Version	Data rate	Max. application throughput
1	20	~100	1.2	1 Mbit/s	>80kbit/s
2	4	~10	2.0 + EDR	3 Mbit/s	>80kbit/s
3	0	~1	3.0 + HS	24 Mbit/s	26.9 Mbit/s
			4.0	24 Mbit/s	1Mbit/s

3.4.2.4 BLUETOOTH APPLICATION

Bluetooth technology is a wireless communication protocol that can be used to control and communicate between devices. Some common examples of its applications include using a Bluetooth headset to wirelessly control and communicate with a mobile phone, connecting mobile phones to Bluetooth-compatible car stereo systems, connecting tablets and speakers to other devices such as iOS and Android devices, using a wireless Bluetooth headset and intercom, streaming audio to headphones without communication capabilities, creating wireless networks between PCs in a limited space and with minimal bandwidth needs, connecting PC input and output devices such as a mouse, keyboard, and printer, transferring files, contacts, calendar appointments, and reminders between devices, replacing wired RS-232 serial communication in test equipment, GPS receivers, medical devices, barcode scanners and traffic control devices and using Bluetooth as an alternative to infrared for controls.

3.4.3 Wi-Fi

Wi-Fi is a wireless networking technology that allows electronic devices such as personal computers, smartphones, and digital cameras to connect to a network and access the internet. It operates on the 2.4 GHz and 5 GHz radio bands, which are standardized by the IEEE 802.11 standards. The 2.4GHz band is the most commonly used, but it can experience interference from other electronic devices. The 5GHz band is less crowded and can provide better performance for devices that are capable of using it. One of the main advantages of Wi-Fi is its convenience, as it eliminates the need for physical cables and allows for easy access to the internet. However, Wi-Fi can also be less secure than wired connections and is vulnerable to unauthorized access, eavesdropping and attacks. To address this, Wi-Fi has adopted various encryption technologies such as WEP, WPA, and WPA2, but these protocols have their own weaknesses and limitations. Additionally, an optional feature called Wi-Fi Protected Setup (WPS) had a flaw that allowed attackers to recover the router's password. The Wi-Fi Alliance has since updated its test plan and certification program to ensure that all newly certified devices are resistant to attacks. It is important to use a strong password and to keep the router's firmware up to date to ensure the security of the network.

CHAPTER 4: IMPLEMENTATION OF AUTOMATION CONTROLLED HOME

4.1 INTRODUCTION

A home automation project with face recognition would involve integrating a face recognition system into a home automation system to control access to the home and certain features within the home.

Additionally, I would like to mention an advanced application of home automation - integrating facial recognition technology. This would allow for personalized access to the home for different family members or guests, and would provide an added level of security. For example, the system could automatically adjust lighting, temperature, and even play personalized music or shows based on the person entering the home.

4.2 STEPS OF IMPLEMANTATION

The implementation of such a project would involve several steps:

- **Setting up the hardware**: This would involve installing the necessary hardware components such as cameras, servers, and controllers. The cameras would be used to capture images of the person trying to gain access to the home. The server would be used to process the images and match them against a database of authorized faces. The controllers would be used to control various devices and appliances within the home.

- **Setting up the software**: This would involve configuring the software that runs on the server and the controllers. The software would include the face recognition algorithm, which would be used to match the images captured by the cameras against the database of authorized faces. The software would also need to be configured to communicate with the controllers and control the various devices and appliances within the home.

- **Setting up the database**: This would involve creating a database of authorized faces. This database would be used by the face recognition algorithm to match the images captured by the cameras against the authorized faces. The database would need to be maintained and updated as new authorized faces are added or removed.

- **Training the system**: This would involve capturing images of authorized faces and inputting them into the system. The face recognition algorithm would then use these images to train itself to recognize the authorized faces.

- **Testing and fine-tuning**: Once the system is set up and trained, it would need to be tested to ensure that it is working correctly. Any issues or errors would need to be identified and addressed. The system would also need to be fine-tuned to optimize its performance.

- **Deployment**: Once the system is fully tested and fine-tuned, it can be deployed in the home. At this stage, the system would be ready to control access to the home and certain features within the home based on the face recognition.

In addition to the steps mentioned above, the implementation of a home automation project with face recognition would also involve the following:

- **Integration with other systems**: The face recognition system would need to be integrated with other systems within the home, such as the security system, lighting, heating, and cooling systems. This would allow the system to control access to the home and certain features within the home based on the face recognition. For example, if the face recognition system recognizes an authorized face, it could automatically unlock the front door, turn on the lights, and adjust the temperature to the person's preferred settings.

- **User interface**: A user interface would need to be created to allow users to interact with the system. This could include a mobile application or web portal that allows users to view the status of the system, add or remove authorized faces, and control various devices and appliances within the home.

- **Network security**: As the system would be connected to the internet, network security would need to be considered to protect against unauthorized access, eavesdropping, and attacks. This could involve implementing firewalls, virtual private networks (VPNs), and other security measures to protect the system.

- **Maintenance and updates**: The system would need to be maintained and updated to ensure that it continues to function correctly and to address any security vulnerabilities that may be discovered. This could involve applying software updates, monitoring the system for errors, and performing regular backups of the data.

- **Data privacy**: As the system would be capturing and storing images of people, data privacy concerns would need to be considered. This could involve implementing measures such as data encryption, secure data storage, and data deletion policies to protect the privacy of the people captured by the system.

It's worth mentioning that the implementation of a home automation project with face recognition can be complex and may require specialized knowledge and skills in areas such as computer vision, machine learning, network security and data privacy. It is recommended to consult with experts if you want to implement this kind of project [20].

