AISSMS
INSTITUTE OF INFORMATION TECHNOLOGY
(IOIT)
ADDING VALUE TO ENGINEERING
An Autonomous Institute Affiliated to Savitribai Phule Pune University
Approved by AICTE, New Delhi and Recognised by Govt. of Maharashtra
Accredited by NAAC with "A+" Grade | NBA - 5 UG Programmes

ACTIVITY BASED PROJECT REPORT

ON

"SMART CAMPUS"

For Engineering in Instrumentation Engineering

Submitted by

1. **Mr. Om Borle**
2. **Mr. Mahendra Girnekar**
3. **Mr. Viraj Pednekar**

Under The Guidance Of

Miss. S.R.Garthe

DEPARTMENT OF INSTRUMENTATION ENGINEERING

ALL INDIA SHRI SHIVAJI MEMORIAL SOCIETY'S

INSTITUTE OF INFORMATION TECHNOLOGY

PUNE, 411001

AISSMS INSTITUTE OF INFORMATION TECHNOLOGY (IOIT)

ADDING VALUE TO ENGINEERING

An Autonomous Institute Affiliated to Savitribai Phule Pune University
Approved by AICTE, New Delhi and Recognised by Govt. of Maharashtra
Accredited by NAAC with "A+" Grade | NBA - 5 UG Programmes

CERTIFICATE

This is to certify that **Mr. Om Borle**, **Mr. Mahendra Girnekar**, **Mr. Viraj Pednekar** from INSTRUMENTATION **DEPARTMENT AISSMS INSTITUTE OF INFORMATION TECHNOLGY** Having Exam No. 23220009, 23220011, 23220024,

Has completed project of third year having title: Smart Campus during the academic year 2024-2025. The project completed in group consisting of following persons under the guidance of Miss. S.R. Garthe

1. Mr. Om Borle

2. Mr. Mahendra Girnekar

4. Mr. Viraj Pednekar

Miss. S. R. Garthe
Guide
Instrumentation Engineering Dept.
AISSMS IOIT, PUNE

Dr. A. A. Shinde
Head Of Dept.
Instrumentation Engineering Dept.
AISSMS IOIT, PUNE

Dr. P. B. Mane
Principal
AISSMS IOIT, PUNE

② ACKNOWLEDGEMENT

We feel great pleasure in submitting this Project Based Learning on **"Smart Campus"**. We wish to express true sense of gratitude towards our project guide, **Miss. S. R. Garthe** who at very discrete step in study of this subject contributed her valuable guidance and help to solve every problem that a rose.

We would wish to thank our Head of Instrumentation Engineering Department **Dr. A. A. Shinde** for opening the doors of the department towards the realization of the project report.

We would like to extend our special thanks to Principal **Dr. P. B. Mane** for spending his valuable time to go through our report and providing many helpful suggestions.

Most likely we would like to express our sincere gratitude towards our family and friends for always being there when we needed them the most. With all respect and gratitude, we owe our all success to them.

1.	**Mr. Om Borle**	**(23220009)**
2.	**Mr. Mahendra Girnekar**	**(23220011)**
3.	**Mr. Viraj Pednekar**	**(23220024)**

Vision mission

Vision, Mission, Program Educational Objectives (PEOs), Program Specific Objectives (PSOs) and Program Outcomes (POs)

Vision of Institute:

"To uplift the common masses by rendering value added education".

Mission of Institute:

"Empowering society through dynamic education".

Vision of department:

"To be well known department that will serve as a source of knowledge and expertise in the field of Instrumentation for the society by rendering value added education".

Mission of department:

"To impart dynamic education and develop engineers, technocrats, and researchers to provide services and leadership for development of the nation".

Program educational objectives :

PEO1: To train graduates with the basic techniques and modern tools of instrumentation engineering to solve real life problems of the society.

PEO2: To enrich graduates by imparting dynamic and value-added education to acquire good position in industry.

PEO3: To motivate graduates to contribute as a socially responsible citizen, ethical leader for the development of the nation.

PEO4: To encourage graduates for higher education, research, competitive examinations, and to become an entrepreneur.

Programing specific outcomes:

PSO1: Students will be able to utilize their knowledge of measurement and control to solve the environmental, health, agricultural and safety related problems.

PSO2: Students will be able to demonstrate their acquired skills related to modern engineering tools such as Distributed control system, programmable logic controller (PLC), supervisory control and data acquisition systems, lab view and embedded systems etc.

Programme Outcomes:

Graduates will be able to:

1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. **[Engineering knowledge]**.
2. Identity, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences. **[Problem analysis].**
3. Design solutions for complex engineering problems and design system components of processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations. **[Design / development of solutions]**
4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions. **[Conduct investigations of complex problems]**
5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations. **[Modern tool usage]**
6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice. **[The engineer and society]**
7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of and need for sustainable development. **[Environment and sustainability]**
8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. **[Ethics].**
9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. **[Individual and team work].**
10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. **[Communication]**
11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments. **[Project management and finance].**
12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. **[Life-long learning]**

Group No:

Class: T.Y.Btech

Subject: Activity based Project

Academic Year: 2024-2025

Group Members:

Sr. No	**Student Name**	**Roll. No**	**Sign**
1.	Om Ajay Borle	14	
2.	Mahendra Girnekar	22	
3.	Viraj Pednekar	55	

Selected Topic :

"Smart Campus"

Co-Ordinator Name : **Sign:**

Miss. S.R Garthe

CONTENT

ABSTRACT

The Smart Campus project aims to implement a range of automated systems using modern technologies to enhance the safety, efficiency, and sustainability of a campus environment. Through the integration of microcontrollers like Arduino and IoT devices, this project develops practical applications such as an RFID-based access control system, a wireless security camera using the ESP32-CAM, an automated elevator system using a DC motor, an HVAC system that regulates environmental conditions, and a home automation system for controlling electrical appliances remotely. These systems work synergistically to improve overall campus operations by automating key functions such as entry control, surveillance, climate regulation, and appliance management. The project demonstrates how automation technologies can reduce human error, increase energy efficiency, enhance security, and provide a seamless, intelligent experience for users. By focusing on real-world applications of building automation, this project serves as a step towards creating smarter, safer, and more efficient campuses.

