# IOT ARDUINO BASED SERVO DISTANCE CONTROLLER

**A Project Report**

Submitted in partial fulfilment of the

Requirements for the award of the degree of

**BACHELOR OF SCIENCE (INFORMATION TECHNOLOGY)**

**By**

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## CERTIFICATE

This is to certify that the project entitled, IoT Arduino-based servo distance controller**,** Is bonafied work of **Pandey Vishal Rishidev** bearing Seat No.: **1070172** submitted in partial fulfilment of the requirements for the award of degree of **BACHELOR OF SCIENCE in INFORMATION TECHNOLOGY** from University of Mumbai.

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**External Examiner**

**Date:** **College Seal**

## PROFORMA FOR THE APPROVAL PROJECT PROPOSAL

***(Note: All entries of the proforma of approval should be filled up with appropriate and complete information. Incomplete proforma of approval in any respect will be summarily rejected.)***

PNR No.: **……………………**  Roll no: ____________

a) Name of the Student

______________________________________________

b) Title of the Project

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c) Name of the Guide

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d) Teaching experience of the Guide

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e) Is this your first submission? Yes ☐ No ☐

Signature of the Student  Signature of the Guide

Date: …………………  Date: ………………….

Signature of the Co-ordinator

Date: …………………

# Abstract

In IoT applications, the integration of Arduino microcontrollers with servo motors presents a versatile solution for distance control systems. This project proposes an Arduino-based servo distance controller without Wi-Fi connectivity, providing a practical alternative for scenarios where internet connectivity is unavailable or undesired.

The system utilizes Arduino microcontrollers in conjunction with ultrasonic sensors to accurately measure distances in real-time. Unlike traditional IoT setups, which rely on Wi-Fi modules for communication, this system operates locally without the need for internet connectivity.

Distance data collected by the Arduino boards is processed internally, allowing for immediate control of servo motor positions based on predefined thresholds or user input. This standalone operation makes the system suitable for applications where internet access is restricted, such as remote areas or secure environments.

Users interact with the system through a simple interface directly connected to the Arduino board, enabling them to monitor distances and adjust servo positions manually or through predefined control algorithms. This user-friendly approach enhances accessibility and usability in diverse settings.

Future enhancements may include the integration of additional sensors for environmental monitoring or the implementation of wireless communication protocols for remote monitoring and control without relying on internet connectivity.

By offering a Wi-Fi-independent solution, the Arduino-based servo distance controller addresses the need for reliable and versatile distance control systems in environments where internet connectivity may be limited or impractical.

# Acknowledgement

It gives me happiness and dignity to present my project on the topic “IoT Arduino-based servo distance controller”. Through this acknowledgement, I can appreciate all those who had shown me the right path to pack and deliver this project with their wonderful ideas and great experience of knowledge.

My project has consumed huge amount of work, research, and dedications. But this project could not have been possible without the support of the individuals. It becomes essential to appreciate and show my gratitude to all of them who gave their contribution in completing my project.

I am very much grateful to my project guide “**Prof. Khalil Mujawar**” and “**Prof. Bhupinder Singh**” for giving appropriate guidance, inspiration, motivation, and constructive suggestion that helped me a lot in the full-fledged preparation of the project.

# DECLARATION

I hereby declare that the project entitled, IoT Arduino-based servo distance controller done at place where the project is done, has not been in any case duplicated to submit to any other university for the award of any degree. To the best of my knowledge other than me, no one has submitted to any other university.

The project is done in partial fulfilment of the requirements for the award of degree of **BACHELOR OF SCIENCE (INFORMATION TECHNOLOGY)** to be submitted as final semester project as part of our curriculum.

**Mr. Pandey Vishal Rishidev**

# Chapter 1
# Introduction

## 1.1 Background of project

In various fields such as robotics, automation, and sensor-based systems, distance measurement and control play a crucial role. Traditional methods often involve manual intervention or fixed control mechanisms, limiting flexibility and adaptability in dynamic environments. With the advent of Internet of Things (IoT) technologies and Arduino microcontrollers, there's an opportunity to develop sophisticated distance control systems that offer real-time monitoring and automation capabilities.

Arduino microcontrollers provide a cost-effective and user-friendly platform for prototyping and developing embedded systems. Their versatility, coupled with a wide range of available sensors and actuators, makes them ideal for applications requiring distance measurement and control. Additionally, Arduino's open-source nature and extensive community support facilitate rapid development and innovation.

Servo motors, known for their precise control and positional accuracy, are commonly used in distance control systems. By integrating servo motors with Arduino microcontrollers, it's possible to create dynamic and responsive distance control mechanisms capable of adjusting positions based on real-time distance measurements.

Ultrasonic sensors, which utilize sound waves to measure distance, are frequently employed in Arduino-based distance measurement systems due to their reliability and accuracy. These sensors emit ultrasonic pulses and measure the time taken for the pulses to reflect off an object and return, allowing for precise distance calculations.

The absence of internet connectivity in certain environments or applications poses a challenge for traditional IoT-based distance control systems, which rely on Wi-Fi or other wireless protocols for communication. Developing an Arduino-based servo distance controller without Wi-Fi addresses this challenge, providing a standalone solution that operates locally without the need for internet access.

By leveraging Arduino microcontrollers, ultrasonic sensors, and servo motors, this project aims to create a robust and accessible distance control system suitable for a wide range of applications, from robotics and automation to surveillance and navigation. The background sets the stage for understanding the rationale behind developing such a system and the potential impact it can have in various domains.

## 1.2 Objective

The objective of this project is to design and implement an IoT Arduino-based servo distance controller without Wi-Fi connectivity. The system aims to provide real-time distance monitoring and control capabilities in scenarios where internet connectivity is unavailable or undesired.

Specific objectives include:

1. **Hardware Integration**: Integrate Arduino microcontrollers, ultrasonic sensors, and servo motors to create a functional distance control system.
2. **Distance Measurement**: Develop algorithms to accurately measure distances using ultrasonic sensors and convert sensor readings into usable distance data.
3. **Servo Control**: Implement servo control mechanisms to adjust servo motor positions based on real-time distance measurements.
4. **Standalone Operation**: Design the system to operate locally without the need for internet connectivity, allowing for standalone functionality.
5. **User Interface**: Develop a user interface for interacting with the system, enabling users to monitor distances and control servo positions manually or through predefined algorithms.
6. **Testing and Validation**: Conduct thorough testing and validation to ensure the system's accuracy, reliability, and usability in real-world scenarios.
7. **Documentation and Presentation**: Document the design process, implementation details, and testing results, and present the project findings in a clear and comprehensive manner.

By achieving these objectives, the project aims to demonstrate the feasibility and effectiveness of an Arduino-based servo distance controller without Wi-Fi, providing a practical solution for distance monitoring and control in diverse environments.

## 1.3 Purpose, Scope & Applicability

### 1.3.1 Purpose

The purpose of the project is to create a distance controller using Arduino and servo motors without relying on Wi-Fi connectivity. This system likely aims to control the position of a servo motor based on input from distance sensors, enabling precise control of devices or mechanisms without needing an internet connection.

### 1.3.2 Scope

The scope of the project encompasses the design and development of an IoT Arduino-based servo distance controller without Wi-Fi connectivity. The system will focus on providing real-time distance monitoring and control capabilities in scenarios where internet connectivity is unavailable or undesired. Key components and functionalities within the scope of the project include:

- **Hardware Selection and Integration**: Selecting suitable Arduino microcontrollers, ultrasonic sensors, and servo motors for integration into the distance control system. Ensuring compatibility and seamless interaction between hardware components.
- **Distance Measurement Algorithm**: Developing algorithms to accurately measure distances using ultrasonic sensors. Implementing signal processing techniques to filter noise and improve measurement accuracy.