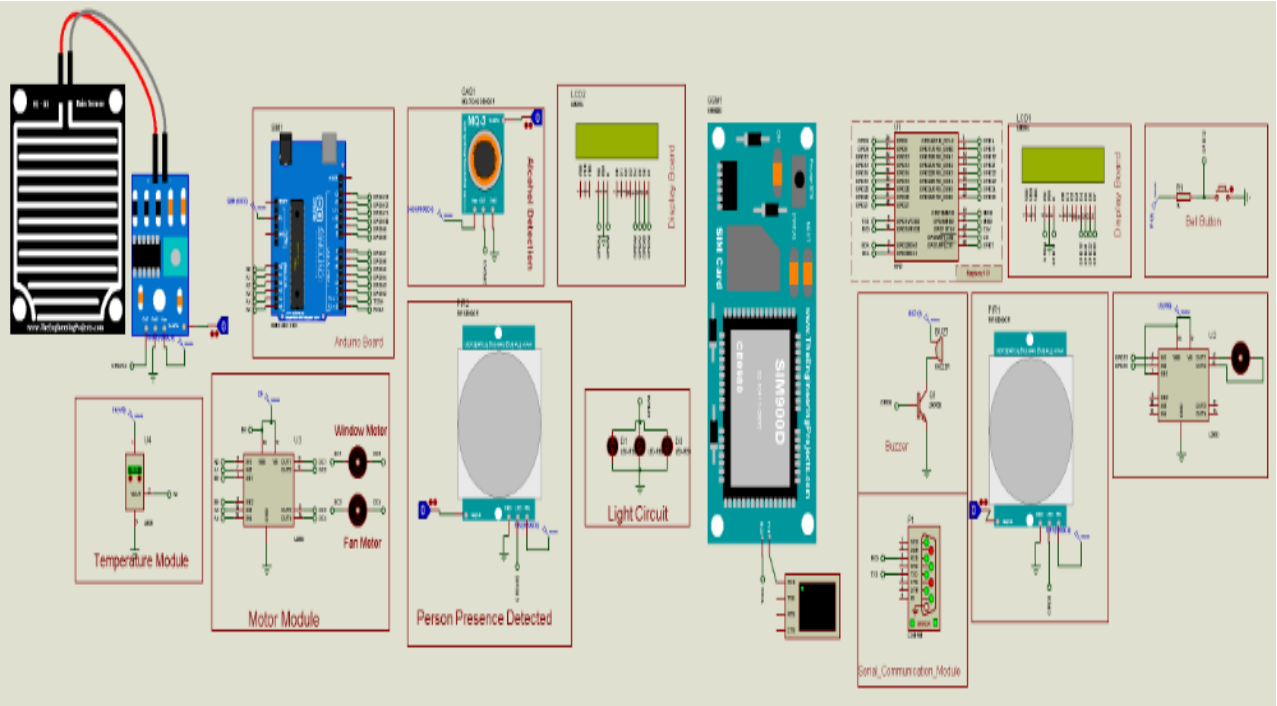


Figure 7. home automation system circuit diagram in proteus

This picture displays the interconnection of two systems: the home automation system and the face recognition system in a Proteus simulation. It requires significant power to run, and capturing images quickly may be challenging depending on the capacity of the machine being used.

4.3 FACE RECOGNITION PSYCHOLOGY

Face recognition is a process by which an individual can identify or verify a person from their face. In psychology, face recognition is a subfield of cognitive psychology that studies how people perceive and recognize faces. Studies in this area have shown that the human brain is highly efficient at recognizing faces, even when presented with only a small amount of information. Additionally, research has shown that the brain processes faces differently than other types of visual information, such as objects or landscapes. Factors such as lighting, perspective, and facial expressions can all affect how well a face is recognized. Studies on face recognition have important applications in fields such as security, surveillance, and social psychology.

4.3.1 COMPARATIVE FACE SOFT BIOMETRICS FOR HUMAN IDENTIFICATION

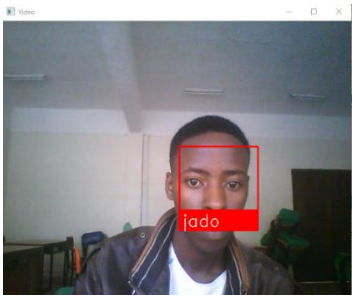
Comparative facial soft biometrics refers to the use of facial features that are not unique to an individual, such as facial expressions or hairstyles, for the purpose of identification and verification. This approach is often used in "unconstrained" environments, where the person being identified may not be looking directly at the camera or may be wearing sunglasses or a hat. The idea is that even if a person's unique facial features are obscured, their comparative facial soft biometrics can still be used to accurately identify them. This can be useful in applications such as security systems or online identity verification.

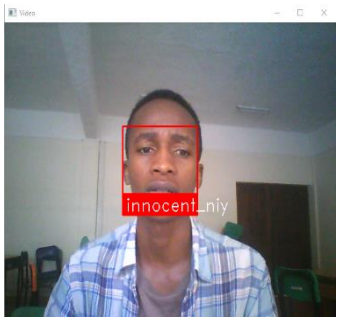
Table 3. Comparative facial soft biometrics defined to analyses unconstrained human identification and verification [21].