CHAPTER 1

INTRODUCTION

In recent years, the concept of a Smart Campus has gained significant attention as educational institutions seek to improve safety, comfort, operational efficiency, and energy management through the use of advanced technologies. A Smart Campus integrates digital infrastructure and intelligent systems to automate and monitor building facilities. This includes access control, security surveillance, climate control (HVAC), elevator automation, and appliance management. These systems not only improve the user experience but also help reduce manual intervention and energy consumption.

This project, titled "Smart Campus Using Building Automation," presents a scaled-down implementation of several key components of a smart building. It leverages popular microcontrollers such as Arduino and ESP32 along with sensors, actuators, and IoT-based communication to demonstrate intelligent control systems.

The following modules have been developed as part of the project:

Access Control System using Arduino: Grants or denies entry based on secure authentication.

ESP32-CAM Security Camera: Offers real-time surveillance via a wireless camera.

Elevator System using DC Motor: Simulates floor navigation and movement control.

HVAC (Heating, Ventilation, and Air Conditioning) System: Maintains environmental comfort based on sensor data.

Home Automation System: Enables remote or automated control of lights, fans, and other devices.

Each module represents a real-world application of embedded systems and contributes to the creation of a safe, responsive, and energy-efficient campus environment.

Let me know if you want this added to the Word file or if you'd like a Hindi translation or presentation slide version as well.

CHAPTER 2

LITERATURE SURVEY

A significant amount of research and development has been dedicated to the concept of Smart Campus and building automation systems over the past decade. Building automation focuses on integrating various technologies, such as sensors, microcontrollers, and IoT devices, to optimize the management of facilities. Studies have shown that automation in campus environments improves energy efficiency, enhances security, and increases operational convenience. For instance, RFID-based access control systems have been widely adopted in security applications, as they offer reliable and secure methods for controlling entry and preventing unauthorized access. Similarly, IoT-based smart surveillance systems using cameras like ESP32-CAM provide cost-effective solutions for real-time video monitoring and remote access. Research into HVAC automation highlights the advantages of energy savings through temperature and humidity regulation, ensuring comfort while minimizing energy consumption. Furthermore, home automation, controlled via microcontrollers such as Arduino, has become increasingly popular due to its simplicity and flexibility, allowing users to remotely control devices and appliances. These advancements form the foundation of the Smart Campus project, leveraging existing research and technologies to build an integrated, intelligent campus infrastructure.

CHAPTER NO 3

SCOPE OF PROJECT

The scope of this Smart Campus project encompasses the design, development, and demonstration of multiple intelligent building automation systems tailored for modern educational institutions. The project aims to implement five key modules—access control, surveillance, elevator automation, HVAC management, and home automation—each contributing to the overall functionality, safety, and efficiency of the campus infrastructure. The Access Control System uses RFID technology to manage secure entry into restricted areas, ensuring that only authorized individuals can gain access. The ESP32-CAM-based surveillance system enhances campus safety through real-time monitoring and wireless video transmission. The elevator system simulates floor-based motion control using a DC motor, illustrating the principle of automated vertical mobility in multi-storey buildings. The HVAC system uses temperature and humidity sensors with Arduino to maintain environmental comfort automatically, demonstrating the potential for smart energy usage. Finally, the home automation module allows users to control electrical appliances remotely, enabling convenience and efficient energy usage in campus housing or offices.

This project offers a scalable model that can be extended with additional features such as cloud integration, mobile app control, voice assistant support, and data logging for analytics. It promotes the practical use of microcontrollers, sensors, actuators, and wireless modules in real-world applications, making it highly relevant for engineering students and professionals in the field of automation and IoT. Furthermore, the modular design ensures each system can function independently or as part of an integrated solution, making the project adaptable to different campus layouts and requirements. The Smart Campus project provides a foundation for future enhancements such as smart lighting, fire detection, water level monitoring, and AI-driven analytics, paving the way for a fully connected, intelligent educational environment.

CHAPTER NO 4

METHODOLOGY

1.1 INFORMATION

The methodology of the Smart Campus project is centered on modular design, microcontroller-based implementation, and sensor-actuator integration to simulate an intelligent building automation system. Each component of the project was developed independently and then integrated to create a cohesive smart environment. The development began with circuit design and hardware selection for each module. The access control system was built using an Arduino UNO, RFID reader (RC522), and servo motor to simulate door locking and unlocking based on card authentication. For surveillance, the ESP32-CAM module was programmed to stream real-time video over Wi-Fi, enabling remote monitoring through a local server. The elevator system utilized a DC motor, motor driver (L298N), and push buttons to simulate multi-floor navigation, with logic implemented on an Arduino. For HVAC control, temperature and humidity were sensed using the DHT11 sensor, and based on the readings, cooling (fan) or heating (bulb or resistor) devices were activated via relays using Arduino logic. In the home automation module, basic appliances like bulbs and fans were controlled using a smartphone or manually via push buttons, interfaced through the Arduino and relay board.

All modules were programmed using the Arduino IDE and tested individually for stability and accuracy. The systems were then arranged in a physical layout to resemble a smart campus model. Wireless communication was implemented where applicable using Wi-Fi or IR modules. Emphasis was placed on safety, responsiveness, and power efficiency in logic design. The hardware-software interaction was validated through multiple testing cycles and fine-tuned for optimal performance. Overall, the methodology showcases a hands-on approach to combining embedded systems, automation logic, and IoT concepts to simulate real-world building operations in a scalable smart campus prototype.