- **Servo Control Mechanism**: Designing servo control mechanisms to adjust servo motor positions based on real-time distance measurements. Implementing proportional-integral-derivative (PID) control or other control algorithms for precise servo positioning.
- **Standalone Operation**: Designing the system to operate autonomously without the need for internet connectivity. Implementing local control logic to enable standalone functionality.
- **User Interface Development**: Creating a user interface for interacting with the system. Designing user-friendly interfaces for distance monitoring and servo control, accessible via a display screen or physical interface.
- **Testing and Validation**: Conducting comprehensive testing and validation to ensure the accuracy, reliability, and robustness of the system. Performing real-world testing in various environments to validate system performance.
- **Documentation and Reporting**: Documenting the design process, implementation details, and testing results. Providing clear and concise documentation to facilitate understanding and replication of the project. Presenting project findings in a final report or presentation format.

The scope of the project is focused on delivering a functional Arduino-based servo distance controller system that meets the specified requirements and objectives. Future enhancements and expansions beyond the scope of this project may include additional features, integration with other technologies, and optimization for specific applications.

### 1.3.3 Applicability

The project's applicability lies in scenarios where real-time control of devices or mechanisms is needed without relying on Wi-Fi connectivity. It can be particularly useful in environments where Wi-Fi signals are weak or unavailable, such as remote locations or industrial settings with electromagnetic interference. Additionally, it offers a cost-effective solution for implementing distance-based control systems using readily available Arduino hardware and sensors. This project's versatility opens up possibilities for applications in robotics, automation, and IoT projects where precise servo control is essential but internet connectivity is not feasible or desirable.

## 1.4 Achievements

The achievements of the project lie in its successful implementation of a reliable and versatile distance controller system using Arduino and servo motors, all without the need for Wi-Fi connectivity. Key accomplishments include:

- **Reliability:** By eliminating reliance on Wi-Fi, the project ensures consistent operation even in environments with poor or no internet connectivity. This enhances the system's reliability, making it suitable for applications where consistent performance is crucial.

- **Versatility:** The project's design allows for a wide range of applications across various industries. Whether in robotics, automation, or IoT projects, the distance controller can be adapted to suit different needs, providing precise control without being tethered to a Wi-Fi network.
- **Cost-effectiveness:** Utilizing affordable Arduino hardware and off-the-shelf components, the project offers a cost-effective solution for implementing distance-based control systems. This makes it accessible to hobbyists, students, and professionals alike, without requiring expensive proprietary equipment.
- **Scalability:** The project's modular design allows for scalability, enabling users to expand or modify the system as needed to accommodate additional sensors, actuators, or control logic. This scalability enhances its applicability to a wide range of projects and scenarios.
- **Ease of implementation:** With Arduino's user-friendly development environment and extensive online resources, implementing the project is straightforward even for those with limited programming or electronics experience. This ease of implementation encourages experimentation and innovation in the development of new applications and functionalities.

## 1.5 Organization of report

- Chapter 1: This chapter summarizes the motive idea and use of the project.
- Chapter 2: A brief overview about all the important modules used in the system.
- Chapter 3: Includes the need to make a project along with the planning phase.
- Chapter 4: Describes the basic connectivity of the modules.
- Chapter 5: Contains the code of the system along with the different types of tests carried out.
- Chapter 6: Shows the result of the tests carried out.
- Chapter 7: Contains the summary of the project, its limitations and scope in the Future.

# Chapter 2

# Survey of Technologies

## 2.1 ARDUINO UNO:

Arduino R3 is a small board and also called as Micro-Controller. It acts as a input/output to various external components. Arduino board are published under a Creative Commons license, hence well experience users can create their programs according to their convenience. It consist of 14 digital pins, 6 analog pins and 8 power pins. Power pins act as a power supplier to external components, digital pins are used to read or write data, analog pins accept analog data.

Arduino Uno can studies the surroundings from the input. Here inputs are a variety of sensors and these can have major impact on its surroundings through controlling motors, lights, other actuators, etc. The ATmega328 microcontroller on the Arduino board can be programmed with the help of an Arduino programming language and the IDE (Integrated Development Environment) where C is used. Arduino projects can also communicate with the software while running on a PC.

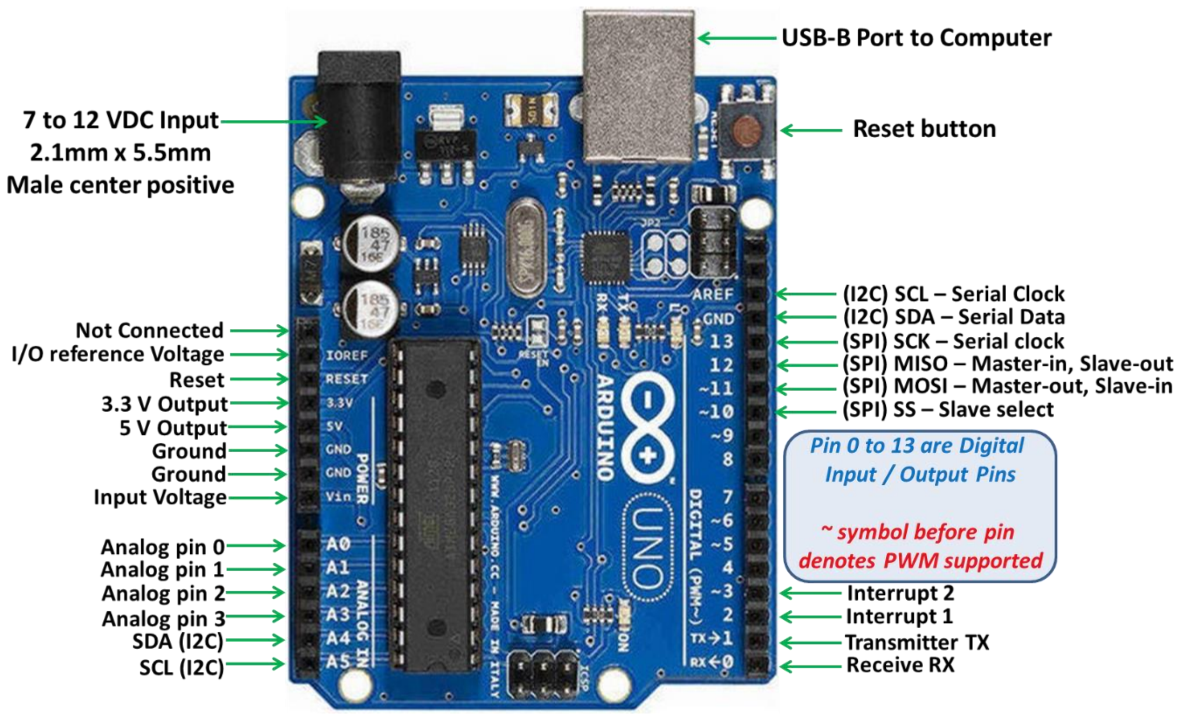
Each Arduino board has its own microcontroller . We can call it as the brain of your board. The main IC (integrated circuit) on the Arduino is little different from board to board. These microcontrollers are usually from the ATMEL Company. You must be aware of which IC your board has before loading up a new program from the Arduino IDE. This information is available on the top corner of the IC.

On your board, you will be able find two labels TX for (transmit) and RX for (receive). They appear at two places on the Arduino UNO board. Firstly, at the digital pins 0 and 1, to show the pins responsible for serial communication. Second, the TX and RX led. The TX led flashes with different speed while transmitting the serial data. The speed of flashing depends on the baud rate used by the board. RX flashes during the receiving process.

The Arduino UNO board has 14 digital I/O pins of which 6 provides PWM (Pulse Width Modulation) output. These pins can be configured to work as input digital pins to read logic values (0 or 1) or as digital output pins to drive different modules like LEDs, relays, etc. The pins labeled like "~" can be used to generate PWM.

- **Inexpensive** - Arduino boards are relatively inexpensive compared to other microcontroller platforms. the smallest amount expensive version of the Arduino module is assembled by hand, and even the pre-assembled Arduino modules cost but 4021.92
- **Cross-platform** - The Arduino Software (IDE) runs on Windows, Macintosh OSX, and Linux operating systems. Most microcontroller systems are limited to Windows. Simple, clear programming environment - The Arduino Software (IDE) is easy-to-use for beginners, yet flexible enough for advanced users to require advantage of in addition. For teachers, it's conveniently supported the Processing programming environment, so students learning to program therein environment are aware of how the Arduino IDE works.