No.	Attribute	Label
1	Chin height	[More Small, Same, More Large]
2	Eyebrow hair color	[More Light, Same, More Dark]
3	Eyebrow length	[More Short, Same, More Long]
4	Eyebrow shape	[More Low, Same, More Raised]
5	Eyebrow thickness	[More Thin, Same, More Thick]
6	Eye-to-eyebrow distance	[More Small, Same, Larger]
7	Eye size	[More Small, Same, Larger]
8	Face length	[More Short, Same, More Long]
9	Face width	[More Narrow, Same, Wider]
10	Facial hair	[Less Hair, Same, More Hair]
11	Forehead hair	[Less Hair, Same, More Hair]
12	Inter eyebrow distance	[More Small, Same, Larger]
13	Inter pupil distance	[More Small, Same, Larger]
14	Lips thickness	[More Thin, Same, Thicker]
15	Mouth width	[More Narrow, Same, Wider]
16	Nose length	[More Short, Same, More Long]
17	Nose septum	[More Short, Same, More Long]
18	Nose-mouth distance	[More Short, Same, More Long]
19	Nose width	[More Narrow, Same, Wider]
20	Spectacles	[Less Covered, Same, More Covered]
21	Age	[More Young, Same, Older]
22	Figure	[More Thin, Same, Thicker]
23	Gender	[More Feminine, Same, More Masculine]
24	Skin color	[More Light, Same, Darker]

4.3.2 RECOGNIZE FACES IN IMAGES AND IDENTIFY WHO THEY ARE

```
# Load a sample picture and learn how to recognize it.
jado_image = face_recognition.load_image_file(image)
jado_face_encoding = face_recognition.face_encodings(jado_image)[0]
# Load a second sample picture and learn how to recognize it.
innocent_image = face_recognition.load_image_file(image2)
innocent_face_encoding = face_recognition.face_encodings(innocent_image)[0]
#arrays of known face encodings and their names
known_face_encodings = [
    jado_face_encoding,
    innocent_face_encoding
]
known_face_names = [
    "jado",
    "innocent_niy"
```





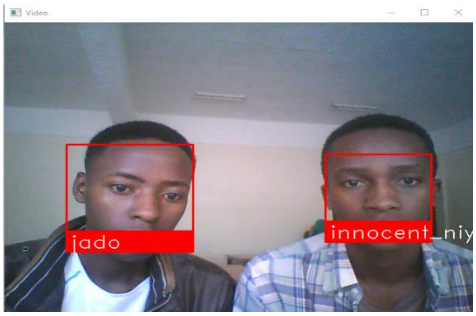


Figure 8: Known_faces

An unknown_person is a face in the image that didn't match anyone in your folder of known people

```
import face_recognition
unknown_image = face_recognition.load_image_file("unknown.jpg")
unknown_encoding = face_recognition.face_encodings(unknown_image)[0]
results = face_recognition.compare_faces([salomon_encoding], unknown_encoding)
```

Figure 9: unknown_person

Proteus is a software tool designed for simulating the behavior of electronic circuits and systems, not for identifying individuals. Identifying an unknown person in Proteus requires designing a facial recognition system and simulating its operation, but achieving accurate identification is challenging due to the complexity and variability of human faces, as well as factors like lighting, pose, and facial expressions. Additionally, Proteus lacks access to real-world data, further complicating the accuracy of facial recognition simulations.

In summary, identifying an unknown person is not the main purpose of Proteus simulations, and doing so using Proteus is challenging due to the complexity of facial recognition and the lack of real-world data. As a result, it may be more effective to use specialized facial recognition software that is specifically designed for identifying individuals.

Face detection in face recognition systems typically involves several steps:

- **Image acquisition:** The first step is to acquire an image of a person's face. This can be done using a digital camera or a webcam.

- **Image pre-processing:** The acquired image is then pre-processed to improve the quality and clarity of the image. This can include removing noise, adjusting the lighting and contrast, and aligning the face in the image.

- **Face detection:** The next step is to locate and detect the face in the image. This is typically done using a technique called Viola-Jones algorithm, which uses a cascade of simple classifiers to quickly reject non-face regions in the image and identify potential face regions.

- **Feature extraction:** Once the face is detected, the next step is to extract features from the face that can be used for recognition. This can include extracting the shape, size, and position of the eyes, nose, and mouth, as well as the texture of the skin.

- **Feature comparison:** The extracted features are then compared with a database of known faces to find the best match. This can be done using techniques such as Principal Component Analysis (PCA) or Linear Discriminant Analysis (LDA).

- **Recognition:** The system will identify a face and output the result once it finds the best match. However, the accuracy and performance of face detection and recognition can be influenced by factors like lighting, pose, and facial expression. Therefore, a large and diverse dataset is needed to train the system and improve its recognition performance.

4.3.3 BIOMETRIC TECHNOLOGY BIHIND FACE RECOGNITION

Biometrics is a technology that uses unique physical or behavioral characteristics of an individual to identify or verify their identity. These characteristics can include fingerprints, facial features, iris patterns, voice or signature. The process involves measuring and analyzing these characteristics to create a unique biometric template, which is then compared against a database of records to confirm or deny the identity of the individual. Biometrics is an automated process that is designed to be more secure and accurate than traditional methods of identification, such as passwords or ID cards.

Face recognition is a type of biometric technology that uses the unique characteristics of a person's face to identify or verify their identity. The main biometric features used in face recognition are:

- **Facial geometry:** This includes the distance between different facial features, such as the distance between the eyes, nose, and mouth.

- **Facial texture:** This includes the unique patterns and features of the skin, such as wrinkles, freckles, and pores.

- **Facial color:** This includes the overall color of the face and the color of specific facial features, such as the eyes and lips.

- **Facial deformation:** this includes the ability of the system to adapt to facial changes such as age, makeup, weight, and other factors that can change the shape and appearance of the face over time.

The system uses these characteristics to create a unique biometric template for each individual, which can then be used for identification or verification.