CHAPTER NO 5

ACCESS CONTROL DOOR (ARDUINO)

5.1 Access Control Door System (Using Arduino)

- **Overview:**
  The Access Control Door system is designed to grant or deny access based on authorized input, such as an RFID card or keypad password. This system ensures only verified users can enter secure areas within the campus. It is an essential part of any Smart Campus to maintain safety and limit unauthorized entry.

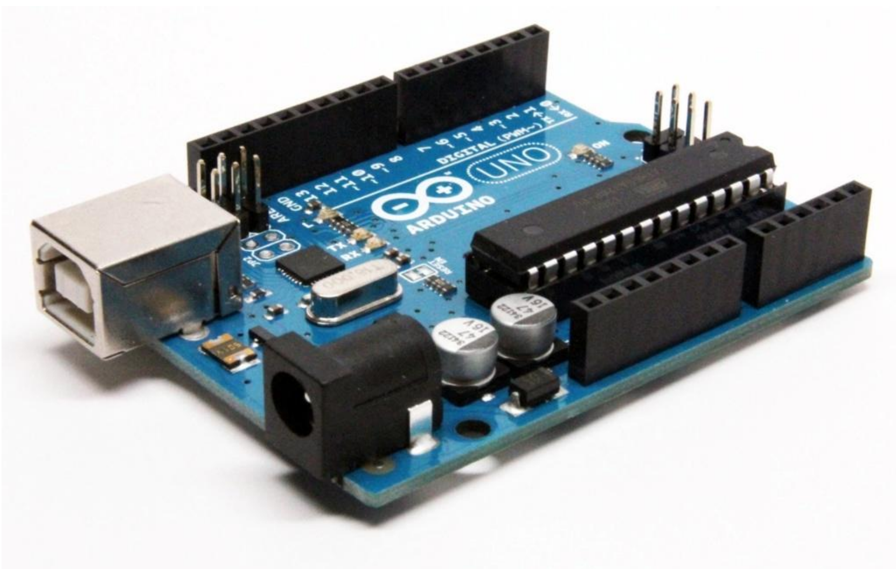
5.2 Working Principle:

- When a user brings an RFID card near the RFID module (RC522), the module reads the card's UID (Unique Identification Number) and sends it to the Arduino Uno. If the UID matches a pre-authorized value stored in the Arduino code, it triggers a servo motor to rotate and unlock the door. A buzzer provides audio feedback — a beep on success or error. In keypad-based systems, the entered password is checked against a stored passcode. If matched, the door unlocks for a limited time.

5.3 Circuit Components:

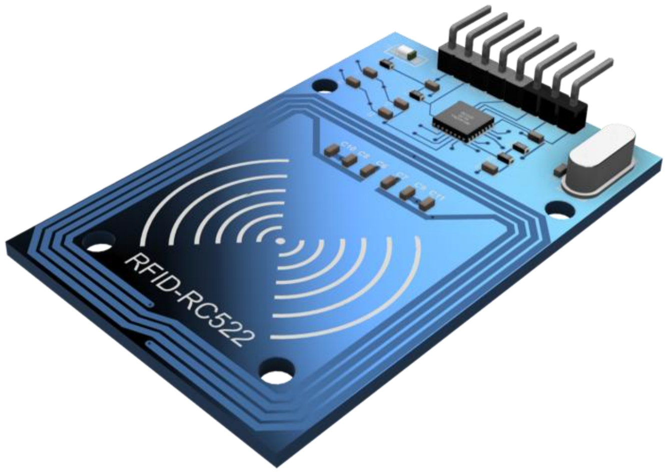
Arduino Uno:

- Function: Acts as the central microcontroller ("brain") of the system.
- Role: It processes input from devices like the RFID module, and controls output components like the servo motor.
- Key Features: Based on the ATmega328P microcontroller, includes digital/analog I/O pins, USB interface, and programmable via Arduino IDE.



RFID Module (RC522):

- **Function**: Reads data from RFID cards or tags using radio-frequency communication.
- **Role**: Detects and sends the unique identification number (UID) of a card/tag to the Arduino for processing.
- **Key Features**: Operates at 13.56 MHz, uses SPI or I2C interface, supports MIFARE 1K and 4K cards.