- **Open source and extensible software -** The Arduino software is published as open source tools, available for extension by experienced programmers. The language is expanded through C++ libraries, and other people needing to understand the technical details can make the leap from Arduino to the AVR C artificial language on which it's based. Similarly, you'll be able to add AVR-C code directly into your Arduino programs if you wish to.
- **Open source and extensible hardware -** The plans of the Arduino boards are published under an explicit Commons license, so experienced circuit designers can make their own version of the module, extending it and improving it. Even relatively inexperienced users can build the breadboard version of the module in order to know how it works and save cash.



**(Fig no.2.1.1: Arduino UNO)**

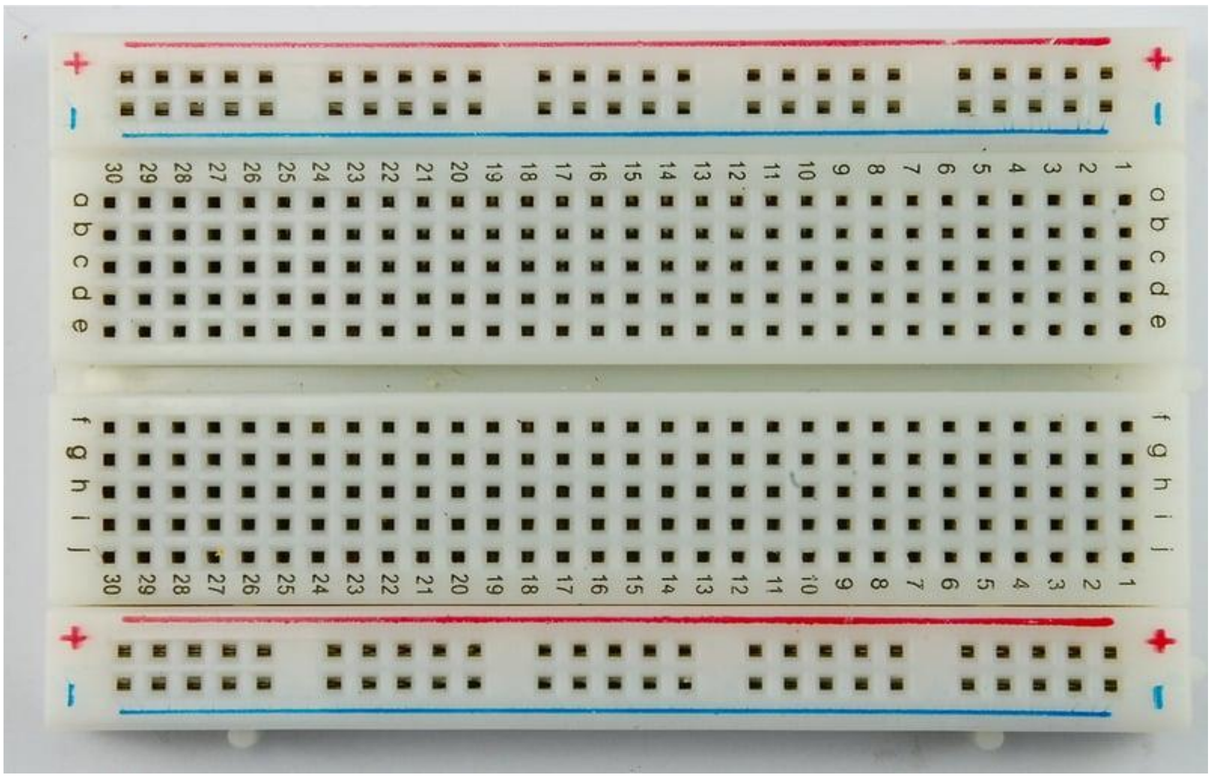
## 2.2 Breadboard:

A breadboard is a fundamental tool in electronics and prototyping that allows you to quickly build and test electronic circuits without the need for soldering. It consists of a flat plastic board with a grid of holes and metal clips that connect the holes in specific patterns. Breadboards are commonly used by engineers, students, and electronics enthusiasts for testing, designing, and experimenting with circuits. Here are some key features and characteristics of a breadboard:

- **Hole Grid:** The breadboard features a grid of holes arranged in rows and columns. These holes are used to insert and connect electronic components, such as resistors, capacitors, integrated circuits, and wires.

- **Electrical Connections:** Inside the breadboard, there are metal clips that connect specific rows of holes. Each row typically contains five holes, and these are electrically connected, making it easy to connect components in parallel.
- **Terminal Strips:** Breadboards often have two sets of long rows along the edges of the board, known as terminal strips. These are typically used for power and ground connections.
- **Breadboard Layout:** Breadboards come in various sizes and configurations, with the most common being the half-size (small) and full-size (large) breadboards. The smaller breadboards are convenient for simple experiments, while the larger ones provide more space for complex circuits.
- **Component Placement:** Electronic components can be inserted directly into the holes on the breadboard. Components with two or more leads can be securely placed in the holes, forming electrical connections with the metal clips.
- **Reusability:** Breadboards are reusable, and components can be easily removed and reinserted as needed. This makes them ideal for prototyping and experimentation.
- **No Soldering Required:** Unlike traditional circuit construction methods that require soldering, breadboards do not use solder. This eliminates the need for specialized equipment and allows for rapid circuit design changes.
- **Wire Connection:** Wires, called jumper wires, are used to make connections between components on the breadboard. Jumper wires can be easily inserted into the holes and connected to components to establish electrical connections.
- **Prototyping:** Breadboards are widely used for prototyping electronic circuits, allowing engineers and hobbyists to quickly test and verify their designs before building a permanent circuit.
- **Educational Tool:** Breadboards are commonly used in electronics education to teach students the principles of circuit design and to help them understand how components are interconnected in a circuit.
- **Breadboard Power Supplies:** Some breadboards come with built-in power supply options, making it easier to provide voltage and current to your circuit.
- **Limitations:** Breadboards are not suitable for high-frequency or high-current applications. They may introduce resistance and capacitance in the connections, affecting circuit performance. For production-ready circuits, soldered printed circuit boards (PCBs) are typically used.
- **Breadboard Accessories:** Additional accessories, such as adhesive backing, transparent covers, and bus strips, are available to enhance the functionality and convenience of breadboards.

Breadboards are an essential tool for anyone working with electronics. They provide a flexible and user-friendly platform for creating and testing circuits, making them a valuable resource in electronic design and prototyping.



**(Fig no.2.2.1: Breadboard)**

## 2.3 Jumper wires:

Jumper wires are used for connection between circuits, they are also know as electrical wires. There are three types of jumper wires male to male, female to femaleor male to female. Male to male wires consist of pins at both the end of wires, femaleto male pins consist a pin and slot for external component to attach. female to female are open from both ends it allows insertion of pins from external circuit or component.It is also used to diagnose problem in a circuit. It can also be used without soldering. There are differing kinds of jumper wires. Some have the identical type of electricalconnector at both ends, while others have different connectors. Some commonconnectors are:

- **Solid tips** – are wont to connect on/with a breadboard or female header connector.The arrangement of the weather and easy insertion on a breadboard allows increasing the mounting density of both components and jump wires without concern of short- circuits. The jump wires vary in size and colour to tell apart the various working signals.

- **Crocodile clips** – are used, among other applications, to temporarily bridge sensors, buttons and other elements of prototypes with components or equipment that have arbitrary connectors, wires, screw terminals, etc.
- **Banana connectors** – are commonly used on equipment for DC and low-frequency ACsignals.
- **Registered jack (RJnn)** – are commonly utilized in telephone (RJ11) and computer networking (RJ45).
- **RCA connectors** – are often used for audio, low-resolution composite video signals,or other low-frequency applications requiring a shielded cable.
- **RF connectors** – are wont to carry radio frequency signals between circuits, equipment, and antennas.
- **RF jumper cables** - Jumper cables may be a smaller and more bendable corrugated cable which is employed to attach antennas and other components to network cabling.Jumpers also are employed in base stations to attach antennas to radio units.