Face recognition technology also uses various algorithms to match the feature points of the face to the stored templates in a database, this can be done through 2D or 3D model of the face. These algorithms typically use a combination of mathematical techniques, such as Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), and Elastic Bunch Graph Matching(EBGM).

Overall, Face recognition is a complex task that relies on a combination of biometric features and advanced algorithms to accurately identify and verify individuals [22].

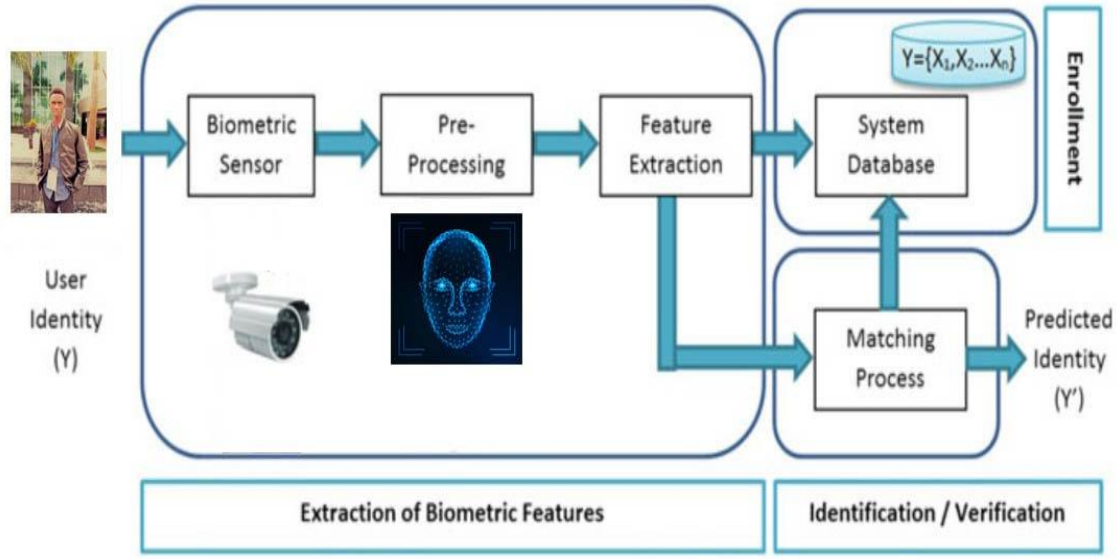


Figure 10: Overview of a biometric system

This picture shows the system of Face recognition, including extraction of Biometric Features and identifications or verification. Fig 1.2. Technologies for Civilian, Military and Cyber Surveillance (Anthony, 2018, p.8).

4.4 CODING

4.4.1 FACE RECOGNITION CODING

The world's simplest face recognition library is a tool that enables developers to easily recognize and manipulate faces using Python or command line interface. This library is built using dlib, which is a state-of-the-art face recognition technology that utilizes deep learning algorithms. With this library, developers can easily identify faces in images or videos, and manipulate them in various ways such as cropping, resizing, or rotating. The library is designed to be user-friendly and can be integrated into a variety of applications such as security systems, social media platforms, and robotics. It is a powerful tool for developers and researchers working on projects related to facial recognition and computer vision. It is done by python scripts by the codes.

The code provided is a Python script that uses the OpenCV and face recognition libraries to perform face recognition on live video from a webcam. The script takes several steps:

Establishing a serial connection with a device on a specific port and baudrate. Loading a sample image of a known person and encoding their face with the face recognition library. This is done for multiple people. Initializing a video capture object to capture video frames from the computer's webcam. Running a while loop that continually captures video frames and performs face recognition on them. Resizing the video frames to 1/4 of their original size to improve performance. Converting the video frames from BGR color format to RGB color format to match the format used by the face_recognition library. Detecting the locations of faces in the video frames using the face_locations function, and encoding the faces using the face_encodings function. Comparing the encoded faces to the known faces using the compare_faces function, and determining the closest match using the face_distance function. Displaying the name of the recognized person in the video frame, or "Unknown" if no match is found. Sending the data to the device connected via serial The script uses the face_recognition library to detect faces in the video frames and compare them to known faces, and uses the OpenCV library to capture video frames from the webcam. Additionally, the script uses the serial library to establish a connection with an external device, and send data to it.

4.4.2 RASBERRY PI 3 CODE FOR FACE RECOGNITION

Implementing a face recognition project on a Raspberry Pi would involve several steps, similar to those on a computer, but with some additional considerations:

- **Setting up the Raspberry Pi:** This would involve installing the operating system, such as Raspbian, on the Raspberry Pi and configuring the network settings. Installing dependencies: This would involve installing the required libraries, such as OpenCV, dlib, and face_recognition, on the Raspberry Pi.

- **Gathering training data:** This would involve collecting images of known individuals and encoding their faces using the face recognition library.

- **Setting up the camera:** This would involve configuring the Raspberry Pi camera, or connecting an external camera, and capturing video frames.

- **Running the face recognition script**: This would involve writing a Python script to perform face recognition on the video frames, as discussed in the previous answer.

- **Optimizing performance:** This would involve fine-tuning the script to optimize performance on the Raspberry Pi, which has limited resources compared to a computer.

This might involve reducing the resolution of the video frames, or running the script at a lower frame rate. Controlling other devices via Raspberry Pi: This would involve connecting other devices, such as lights or thermostats, to the Raspberry Pi and controlling them with the script, using libraries such as RPi. GPIO or other specific libraries for the device. It is important to note that Raspberry Pi's processing power is less than a typical computer and running a face recognition algorithm can be computationally intensive.