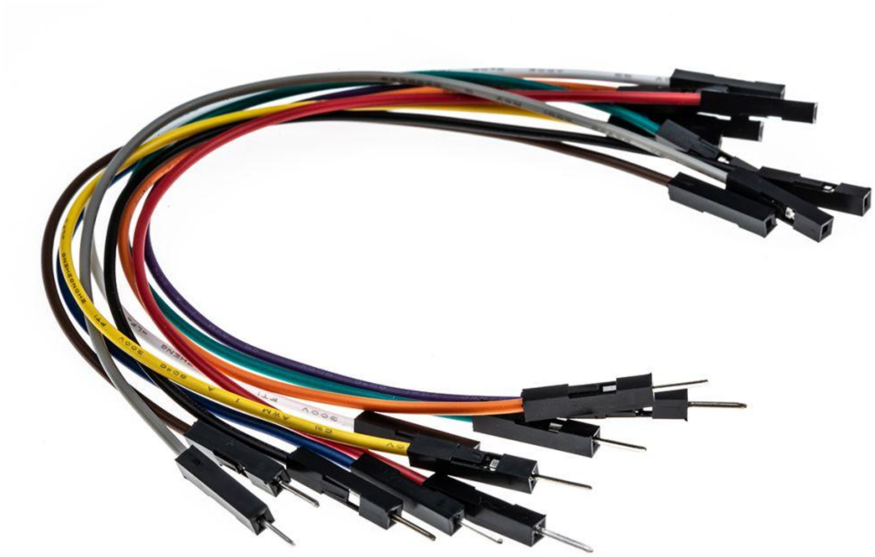


Servo Motor

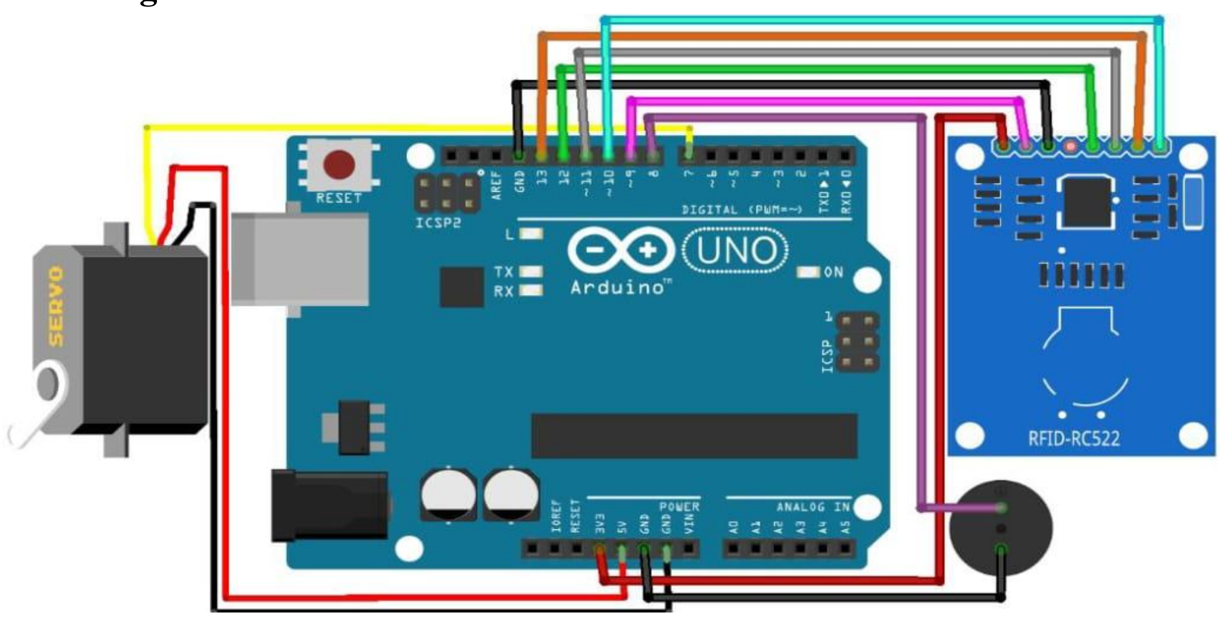
- **Function**: Provides controlled rotational motion.
- **Role**: Engages or disengages the physical locking mechanism (e.g., turning a latch or lever).
- **Key Features**: Controlled by PWM signal from Arduino; commonly uses SG90 or MG996R servos; rotation typically limited to 0°–90°.

Jumper Wires and Breadboard

- **Function**: Used for connecting electronic components without soldering.
- **Role**: Facilitate temporary circuit assembly and easy prototyping.
- **Key Features**:
  - **Jumper wires**: Available in male-to-male, male-to-female, or female-to-female types.
  - **Breadboard**: Contains a grid of holes connected internally for quick circuit building.



5.4 Circuit Diagram:



5.5 Applications:

1. Laboratories

In academic and research institutions, laboratories often house expensive instruments, chemicals, and sensitive experiments. An Arduino-based access control system ensures that only authorized students or faculty with valid RFID cards or access codes can enter. This helps prevent unauthorized handling, theft, or tampering with lab equipment, ensuring a secure and controlled environment conducive to research and learning.

2. Hostels

Security in hostels is critical for the safety of students. Implementing this system at entry points allows only registered hostel residents or staff to gain access. It eliminates the risks posed by unauthorized visitors and provides peace of mind to both students and administration. Additionally, entry logs can be maintained, helping authorities track movements during emergencies or inspections.

3. Libraries

Libraries often require access restrictions to ensure that only enrolled students or registered members use the facility. The access control system can verify users via RFID cards and log entry/exit times, aiding in attendance tracking and time management. It enhances library security, prevents overcrowding, and enables better resource allocation based on user data.

CHAPTER NO 6

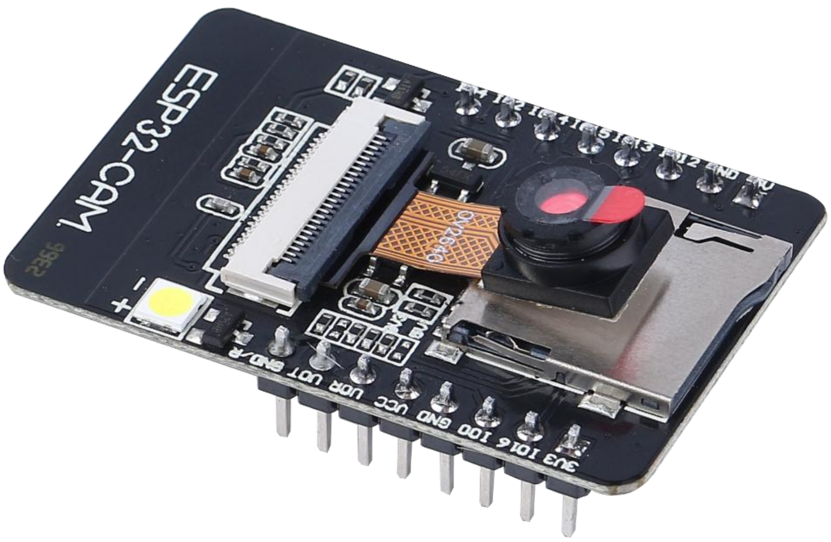
ESP32-CAM SECURITY CAMERA

6.1 ESP32-CAM – Wireless Video Surveillance Module

- **Overview:**
  The **ESP32-CAM** is a powerful and affordable Wi-Fi-enabled camera module designed for remote surveillance and real-time video streaming. It integrates an ESP32 microcontroller with an OV2640 camera and supports wireless connectivity, allowing it to host a web server and stream live video directly to any browser within the same network. This makes it an ideal solution for lightweight, low-cost security systems that don't require complex infrastructure.