When working with other components, choose an even color. for instance if working with an RGB led, you'd possibly use a Green, Orange (because red is for power) and Blue cable to attach to every of the colour terminals on the LED.

**(Fig no.2.3.1: Jumper Wires)**

## 2.4 Micro servo 9g:

The micro servo 9g is a small, lightweight servo motor commonly used in various hobbyist projects, robotics, and DIY applications. Here are some key features and specifications of the micro servo 9g:

- **Size and Weight**: The "9g" in the name refers to its weight of approximately 9 grams. Its compact size makes it suitable for applications where space is limited or weight is a concern.
- **Torque**: Typically, micro servo 9g motors offer a torque range of around 1.5 to 2.5 kg/cm, allowing them to exert a moderate amount of force to move attached components or mechanisms.
- **Operating Voltage**: The operating voltage for micro servo 9g motors is commonly in the range of 4.8V to 6V. It's essential to power the servo within this voltage range to ensure proper operation.
- **Control Signal**: Micro servo 9g motors are controlled using pulse-width modulation (PWM) signals. By varying the width of the PWM signal pulses between certain ranges (usually around 1000 to 2000 microseconds), you can control the servo's position.
- **Rotation Range**: The rotation range of a micro servo 9g is typically around 180 degrees, allowing it to rotate from one end to the other within this range.
- **Feedback Mechanism**: Micro servo 9g motors often feature a built-in potentiometer for positional feedback, allowing them to accurately maintain their position even under load or external forces.
- **Mounting Options**: These servo motors usually come with mounting holes or brackets for easy installation and attachment to other components or structures.
- **Compatibility**: Micro servo 9g motors are compatible with a wide range of microcontroller platforms, including Arduino, Raspberry Pi, and other hobbyist electronics platforms.

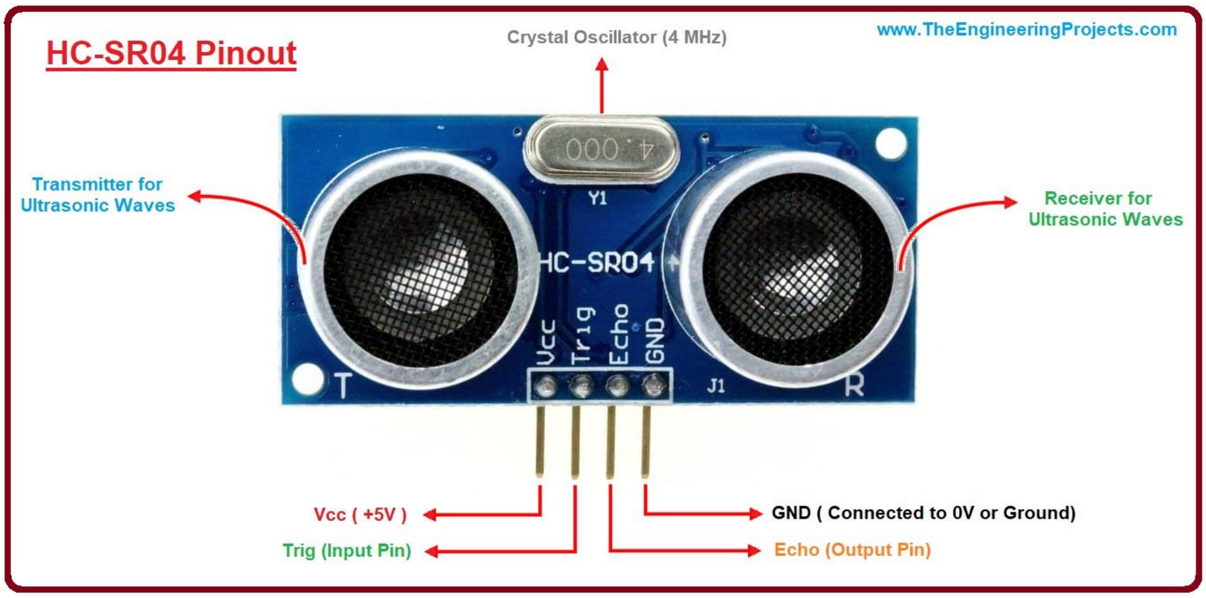
Overall, the micro servo 9g is a versatile and widely used component in electronics and robotics projects, offering precise control and compact size suitable for various applications.

**(Fig no.2.4.1: Micro servo 9g)**

## 2.5 Ultrasonic Sensor:

The ultrasonic sensor is a pivotal component in IoT (Internet of Things) projects, particularly those involving distance measurement and proximity sensing. This sensor emits high-frequency sound waves and detects their reflection to determine the distance to an object.

- Distance Measurement: Ultrasonic sensors excel at accurately measuring distances in various environments, making them indispensable in IoT applications where precise distance monitoring is required.
- Non-Contact Sensing: Unlike traditional methods such as contact sensors or physical switches, ultrasonic sensors offer non-contact detection, making them suitable for applications where avoiding physical contact is necessary, or where the target object is in motion.
- Versatility: Ultrasonic sensors are versatile and can be used in a wide range of IoT projects, from simple obstacle detection to more complex applications like smart parking systems, industrial automation, and robotics.
- Cost-Effectiveness: These sensors are relatively inexpensive and readily available, making them accessible for hobbyists, students, and professionals alike. This affordability encourages experimentation and innovation in IoT projects.


HC-SR04 Pinout
Crystal Oscillator (4 MHz)
www.TheEngineeringProjects.com
Transmitter for Ultrasonic Waves
Receiver for Ultrasonic Waves
4.000
Y1
HC-SR04
Vcc
Trig
Echo
GND
T
R
J1
Vcc ( +5V )
Trig (Input Pin)
GND ( Connected to 0V or Ground)
Echo (Output Pin)

**(Fig no.2.5.1: Ultrasonic Sensor)**

## 2.6 Arduino Idle:

Arduino Integrated Development Environment (IDE) is a text editor and is use to transfer code to any Arduino board is a user-friendly platform useful for beginners as well as for experienced person. It provides easy understanding to users, as it consist ofvarious prewritten examples through which users can learn. The codes are written in C/C++ language. Programs written by Arduino IDE are also called sketches, these sketches are written and saved by an extension file .ino. IDE contains various prewritten examples of code for a beginner to get hand on. There are various code for various components so that no one faces difficulty while starting with the Arduino IDE. Program should be written in the IDE and Arduino board should be connected todevice so that when we upload code from the Arduino IDE it gets uploaded to the Arduino board. It is a beginner friendly software.

The Arduino Software (IDE) uses the concept of a sketchbook: a customary place to store your programs (or sketches). The sketches in your sketchbook are often opened from the File > Sketchbook menu or from the Open button on the toolbar. the primary time you run the Arduino software, it'll automatically create a directory for your sketchbook. you'll be able to view or change the situation of the sketchbook location from with the Preferences dialog.

# Chapter 3
# Requirements and Analysis

## 3.1 Problem Definition

### 3.1.1 Problem Statement

Several potential problem statements could arise in the development or implementation of an IoT Arduino-based servo distance controller without Wi-Fi connectivity. Here are some common ones:

- Sensor Accuracy and Reliability: The accuracy and reliability of the distance sensor readings could be a concern, especially in varying environmental conditions or with certain types of objects.
- Controller Calibration: Ensuring precise calibration of the Arduino controller to accurately interpret distance sensor data and control the servo motor's position can be challenging.
- Real-Time Responsiveness: Achieving real-time responsiveness in servo motor control without Wi-Fi connectivity may be difficult, especially in scenarios where rapid adjustments are required.
- Interference and Noise: Electrical interference or noise could affect the communication between the components, leading to inaccurate distance measurements or erratic servo motor behavior.
- Power Consumption: Optimizing power consumption to prolong the system's battery life or operate efficiently in low-power environments may pose a challenge.
- Mechanical Integration: Integrating the servo motor and distance sensor into the physical design of the project, especially in constrained spaces or complex mechanical systems, could be problematic.