The code is a Python script that uses the RPi. GPIO library to control various hardware components connected to a Raspberry Pi. The script starts by importing the necessary libraries and defining the pins that are connected to the LCD screen, the PIR sensor, the buzzer, the switch, and the motor. Next, it defines some timing constants and initializes the pins as inputs or outputs. The script then defines several functions to control the LCD screen, such as lcd_init() and lcd_byte() which are used to initialize the LCD and send data to it, respectively. It also defines a function to toggle the enable pin of the LCD. The script also includes a function to handle the input from the PIR sensor and the switch and take appropriate actions, such as triggering the buzzer and the motor. The script then enters into a loop that repeatedly checks for input from the PIR sensor and switch. It also sends the status of the input to the LCD screen. The script allows for a home automation system that can detect motion, sound an alarm and open a door with the use of a motor. This system can be further expanded to include more functionality such as sending notifications and integrating with other devices such as cameras and thermost.

4.4.3 ARDUINO CODE FOR CONTROLLING HOME

Arduino is an open-source electronics platform that can be used to control various devices in a smart home system. The code for an Arduino-based home automation system typically includes instructions for reading sensor data, controlling actuators (such as lights and motors), and communicating with other devices (such as a smartphone or computer). The code is written in the Arduino programming language and is uploaded to the Arduino board via a USB connection. Some common libraries used for home automation with Arduino are IR remote, Servo, and Ethernet. These libraries include pre-written code for common tasks such as sending infrared signals and controlling servo motors, making it easier to build a functional system. The following code shows how coding Arduino for Proteus simulations.

The code uses various sensors such as PIR, fire and rain sensors to detect the environment and make decisions on how to control different devices. For example, if the temperature is above a certain threshold, the code turns on a fan, if the rain sensor detects rain, it will start the window motor, if the PIR sensor detects motion, it will turn on an LED. The code also uses an LCD display to show the status of the system. Additionally, it uses a GSM module to send a message in case of fire detection.

4.5 PROJECT MODULES

We divided the whole Controlled Home Automation into some parts for ease of understanding and task execution. They are as follows:

- **Fan/ AC Switching**: This module is used to control the switching of fan and AC using the voice commands. It can be used to turn on or off the fan or AC using the voice commands. [22]

- **Smart Lighting Module:** This module enables remote control of lighting and dimming settings, either through a mobile app or voice command.

- **Smart Security Module:** This module monitors and controls access to the home, with features such as security cameras, door locks, and alarms**.**

- **Camera Module**: This module captures the images of the faces for recognition
  Face Recognition Algorithm Module: This module is responsible for identifying faces within the images and matching them to known individuals [23].

- **Image recognition**: this module is used for a wide range of applications, such as facial recognition, object recognition in autonomous vehicles.

- **Smart home detectors and sensors Module:** this module is about electronic devices that are designed to detect various environmental changes and events within a home [24]**.**

- **Central Processing Unit (CPU) Module:** This module is the brain of the automation system that receives and processes input from other modules. Some popular options include Raspberry Pi and Arduino.

- **The motor module**: this module is about a device that allows for the remote or automated control of various motorized systems, such as blinds, shades, curtains, or garage doors. This module typically consists of a motor controller and a motor that can be controlled by a central processing unit (CPU) or other smart devices.

- **A GSM Module:** this module is about a device that allows for communication between a home automation system and a mobile network, enabling remote control and monitoring of the system through a mobile device**.**

- **A LCD control circuit Module**: this module is about an electronic device that enables a home automation system to display information on an LCD screen, such as temperature readings or system status [25].

CHAPTER 5: CONCLUSION AND FUTURE SCOPE

5.1 CONCLUSION

Smart home automation technology has the potential to greatly improve our daily lives by providing comfort and convenience through automating various household tasks. This not only reduces human effort, but also eliminates the potential for human error, ultimately saving energy and resources. However, this is just the beginning as advancements in technology such as nanotechnology and neural system sensing have the potential to take smart home automation even further. In the future, we may be able to control our homes simply by thinking or imagining. This could lead to a world where our homes adapt to our moods, with voice control systems and self-cleaning floors becoming a reality. Additionally, the development of portable, hand-held nanotechnology devices that can connect to any device with a touch has the potential to make smart home automation even more accessible. All in all, smart home automation technology is a constantly evolving field with endless possibilities for the future. The implementation of smart home technology has the potential to revolutionize the way we live our everyday lives. By automating various tasks and systems within the home, smart home technology can provide increased comfort and convenience while also saving energy and reducing human effort. However, this technology is not just a solution for current problems; it is also a glimpse into the future of home automation. With advancements in nanotechnology and neural system sensing, we can imagine a world where we have the ability to control our homes simply by thinking or imagining it. The possibilities are endless and the future of smart home technology is exciting and full of potential. We can expect to see developments such as voice control systems, self-cleaning floors, and portable and easy-to-use Nano chips that can connect to any device with just a touch. The future of smart home technology is something to look forward to, as the possibilities are endless and the potential for improvement is ongoing.

5.2 FUTURE SCOPE

Therefore, in the future, we can expect the following implementations in the project above:

- Integration of Artificial Intelligence to make the system more intelligent and efficient in controlling various home appliances.

- Development of more advanced sensors and actuators to improve the accuracy and functionality of the system.

- Integration of more advanced voice recognition technology to improve the user-friendliness of the system.

- Development of more advanced algorithms for better decision-making and control of the system.

- Integration of more advanced security features to make the system more secure and tamper-proof.

- Development of more advanced user interfaces and apps to make the system more user-friendly and easier to use.

- Development of more advanced energy management features to reduce the energy consumption of the system.