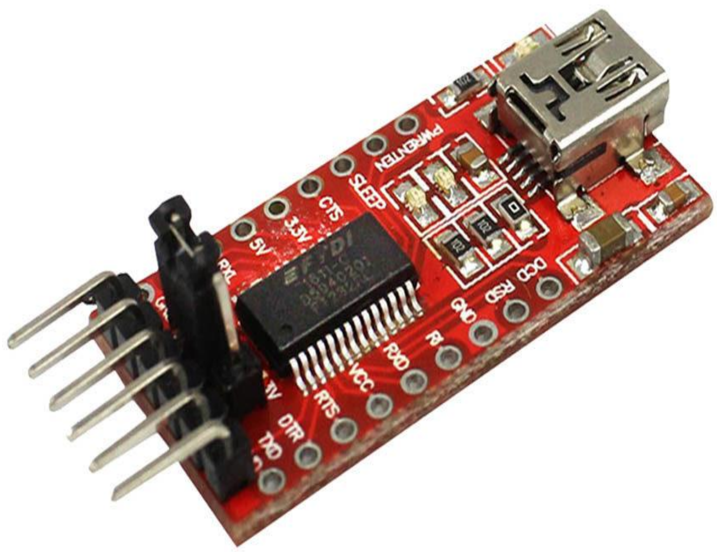
6.2 Circuit Components:

- **ESP32-CAM Module:**
  The core component of the system, this module combines the **ESP32-S chip** (dual-core microcontroller with built-in Wi-Fi and Bluetooth) and an **OV2640 camera**, capable of capturing images and streaming video at decent resolutions. It also includes a microSD card slot for storing images and a flash LED for low-light conditions. With its GPIO pins, it can be integrated with sensors or actuators for extended functionality like motion detection.



- **FTDI Programmer (USB-to-Serial Adapter):**
  The ESP32-CAM lacks a native USB interface for programming, so an **FTDI programmer** is used to upload code from the Arduino IDE or other development platforms. The connections are made via serial communication:

  - FTDI **TX → ESP32-CAM RX**
  - FTDI **RX → ESP32-CAM TX**
  - **GND → GND**
  - **5V → 5V**
    A jumper must also be placed between GPIO0 and GND during programming to put the ESP32-CAM into flashing mode.



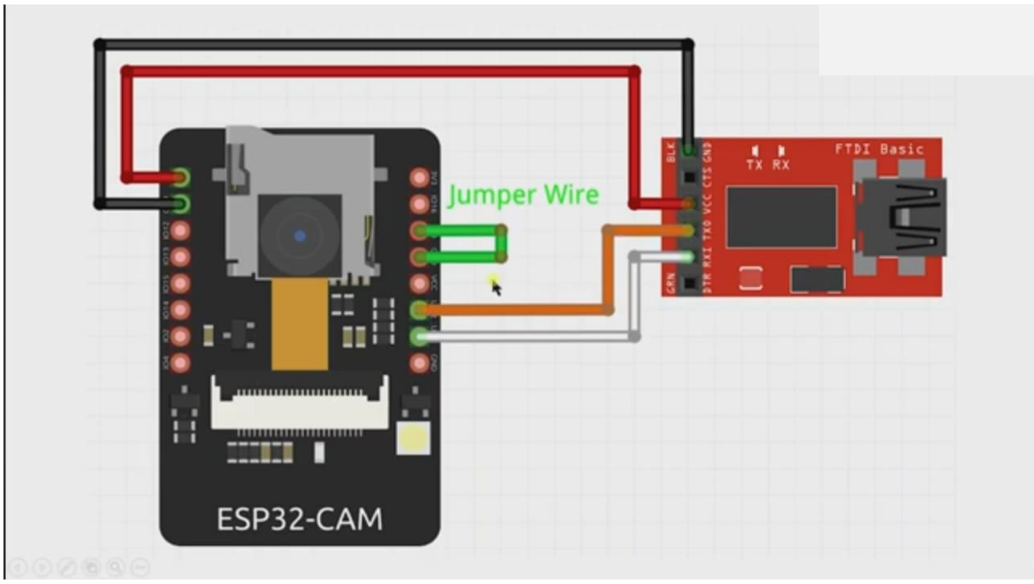
6.3 Working Principle.

- Once the code is uploaded and the ESP32-CAM connects to a Wi-Fi network, it starts a web server and generates an IP address. This IP can be entered into any browser on the same network to access the live video stream. The module can also be programmed to take still pictures, detect motion using PIR sensors, or even trigger alerts (e.g., send an email or control a relay).

6.4 Applications:

1) **Corridors**: The ESP32-CAM provides live monitoring of school or office corridors, helping detect unusual activities or unauthorized movements.
2) **Gates**: Installed at campus or building entrances, it helps verify who is entering or exiting, improving access control and security.
3) **Parking Areas**: It can monitor vehicle movement, record parking activity, and help in managing space more effectively.

6.5 Circuit Diagram:



CHAPTER NO 7

ELEVATOR SYSTEM (DC MOTOR)

7.1 Elevator System (Gear Motor)

- **Overview:**
  This is a basic model of an elevator system powered by a gear motor and controlled through a simple circuit using jumper wires. It is powered by a lithium-ion battery and simulates the vertical movement of an elevator cabin between different floors. The system demonstrates the basic mechanical and electrical principles behind lift operation.

7.2 Components:

1. **Gear Motor**: Provides the torque needed to lift and lower the elevator cabin with controlled speed.
2. **Pulley or Spool Mechanism** (optional): Helps guide the lift's vertical movement using a string or cable.
3. **Jumper Wires**: Connect different components in the circuit (motor, power source, switches).
4. **Lithium-Ion Battery**: Powers the motor; portable and rechargeable power source.
5. **Switches or Buttons**: Used to control the direction of the elevator (up/down).
6. **Elevator Cabin Model**: A small platform or box that simulates the elevator car.