### 3.1.2 Problem Definition

Design and develop a system that utilizes Arduino microcontroller technology to control the position of a servo motor based on input from distance sensors, without relying on Wi-Fi connectivity. The system should accurately measure distances to objects in real-time and adjust the servo motor's position accordingly, providing a reliable and responsive control mechanism for various applications.

### 3.1.3 Existing system

Traditional distance control systems often rely on manual intervention or fixed control mechanisms, limiting their flexibility and adaptability in dynamic environments. These systems typically involve standalone controllers or simple feedback loops to adjust positions based on predefined criteria.

In the context of Arduino-based distance control systems, existing solutions often utilize Wi-Fi connectivity for remote monitoring and control. These systems incorporate Arduino microcontrollers, ultrasonic sensors for distance measurement, and servo motors for positional control. However, they require internet connectivity to communicate distance data to a central server or cloud platform, limiting their applicability in environments without reliable internet access.

While Wi-Fi-based Arduino distance control systems offer remote monitoring and control capabilities, they may not be suitable for scenarios where internet connectivity is unavailable or undesired. This limitation motivates the need for an alternative approach that operates locally without relying on internet connectivity.

The existing systems may lack the ability to function autonomously or may not be optimized for standalone operation. Additionally, they may require additional hardware or software components to enable real-time distance monitoring and control without internet connectivity.

In summary, while existing Arduino-based distance control systems provide valuable functionality, there is a need for a standalone solution that operates locally without Wi-Fi connectivity. This project aims to address this gap by developing an IoT Arduino-based servo distance controller without Wi-Fi, providing a practical and versatile solution for distance monitoring and control in various environments.

### 3.1.4 Proposed system

The proposed system is an IoT Arduino-based servo distance controller designed to operate without Wi-Fi connectivity, providing a standalone solution for real-time distance monitoring and control. The system integrates Arduino microcontrollers, ultrasonic sensors, and servo motors to enable precise distance measurement and servo positioning.

Key components and features of the proposed system include:

- **Arduino Microcontrollers**: Utilizing Arduino microcontrollers as the core processing units to interface with ultrasonic sensors and servo motors. These microcontrollers will handle distance measurements, servo control logic, and user interface interactions.

- **Ultrasonic Sensors**: Incorporating ultrasonic sensors to accurately measure distances in real-time. These sensors emit ultrasonic pulses and measure the time taken for the pulses to reflect off objects, allowing for precise distance calculations.

- **Servo Motors**: Integrating servo motors to control mechanical devices or systems based on distance measurements. Servo motors offer precise positional control and can adjust positions dynamically in response to changing distance conditions.

- **Standalone Operation**: Designing the system to operate autonomously without the need for internet connectivity. All processing and control logic will be implemented locally on the Arduino microcontrollers, enabling standalone functionality.

- **User Interface**: Developing a user interface for interacting with the system. This interface may include physical buttons, switches, or a graphical display for distance monitoring and servo control.

- **Control Algorithms**: Implementing control algorithms such as proportional-integral-derivative (PID) control to adjust servo motor positions based on real-time distance measurements. These algorithms will ensure precise and responsive servo control.

- **Testing and Validation**: Conducting thorough testing and validation to ensure the accuracy, reliability, and robustness of the system. Real-world testing in various environments will validate system performance and functionality.
- **Documentation and Reporting**: Documenting the design process, implementation details, and testing results. Providing clear and concise documentation to facilitate understanding and replication of the project. Presenting project findings in a final report or presentation format.

The proposed system aims to provide a practical and versatile solution for distance monitoring and control in scenarios where internet connectivity is unavailable or undesired. By leveraging Arduino microcontrollers, ultrasonic sensors, and servo motors, the system offers an accessible platform for developing standalone distance control applications in diverse environments.

## 3.2 Requirements Specification

### 3.2.1 Functional requirements

Functional requirements for an IoT Arduino-based servo distance controller without Wi-Fi connectivity outline the specific capabilities and features the system must possess to fulfill its intended purpose effectively. Here's a breakdown of the functional requirements:

- **Distance Measurement:** The system must accurately measure distances to objects using ultrasonic or other suitable distance sensors.
- **Servo Motor Control:** The system should control the position of the servo motor based on the distance sensor readings.
- **Real-Time Responsiveness:** The system must respond rapidly to changes in distance sensor data, ensuring real-time adjustments in servo motor position.
- **Distance Threshold Setting:** Users should be able to set distance thresholds to trigger specific actions or servo motor movements.
- **Emergency Stop Mechanism:** It should include an emergency stop feature to halt servo motor movement in critical situations or upon user command.

### 3.2.2 Non-Functional requirements

Non-functional requirements for an IoT Arduino-based servo distance controller without Wi-Fi connectivity specify the quality attributes and constraints that shape the system's overall behavior, performance, and user experience. Here are the non-functional requirements:

- Response Time: The system should have low latency, with rapid response times between receiving distance sensor data and adjusting servo motor position.
- Throughput: It should handle a high volume of distance sensor data and servo motor control commands efficiently, ensuring smooth operation under varying load conditions.

- Accuracy: The system must provide accurate distance measurements and precise servo motor control to maintain desired distances from objects.
- Fault Tolerance: It should be resilient to sensor failures, communication errors, and other hardware/software faults, minimizing system downtime and ensuring uninterrupted operation.
- Availability: The system should be available for use whenever required, with minimal downtime for maintenance or troubleshooting.
- Scalability: The system should be scalable to accommodate additional sensors, actuators, or control logic as needed to support future enhancements or expansions.
- User Interface: The user interface should be intuitive, user-friendly, and accessible to users of varying technical backgrounds.

## 3.3 Planning and Scheduling

### 3.3.1 GANTT Chart (Generalized Activity Normalization Time Table)

The Gantt Chart is a type of bar chart that illustrates a project schedule, shows the dependency relationships between activities and current schedule status. This chart lists the tasks to be performed on the vertical axis, and time intervals on the horizontal axis. The width of the horizontal bars in the graph shows the duration of each activity. Gantt charts illustrate the start and finish dates of the terminal elements and summary elements of a project. Terminal elements and summary elements constitute the work breakdown structure of the project.

### 3.3.2 PERT Chart (Program Evaluation and Review Technique)

A PERT chart, also known as a PERT diagram, is a tool used to schedule, organize, and map out tasks within a project. PERT stands for program evaluation and review technique. It provides a visual representation of a project's timeline and breaks down individual tasks. These charts are similar to Gantt charts, but structured differently.

This diagram consists of a few steps to get you from a project start date to end date.

Creating a project roadmap such as a PERT chart can help you accomplish several projects planning activities, including:

- Getting schedule and timeline signoff from leadership
- Communicating project objectives to stakeholders
- Estimating the time needed to complete individual tasks

## 3.4 Software and Hardware Requirements

### 3.4.1 Software requirements

1. Platform: Windows 10
2. Language used: Arduino Idle

### 3.4.2 Hardware requirements

1. Processor: Intel Core i5
2. RAM: 8GB
3. Hard Drive: 100GB

## 3.5 Preliminary Product Description

The IoT Arduino-based Servo Distance Controller is a system designed to control the position of a servo motor based on input from distance sensors. It offers accurate distance measurement, real-time responsiveness, and customizable control features. Suitable for various applications including smart home systems, industrial automation, and robotics, it ensures reliability, security, and power efficiency. With compatibility across different hardware platforms and environments, it provides a versatile and user-friendly solution for precise distance-based control without Wi-Fi connectivity.

**Use Cases:**

- **Smart Home Systems:** Enables automatic adjustment of device positions based on proximity to objects, enhancing convenience and energy efficiency.
- **Industrial Automation:** Facilitates precise control over machinery or equipment positions in industrial settings, optimizing production processes and ensuring safety.
- **Robotics:** Provides accurate distance-based control for robotic systems, enabling precise navigation and interaction with the environment.