- Development of more advanced monitoring and reporting features to provide more detailed information about the system's performance and status.

- Integration of more advanced automation features to control and manage various other aspects of the home, such as gardening, cooking, and cleaning [26].

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APPENDIX

FACE RECOGNITION CODING

```
import face_recognition

import cv2

import numpy as np

import os

import serial

import smtplib

import imghdr

from email.message import EmailMessage

s = serial.Serial('COM1',9600)

CurrentFolder = os.getcwd() #Read current folder path where project is saved

image = CurrentFolder+'\\jado.jpg'      #import image from current folder, we imported 3 images

image2 = CurrentFolder+'\\innocent.jpg'

# This is a demo of running face recognition on live video from your webcam. It's a little more complicated than the

# other example, but it includes some basic performance tweaks to make things run a lot faster:

#   1. Process each video frame at 1/4 resolution (though still display it at full resolution)

#   2. Only detect faces in every other frame of video.

# Get a reference to computer webcam #0 (the default one)

#to use external camera set reference to #1

video_capture = cv2.VideoCapture(0)

# Load a sample picture and learn how to recognize it.

jado_image = face_recognition.load_image_file(image)

jado_face_encoding = face_recognition.face_encodings(jado_image)[0]

# Load a second sample picture and learn how to recognize it.

innocent_image = face_recognition.load_image_file(image2)

innocent_face_encoding = face_recognition.face_encodings(innocent_image)[0]

#arrays of known face encodings and their names

known_face_encodings = [

    jado_face_encoding,

    innocent_face_encoding

]

known_face_names = [

    "jado",

    "innocent_niy"

]

face_locations = []

face_encodings = []

face_names = []

process_this_frame = True

while True:

print("waiting for bell input")
```

```
serial_data = s.read()
if(serial_data == b'a'):
    while(1):
        # Grab a single frame of video
        ret, frame = video_capture.read()
 # Resize frame of video to 1/4 size for faster face recognition processing
        #Note that this lower quality of picture and for low res camera it get harder for face recognition processin
 small_frame = cv2.resize(frame, (0, 0), fx=0.25, fy=0.25)
 # Convert the image from BGR color (which OpenCV uses) to RGB color (which face_recognition uses)
        rgb_small_frame = small_frame[:, :, ::-1]
 # Only process every other frame of video to save time
        if process_this_frame:
            # Find all the faces and face encodings in the current frame of video
            face_locations = face_recognition.face_locations(rgb_small_frame)
            face_encodings = face_recognition.face_encodings(rgb_small_frame, face_locations)
            face_names = []
            for face_encoding in face_encodings:
                # See if the face is a match for the known face(s)
                matches = face_recognition.compare_faces(known_face_encodings, face_encoding)
                name = "Unknown"
                face_distances = face_recognition.face_distance(known_face_encodings, face_encoding)
                threshold = 0.2
                matches = face_distances <= threshold
                best_match_index = np.argmin(face_distances)
                if best_match_index != -1:
                    name = known_face_names[best_match_index]
                face_names.append(name)
                if(name == "Unknown"):
                    s.write(b'0')
                    i = 0
                    serial_data = s.read()
                    if(serial_data == b'p'):
                        print(" Memebers present inside home no need to send image")
                    elif(serial_data == b'q'):
                        while i < 10:
                            print("sending image on mail")
                            return_value, image = video_capture.read()
                            cv2.imwrite('opencv.png', image)
                            i += 1
                        Sender_Email = "videoscentvisual@gmail.com"
                        Reciever_Email = "niyigabinnocent@gmail.com"
                        Password = "from1to10" #type your password here
```

```
                    newMessage =
EmailMessage()
                    newMessage['Subject'] =
"Alert Theft inside your home"
                    newMessage['From'] =
Sender_Email
                    newMessage['To'] =
Reciever_Email

newMessage.set_content('Let me know what
you think. Image attached!')
                    with open('opencv.png', 'rb')
as f:
                        image_data = f.read()
                        image_type =
imghdr.what(f.name)
                        image_name = f.name

newMessage.add_attachment(image_data,
maintype='image', subtype=image_type,
filename=image_name)
                    with
smtplib.SMTP_SSL('smtp.gmail.com', 465) as
smtp:
                        smtp.login(Sender_Email,
Password)

smtp.send_message(newMessage)
                elif((name == "jado") or (name ==
"innocent_Niy")):
                    s.write(b'1')
        process_this_frame = not
process_this_frame
```

 # Display the results

```
        for (top, right, bottom, left), name in
zip(face_locations, face_names):
```

 # Scale back up face locations since the frame we detected in was scaled to 1/4 size

```
            top *= 4
            right *= 4
            bottom *= 4
            left *= 4
            # Draw a box around the face
            cv2.rectangle(frame, (left, top), (right,
bottom), (0, 0, 255), 2)
            # Draw a label with a name below the
face
            cv2.rectangle(frame, (left, bottom -
35), (right, bottom), (0, 0, 255), cv2.FILLED)
            font =
cv2.FONT_HERSHEY_DUPLEX
            cv2.putText(frame, name, (left + 6,
bottom - 6), font, 1.0, (255, 255, 255), 1)
```