7.3 Working Principle (Brief):

- The system is powered by a lithium-ion battery connected via jumper wires to the gear motor.
- When a button or switch is pressed, current flows through the circuit, activating the motor.
- The gear motor rotates and winds or unwinds a string/rope connected to the elevator cabin, causing it to move up or down.
- Reversing the polarity (or using a DPDT switch) changes the motor direction to lift or lower the cabin.

Applications (Brief):

- Educational model to demonstrate elevator mechanics.
- Prototype for automated vertical transport systems.
- Can be extended with Arduino and sensors for smart elevator projects.
- Useful in mini projects for learning motor control and power circuits.

CHAPTER NO 8

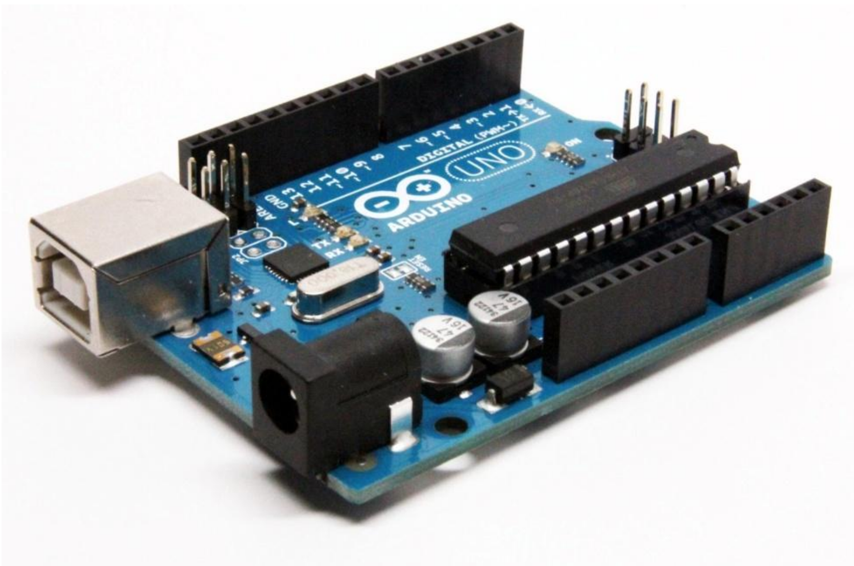
HVAC SYSTEM (ARDUINO)

8.1 HVAC System (Arduino):

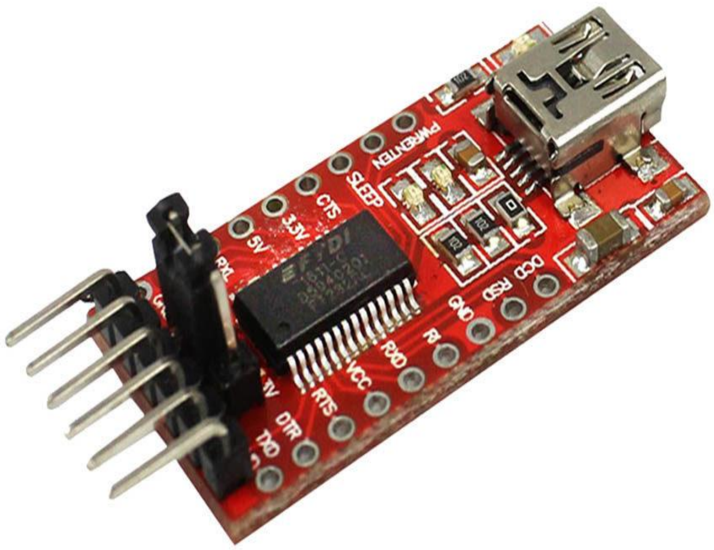
- **Overview:**
  An **HVAC (Heating, Ventilation, and Air Conditioning) System using Arduino** is an automated climate control setup designed to maintain optimal environmental conditions such as temperature and humidity. It uses sensor data to detect changes in the atmosphere and responds by activating heating or cooling devices accordingly. This smart system is ideal for creating comfortable indoor conditions or protecting sensitive equipment in locations like classrooms, server rooms, or labs. Arduino-based HVAC systems are cost-effective, customizable, and ideal for learning embedded control applications.

8.2 Components:

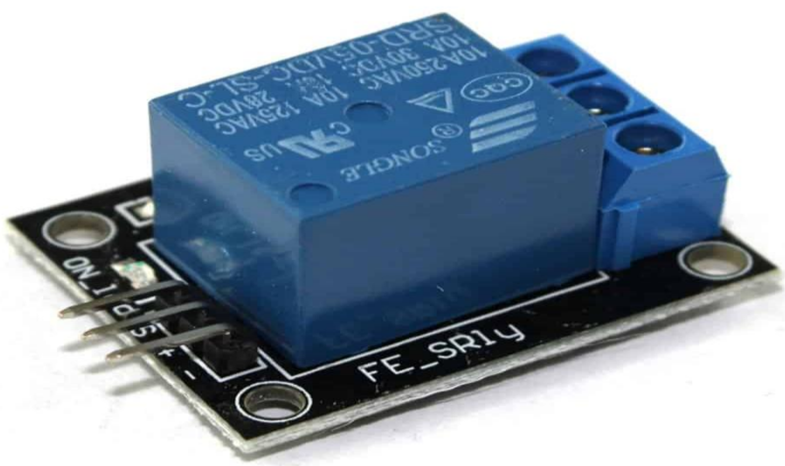
- **Arduino Uno**
  The **Arduino Uno** is the central microcontroller that processes sensor inputs and makes decisions based on preprogrammed logic. It reads data from temperature/humidity sensors, compares them to threshold values, and controls external devices like fans or heaters through the relay module. It features multiple digital and analog pins, making it highly suitable for such control systems.