**Benefits:**

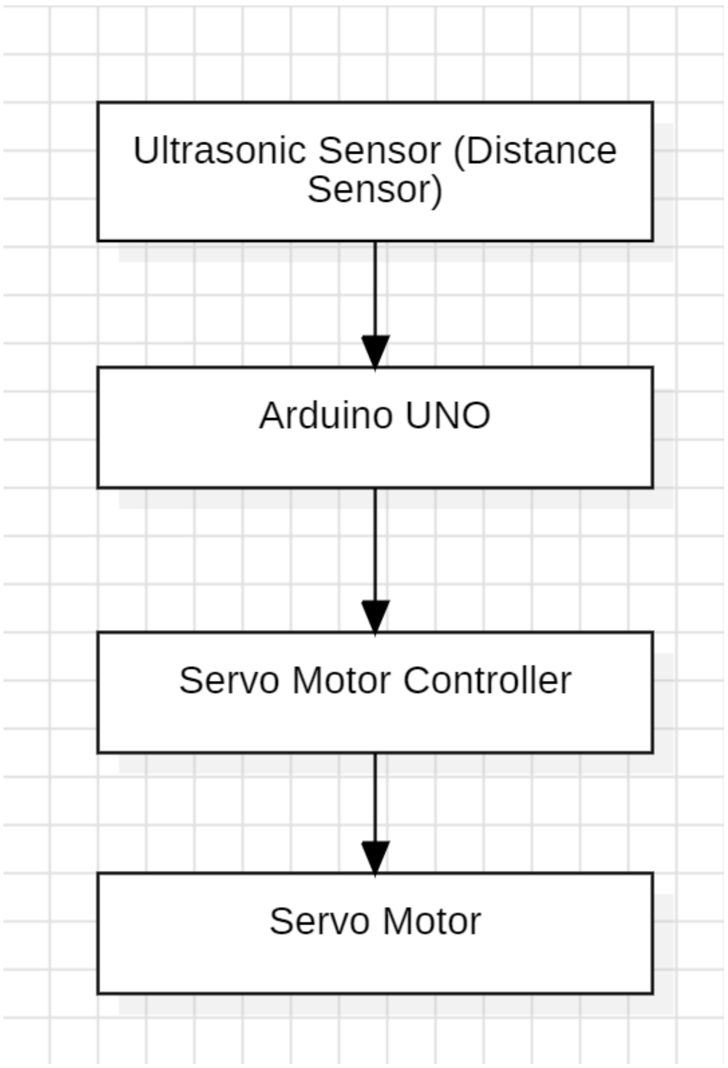
- **Accuracy:** Provides precise distance measurements and servo motor control, ensuring reliable performance in diverse applications.
- **Responsiveness:** Offers real-time responsiveness, enabling rapid adjustments to changing environmental conditions or user requirements.
- **Versatility:** Suitable for a wide range of applications, including robotics, automation, IoT projects, and more, with customizable control features.
- **Ease of Use:** Features an intuitive user interface for configuration and operation, making it accessible to users of varying technical backgrounds.

## 3.6 Conceptual Models

### 3.6.1 Data Flow Diagram

A data flow diagram shows the way information flows through a process or system. It includes data inputs and outputs, data stores, and the various subprocesses the data moves through. DFDs are built using standardized symbols and notation to describe various entities and their relationships.

A data-flow diagram is a way of representing a flow of data through a process or a system (usually an information system). The DFD also provides information about the outputs and inputs of each entity and the process itself. A data-flow diagram has no control flow — there are no decision rules and no loops. Specific operations based on the data can be represented by a flowchart. For each data flow, at least one of the endpoints (source and / or destination) must exist in a process. The refined representation of a process can be done in another dataflow diagram, which subdivides this process into sub-processes.



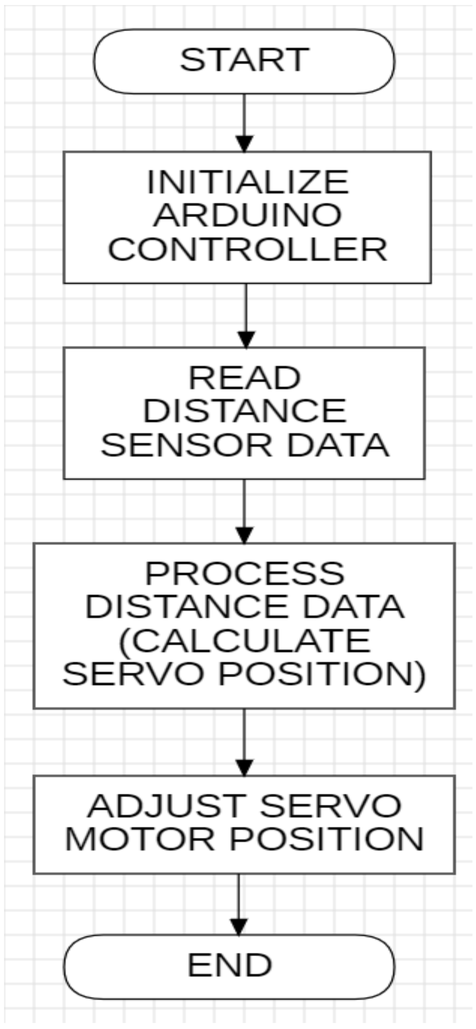
**(Fig no.3.6.1.1: Data Flow Diagram)**

## Explanation:

- **Distance Sensor:** Measures the distance to an object and sends the distance data to the Arduino controller.
- **Arduino Controller:** Receives distance data from the distance sensor, processes it, and determines the required position for the servo motor.
- **Servo Motor Controller:** Receives commands from the Arduino controller to adjust the position of the servo motor based on the distance data.
- **Servo Motor:** Receives signals from the servo motor controller and adjusts its position accordingly.

### 3.6.2 Flowchart

A System Flow Chart symbolically shows how data flows throughout a system and how event controlling decision are made. It was originated from computer science as a tool for representing algorithms and programming logic but had extended to use in all other kinds of processes. Nowadays, flowcharts play an extremely important role in displaying information and assisting reasoning. They help us visualize complex processes or make explicit the structure of problems and tasks. A flowchart can also be used to define a process or project to be implemented.


START
INITIALIZE ARDUINO CONTROLLER
READ DISTANCE SENSOR DATA
PROCESS DISTANCE DATA (CALCULATE SERVO POSITION)
ADJUST SERVO MOTOR POSITION
END