 # Display the resulting image

```
        cv2.imshow('Video', frame)
```

 # Hit 'q' on the keyboard to quit!

```
        if cv2.waitKey(1) & 0xFF == ord('q'):
            break
```

 # Release handle to the webcam

```
    video_capture.release()
    cv2.destroyAllWindows
```

RASBERRY PI 3 CODE FOR FACE RECOGNITION

```
#!/usr/bin/python
import time
import os
import RPi.GPIO as GPIO
import pio
import Ports
pio.uart=Ports.UART () # Define serial port
GPIO.setmode(GPIO.BOARD)
GPIO.setwarnings(False)
# Define GPIO to LCD mapping
LCD_RS = 7
LCD_E  = 11
LCD_D4 = 12
LCD_D5 = 13
LCD_D6 = 15
LCD_D7 = 16
pir_pin = 29
buzzer_pin =31
switch_pin =32
motor_pin1 =33
motor_pin2 =36
'''
define pin for lcd
'''# Timing constants
E_PULSE = 0.0005
E_DELAY = 0.0005
delay = 1
GPIO.setup(LCD_E, GPIO.OUT)  # E
GPIO.setup(LCD_RS, GPIO.OUT) # RS
GPIO.setup(LCD_D4, GPIO.OUT) # DB4
GPIO.setup(LCD_D5, GPIO.OUT) # DB5
GPIO.setup(LCD_D6, GPIO.OUT) # DB6
GPIO.setup(LCD_D7, GPIO.OUT) # DB7
GPIO.setup(pir_pin, GPIO.IN)
GPIO.setup(switch_pin, GPIO.IN)
GPIO.setup(buzzer_pin, GPIO.OUT)
GPIO.setup(motor_pin1, GPIO.OUT)
GPIO.setup(motor_pin2, GPIO.OUT)
# Define some device constants
LCD_WIDTH = 16    # Maximum characters per line
LCD_CHR = True
LCD_CMD = False
LCD_LINE_1 = 0x80 # LCD RAM address for the 1st line
LCD_LINE_2 = 0xC0 # LCD RAM address for the 2nd line
'''
Function Name :lcd_init()
Function Description : this function is used to initialized lcd by sending the different commands
'''def lcd_init():
  # Initialise display
  lcd_byte(0x33,LCD_CMD) # 110011 Initialise
  lcd_byte(0x32,LCD_CMD) # 110010 Initialise
  lcd_byte(0x06,LCD_CMD) # 000110 Cursor move direction
  lcd_byte(0x0C,LCD_CMD) # 001100 Display On,Cursor Off, Blink Off
  lcd_byte(0x28,LCD_CMD) # 101000 Data length, number of lines, font size
  lcd_byte(0x01,LCD_CMD) # 000001 Clear display
  time.sleep(E_DELAY)
'''
Function Name :lcd_byte(bits ,mode)
Fuction Name :the main purpose of this function to convert the byte data into bit and send to lcd port
'''
def lcd_byte(bits, mode):
  # Send byte to data pins
  # bits = data
  # mode = True  for character
  #        False for command
  GPIO.output(LCD_RS, mode) # RS
  # High bits
  GPIO.output(LCD_D4, False)
  GPIO.output(LCD_D5, False)
  GPIO.output(LCD_D6, False)
  GPIO.output(LCD_D7, False)
  if bits&0x10==0x10:
    GPIO.output(LCD_D4, True)
  if bits&0x20==0x20:
    GPIO.output(LCD_D5, True)
```

```
 if bits&0x40==0x40:
    GPIO.output(LCD_D6, True)
 if bits&0x80==0x80:
   GPIO.output(LCD_D7, True)
 # Toggle 'Enable' pin
 lcd_toggle_enable()
 # Low bits
 GPIO.output(LCD_D4, False)
 GPIO.output(LCD_D5, False)
 GPIO.output(LCD_D6, False)
 GPIO.output(LCD_D7, False)
 if bits&0x01==0x01:
   GPIO.output(LCD_D4, True)
 if bits&0x02==0x02:
   GPIO.output(LCD_D5, True)
 if bits&0x04==0x04:
   GPIO.output(LCD_D6, True)
 if bits&0x08==0x08:
   GPIO.output(LCD_D7, True)
 # Toggle 'Enable' pin
 lcd_toggle_enable()
''' Function Name :
lcd_toggle_enable()
Function Description:basically this
is used to toggle Enable pin
'''
def lcd_toggle_enable():
 # Toggle enable
 time.sleep(E_DELAY)
 GPIO.output(LCD_E, True)
 time.sleep(E_PULSE)
 GPIO.output(LCD_E, False)
 time.sleep(E_DELAY)
'''
Function Name
:lcd_string(message,line)
Function  Description :print the data
on lcd
'''
def lcd_string(message,line):
 # Send string to display
 message =
message.ljust(LCD_WIDTH," ")
 lcd_byte(line, LCD_CMD)
 for i in range(LCD_WIDTH):

lcd_byte(ord(message[i]),LCD_CH
R)
# Define delay between readings
delay = 5
lcd_init()
lcd_string("welcome
",LCD_LINE_1)
time.sleep(1)
lcd_byte(0x01,LCD_CMD) #
000001 Clear display
lcd_string("Face Detection
System",LCD_LINE_1)
lcd_string("System",LCD_LINE_2)
time.sleep(1)
while 1:
 lcd_byte(0x01,LCD_CMD) #
000001 Clear display
 lcd_string("Press
Belll",LCD_LINE_1)
 time.sleep(0.2)
 switch_data =
GPIO.input(switch_pin)
 time.sleep(0.2)
 if(switch_data  ==  False):
 pio.uart.print("a")
 GPIO.output(buzzer_pin, True)
 time.sleep(1)
 GPIO.output(buzzer_pin, False)
 while(1):
  Data=pio.uart.recv()
  if(Data == "1"):
    lcd_byte(0x01,LCD_CMD) #
000001 Clear display
    lcd_string("Valid
Person",LCD_LINE_1)
    lcd_string("Door
Opne",LCD_LINE_2)
    GPIO.output(motor_pin1, False)
    GPIO.output(motor_pin2, True)
    time.sleep(1)
    GPIO.output(motor_pin1, True)
    GPIO.output(motor_pin2, False)
    time.sleep(1)
    GPIO.output(motor_pin1, False)
    GPIO.output(motor_pin2, False)
    break
  elif(Data == "0"):
    lcd_byte(0x01,LCD_CMD) #
000001 Clear display
    lcd_string("Unknown
Person",LCD_LINE_1)
    lcd_string("Door
close",LCD_LINE_2)
    time.sleep(0.2)
    pir_data =  GPIO.input(pir_pin)
    time.sleep(0.2)
    if(pir_data  ==  True):
     pio.uart.print("p")
    else:
     pio.uart.print("q")
    time.sleep(1)
    break
```