- **DHT11/DHT22 Sensor**
  These are digital sensors used to monitor **temperature and humidity**.
  - **DHT11**: Basic version, measures temperature (0–50°C) and humidity (20–80%) with moderate accuracy.
  - **DHT22**: More accurate and wider range (temperature: -40 to +80°C, humidity: 0–100%).
    The sensor sends data to the Arduino in digital format using a single data pin, simplifying integration.



- **Relay Module**
  A **relay** acts as an electrically operated switch that allows the Arduino to control high-voltage devices (like a fan or heater) with low-voltage signals. When the Arduino detects that environmental conditions exceed set limits, it sends a signal to the relay, which opens or closes the circuit to the connected load (fan/heater).



- **Fan/Heater**
  These are the **output actuators** that physically regulate the environment.
    - The **fan** helps cool the area when temperatures rise.
    - The **heater** warms the area if the temperature drops below a certain point.
      They are powered by an external AC or DC source and switched on/off via the relay module.

8.3 Working Principle:

- The DHT11/DHT22 sensor continuously monitors temperature and humidity levels in the room and sends the data to the Arduino. The Arduino checks if the temperature or humidity is outside the desired range. If the temperature is too high, it activates a relay to turn on a fan. If it's too low, it can turn on a heater instead. This switching is fully automated based on the programmed threshold values, enabling real-time environmental control.

8.4 Applications:

1. Classrooms and Educational Institutes

In schools, colleges, and training centers, maintaining a comfortable environment enhances focus and learning efficiency. The HVAC system automatically adjusts temperature and humidity, preventing overheating or stuffiness, especially in packed classrooms. By keeping the air quality consistent, it also reduces the risk of fatigue and improves overall student productivity.

2. Smart Homes

In residential settings, the HVAC system can be integrated into smart home automation. It adjusts the internal environment based on time of day, weather conditions, or user preference. This enhances comfort, reduces energy consumption, and ensures a healthier living space.

3. Laboratories and Research Facilities

Experiments and sensitive instruments often require strict environmental control. The HVAC system ensures that experimental conditions remain stable, which is vital for research accuracy and repeatability. It also protects delicate lab instruments from temperature or humidity-induced damage.

4. Greenhouses and Agriculture

In controlled farming and greenhouse setups, plants require specific temperature and humidity ranges to thrive. The Arduino-based HVAC system helps maintain optimal growth conditions by activating ventilation fans or misting systems based on sensor readings. This automation supports better crop yield and reduces the need for manual monitoring.

CHAPTER NO 9

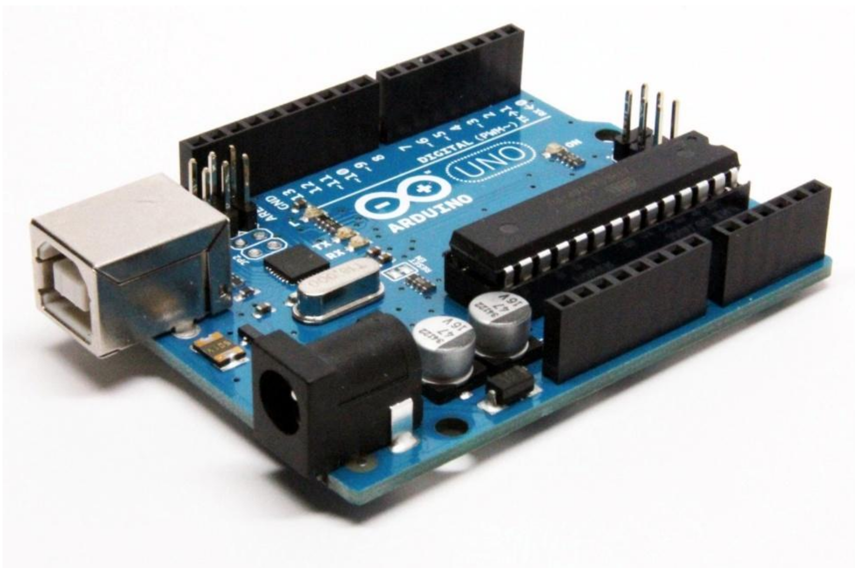
HOME AUTOMATION SYSTEM

9.1 Home Automation:

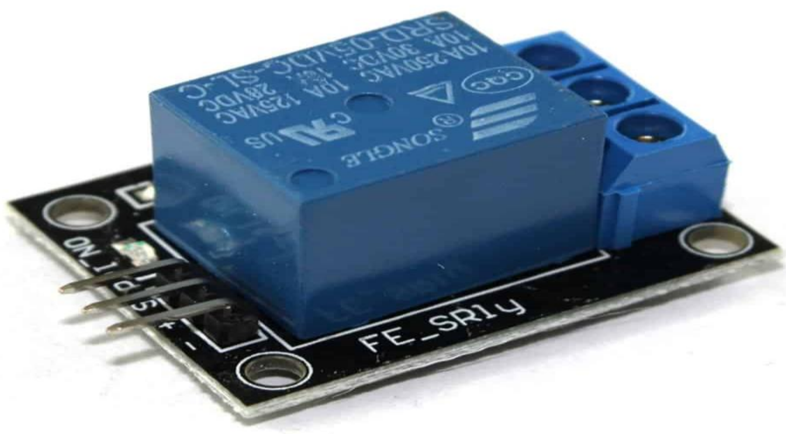
- **Overview:**
  Home automation using Arduino is a smart system that allows users to remotely control household electrical appliances such as lights and fans using a mobile app via Bluetooth or Wi-Fi. This system enhances convenience, safety, and energy efficiency by enabling users to operate appliances without physical switches. It is especially useful for elderly or disabled individuals and can be a cost-effective step toward creating a smart home environment.

9.2 Components:

1. **Arduino Uno**
   The Arduino Uno acts as the central controller or brain of the system. It processes user commands received from the communication module and controls the state of connected appliances accordingly. It is programmed to interpret specific inputs and generate control signals that activate or deactivate relays.