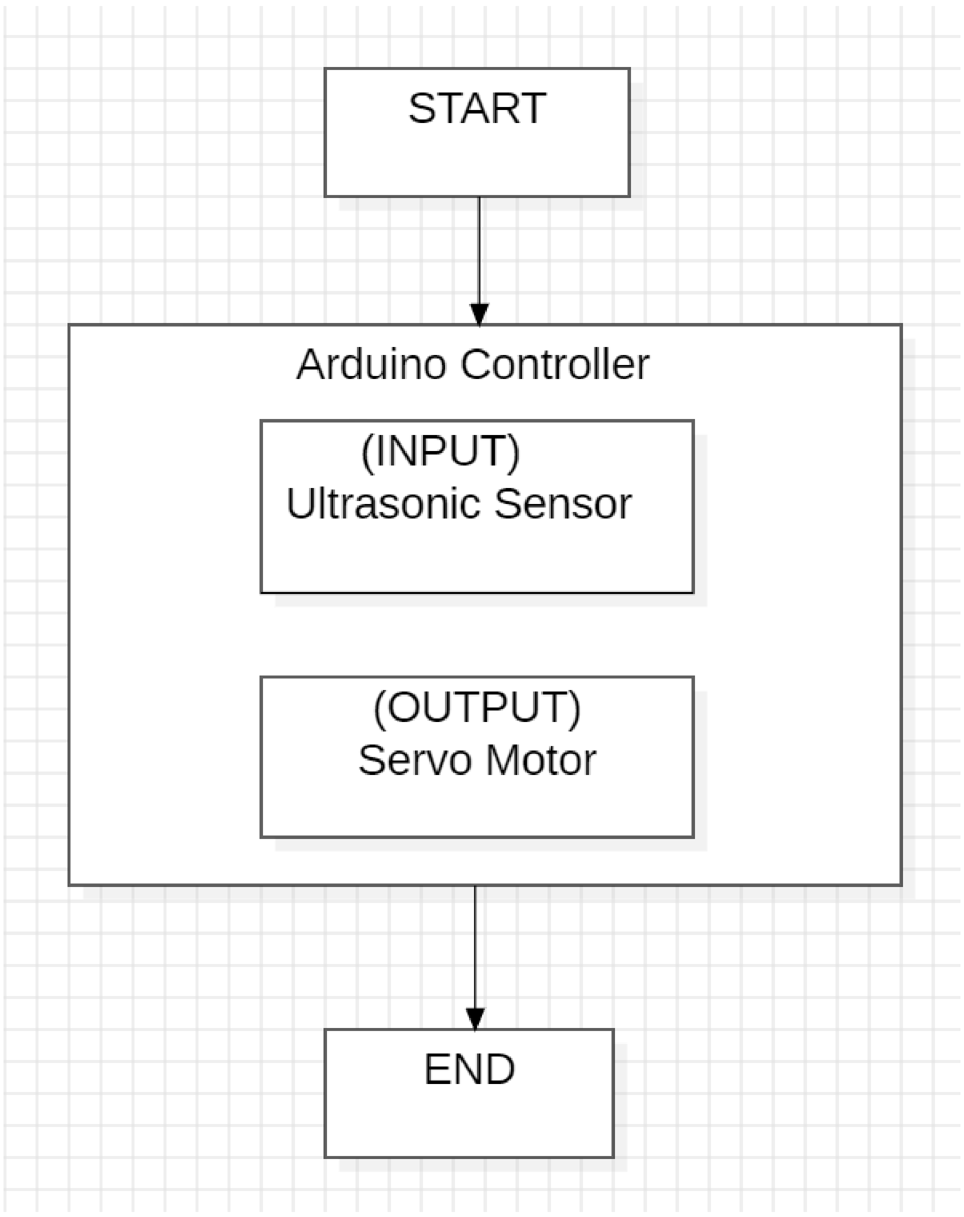
**(Fig no.3.6.2.1: Flow Chart Diagram)**

**Explanation:**

- **Start:** The beginning of the flowchart.
- **Initialize Arduino Controller:** Initialization step for setting up the Arduino controller.
- **Read Distance Sensor Data:** Read data from the distance sensor.
- **Process Distance Data:** Calculate the required servo motor position based on the distance data.
- **Adjust Servo Motor Position:** Send commands to adjust the position of the servo motor.
- **End:** End of the flowchart.

## 3.6.3 Block Diagram

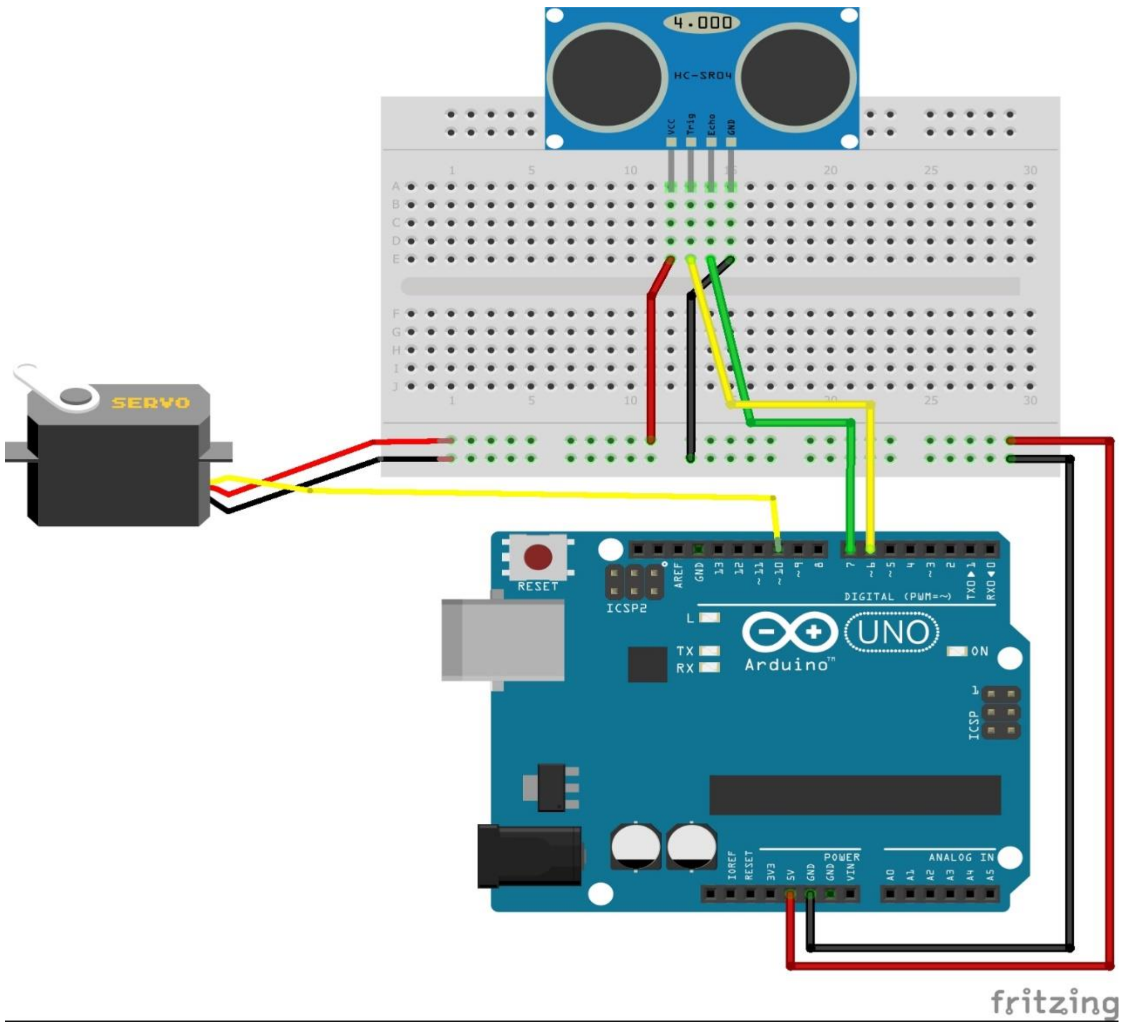
The block diagram provides a higher-level overview of the system architecture, illustrating the major functional blocks and their interconnections. Here's the block diagram for the IoT Arduino-based servo distance controller without Wi-Fi connectivity:



**(Fig no.3.6.3.1: Block Diagram)**

1. Arduino Controller: This block represents the Arduino microcontroller, which serves as the central processing unit of the system. It interacts with two main functional blocks:
    - Distance Sensor Input: This block represents the distance sensor module, responsible for measuring the distance to objects.
    - Servo Motor Output: This block represents the servo motor module, responsible for controlling the position of the servo motor.
2. Start and End: These blocks signify the beginning and end of the system's operation, respectively.

## 3.6.4 Circuit Diagram



(Fig no.3.6.4.1: Circuit Diagram)