ARDUINO CODE FOR CONTROLLING HOME

```
#include <LiquidCrystal.h>
String voice;
LiquidCrystal lcd(4, 5, 6, 7, 8, 9);
const int led_Pin = 2;
const int buzzer_Pin = 3;
const int pir_Sensor = 10;
const int fire_Sensor = 11;
const int rain_Sensor = 12;
const int temp_pin = A5;
const int dc1 = A0;
const int dc2 = A1;
const int dc3 = A3;
const int dc4 = A4;
bool pir_status = LOW;
bool fire_Status = LOW;
bool rain_Status = LOW;
float temperature;
char text= "";
void setup() {
  pinMode(temp_pin, INPUT);
  pinMode(led_Pin, OUTPUT);
  pinMode(buzzer_Pin, OUTPUT);
  pinMode(pir_status, INPUT);
  pinMode(fire_Sensor, INPUT);
  pinMode(rain_Sensor, INPUT);
  pinMode(dc1, OUTPUT);
  pinMode(dc2, OUTPUT);
  pinMode(dc3, OUTPUT);
  pinMode(dc4, OUTPUT);
  pinMode(6, OUTPUT);
  pinMode(5, OUTPUT);
  pinMode(4, OUTPUT);
  Serial.begin(9600);
  lcd.begin(16, 2);
  lcd.print("Home Automation");
  lcd.setCursor(3,2);
  lcd.print("SYSTEM");
  delay(500);
}
void loop()
{
  pir_status = digitalRead(pir_Sensor);
  fire_Status = digitalRead(fire_Sensor);
  rain_Status = digitalRead(rain_Sensor);
  temperature = analogRead(temp_pin);
  temperature= ( temperature*500)/1023;
  lcd.clear();
  lcd.print("Temperature");
  lcd.setCursor(3,2);
  lcd.print(temperature);
  delay(200);
  if(temperature > 35)
  {
    /* Turn ON Fan */
    digitalWrite(dc3, HIGH);
    digitalWrite(dc4, LOW);
    //delay(500);
  }
  else
  {
    /* Turn OFF Fan */
    digitalWrite(dc3, LOW);
    digitalWrite(dc4, LOW);
   // delay(500);
  }
  if(rain_Status == HIGH )
  {
    /* Start the window motor */
    /* turn ON led*/
    lcd.clear();
    lcd.print("Rain Detected");
    digitalWrite(dc1, HIGH);
    digitalWrite(dc2, LOW);
    delay(1000);
    digitalWrite(dc1, LOW);
    digitalWrite(dc2, LOW);
  }
  if(pir_status == HIGH)
  {
    /* turn ON led*/
    lcd.clear();
    lcd.begin(16, 2);
    lcd.print("Person Detected");
    digitalWrite(led_Pin, HIGH);
```

```
  //delay(100);
 }
 else
 {
  /* turn off led*/
  lcd.clear();
  lcd.print("Person not ");
  lcd.setCursor(0,2);
  lcd.print("Detected");
  digitalWrite(led_Pin, LOW);
 // delay(100);
 }

 if(fire_Status == HIGH)
 {
  /* turn ON led*/
  lcd.clear();
  lcd.print("fire detected");
  digitalWrite(buzzer_Pin, HIGH);

Serial.println("AT+CMGF=1"); //Sets the GSM Module in Text Mode
  delay(100);  // Delay of 1000 milli seconds or 1 second
Serial.println("AT+CMGS=\"+919922512017\"\r"); // Replace x with mobile number
   delay(100);
   Serial.println("Fire Detected in home ");// The SMS text you want to send
  delay(100);
 }
 else
 {
  /* turn off led*/
  lcd.clear();
  lcd.print("fire not ");
  lcd.setCursor(0,2);
  lcd.print("Detected");
  digitalWrite(buzzer_Pin, LOW);
  //delay(100);
 }

while(Serial.available()){
 delay(3);
 char c = Serial.read();
 voice+=c;}
if(voice.length() >0){
 Serial.println(voice);
 if(voice == "light on")
 {digitalWrite(6, HIGH);}
 else if(voice == "light off")
 {digitalWrite(6, LOW);}
 else if(voice == "fan on")
 {digitalWrite(5, HIGH);}
 else if(voice == "fan off")
 {digitalWrite(5, LOW);}
 else if(voice == "night lamp on")
 {digitalWrite(4, HIGH);}
 else if(voice == "night lamp off")
 {digitalWrite(4, LOW);}
 else if(voice == "all on")
 {digitalWrite(4, HIGH);
  digitalWrite(5, HIGH);
 digitalWrite(6, HIGH);}
 else if(voice == "all off")
 {digitalWrite(4, LOW);
  digitalWrite(5, LOW);
 digitalWrite(6, LOW);}
 voice = "";}
}
```