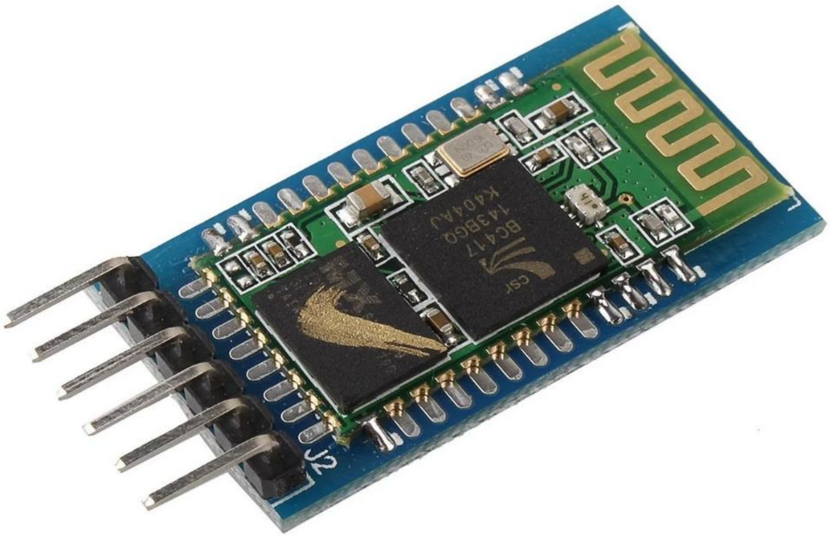
2. **Relay Module**
   A relay module is an electromagnetic switch that allows low-voltage devices like the Arduino to control high-voltage appliances such as lights or fans. When triggered by the Arduino, the relay completes the electrical circuit for the connected device, turning it ON or OFF. It acts as a safe interface between the microcontroller and AC-powered appliances.



3. **Bluetooth Module (HC-05)**

These are **communication interfaces** that allow the Arduino to receive commands from a mobile device.

- **HC-05 (Bluetooth)**: Ideal for short-range control within 10 meters. It connects wirelessly to an Android phone or tablet using a mobile app.
- **ESP8266 (Wi-Fi)**: Enables long-range or internet-based control by connecting the system to a local Wi-Fi network. Commands can be sent from anywhere using an app or web dashboard.



4. **Light/Fan**:

   These are the output devices controlled by the system. They can be turned ON or OFF remotely via the Arduino and relay. The fan can also be connected to a motor driver circuit (for speed control), but in most basic systems, only ON/OFF control is implemented via relays.

9.3 Working Principle:

- The communication module (Bluetooth HC-05 or Wi-Fi ESP8266) establishes a wireless connection between the user's mobile device and the Arduino. When a command is sent through the mobile app (such as "turn on light"), it is received by the Arduino, which decodes the input and activates the appropriate relay. This relay then completes the electrical path for the appliance, switching it ON or OFF. The system operates in real time, providing immediate response to user commands.

9.4 Applications:

1.Home Automation:

Enables remote and automatic control of lights, fans, or other household appliances. It enhances convenience, reduces energy consumption, and improves accessibility for the elderly or people with disabilities. This setup is commonly used in smart homes, energy-efficient buildings, and for voice or app-based control integration with platforms like Alexa or Google Home (when extended with IoT functionality).

CHAPTER NO 10

CONCLUSION

10.1. CONCLUSION

The Smart Campus project exemplifies the integration of IoT and automation technologies to enhance campus life. By implementing systems like RFID-based access control, ESP32-CAM surveillance, Arduino-driven HVAC, and home automation, the campus achieves improved security, energy efficiency, and user convenience. These innovations not only streamline daily operations but also foster a more sustainable and responsive educational environment. Overall, the project demonstrates how smart technologies can transform traditional campuses into intelligent, adaptive spaces that cater to the evolving needs of students and staff.

CHAPTER NO 11

REFERENCES'

REFERENCES AND BIBLIOGRAPHY

1) https://docs.arduino.cc/hardware/uno-rev3/?utm_source
2) Handson Technology. *RC522 RFID Module Datasheet*. Retrieved from https://www.handsontec.com/dataspecs/RC522.pdfHands-on Technology
3) Mouser Electronics. *DHT11 Humidity & Temperature Sensor Datasheet*. Retrieved from https://www.mouser.com/datasheet/2/758/DHT11-Technical-Data-Sheet-Translated-Version-1143054.pdfMouser Electronics
4) SparkFun Electronics. *DHT22 Temperature & Humidity Sensor Datasheet*. Retrieved from https://cdn.sparkfun.com/assets/f/7/d/9/c/DHT22.pdf
5) SunFounder. *ESP32-CAM Module Specifications*. Retrieved from https://docs.sunfounder.com/projects/galaxy-rvr/en/latest/hardware/cpn_esp_32_cam.html
6) Components101. *HC-05 Bluetooth Module Datasheet*. Retrieved from https://components101.com/sites/default/files/component_datasheet/HC-05%20Datasheet.pdfComponents101
7) Espressif Systems. *ESP8266EX Datasheet*. Retrieved from https://www.espressif.com/sites/default/files/documentation/0a-esp8266ex_datasheet_en.pdfEspressif Systems
8) Components101. *5V Single-Channel Relay Module Specifications*. Retrieved from https://components101.com/switches/5v-single-channel-relay-module-pinout-features-applications-working-datasheet
9) Edge Impulse. *Smart HVAC System with Arduino Nicla Vision*. Retrieved from https://docs.edgeimpulse.com/experts/air-quality-and-environmental-projects/arduino-nicla-vision-smart-hvac
10) Arduino Project Hub. *Home Automation Using Arduino and Bluetooth Control*. Retrieved from https://projecthub.arduino.cc/Shubhamkumar97/home-automation-using-arduino-and-bluetooth-control-2fd190