# Chapter 4

# System Design

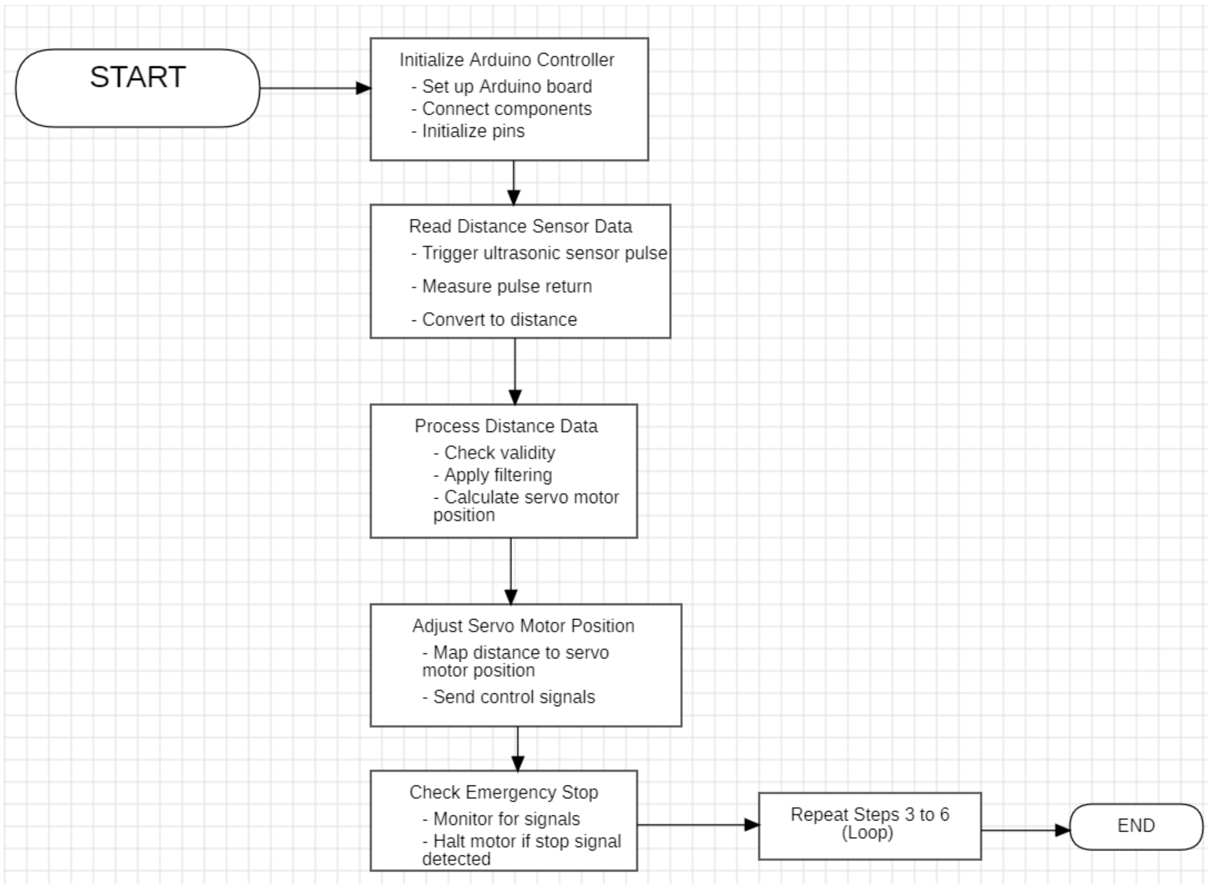
## 4.1 Basic Modules

IoT Arduino-based servo distance controller without Wi-Fi connectivity, several basic modules or components are essential to ensure the system functions as intended. Here are the fundamental modules:

1. **Distance Sensing Module:**
   - **Ultrasonic Sensor:** This module is responsible for measuring the distance between the sensor and nearby objects using ultrasonic sound waves. It typically includes a transmitter and receiver.
2. **Arduino Microcontroller Module:**
   - **Arduino Board**: The Arduino microcontroller serves as the brain of the system, processing input from the distance sensor and generating control signals for the servo motor.
   - **Microcontroller Programming:** This module involves writing and uploading code to the Arduino board to interpret sensor data, calculate servo motor positions, and send control signals.
3. **Servo Motor Control Module:**
   - **Servo Motor:** The servo motor module physically adjusts its position based on control signals received from the Arduino board. It typically consists of a motor and a feedback mechanism for precise positioning.
   - **Motor Driver:** This module may include a motor driver circuit or controller to amplify the control signals from the Arduino board and drive the servo motor efficiently.
4. **Power Supply Module:**
   - **Power Source:** The system requires a stable power source to operate effectively. This can be a battery pack, power adapter, or any other suitable power supply.
   - **Voltage Regulator**: A voltage regulator may be necessary to ensure consistent power delivery to the Arduino board and other components, especially in battery-powered applications.
5. **Enclosure/Casing Module:**
   - **Enclosure:** A protective casing or enclosure to house the hardware components and protect them from environmental factors such as dust, moisture, or physical damage.
6. **Wiring and Connections Module:**
   - **Wiring Harness:** The wiring and connections module involves properly connecting all hardware components together using wires, connectors, and soldering as needed.

## 4.2 Procedural Diagram

Creating a detailed procedural diagram for the IoT Arduino-based servo distance controller without Wi-Fi connectivity involves outlining the step-by-step process from system initialization to servo motor control. Below is a comprehensive procedural diagram for the project:


START
Initialize Arduino Controller
- Set up Arduino board
- Connect components
- Initialize pins
Read Distance Sensor Data
- Trigger ultrasonic sensor pulse
- Measure pulse return
- Convert to distance
Process Distance Data
- Check validity
- Apply filtering
- Calculate servo motor position
Adjust Servo Motor Position
- Map distance to servo motor position
- Send control signals
Check Emergency Stop
- Monitor for signals
- Halt motor if stop signal detected
Repeat Steps 3 to 6 (Loop)
END

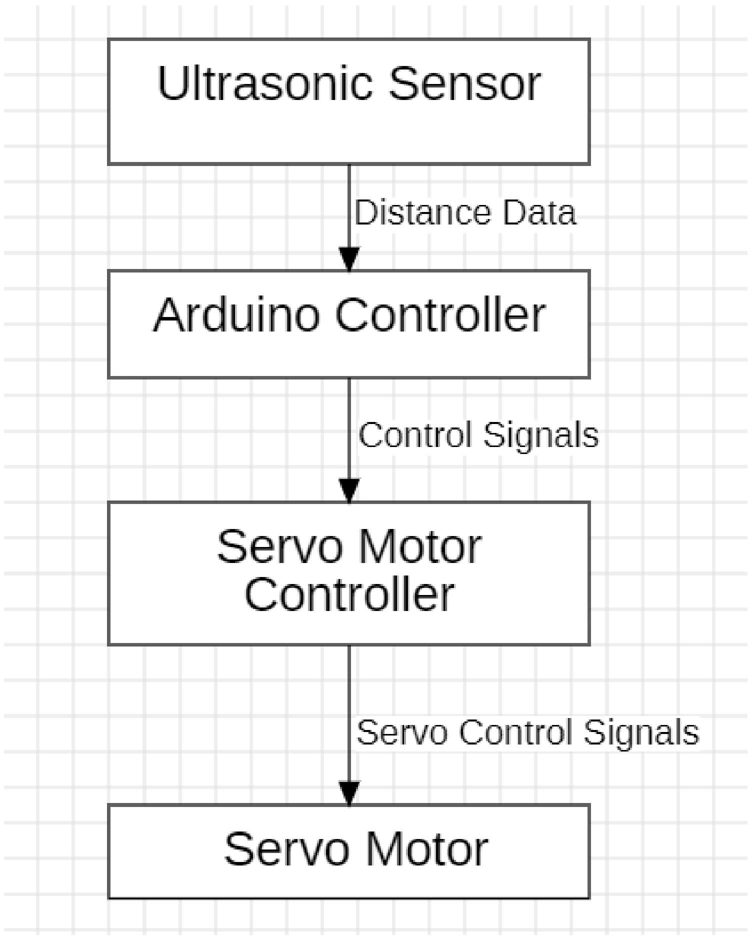
**(Fig no.4.2.1: Procedural Diagram)**

Detailed Explanation:

- **Start:** The beginning of the procedural diagram.
- **Initialize Arduino Controller:** Setup and initialize the Arduino board, including configuring pins for input from the distance sensor and output to the servo motor.
- **Read Distance Sensor Data:** Trigger the ultrasonic sensor to emit a pulse, measure the time it takes for the pulse to return after bouncing off an object, and calculate the distance based on this time measurement.
- **Process Distance Data:** Verify the accuracy and validity of distance readings, apply any necessary filtering or smoothing techniques to the data, and calculate the desired position for the servo motor based on the distance measured.
- **Adjust Servo Motor Position:** Convert the calculated distance into a corresponding angle or position for the servo motor, and send control signals to the servo motor to adjust its position accordingly.

- **Check Emergency Stop:** Continuously monitor for any emergency stop signals or user commands, and immediately halt servo motor movement if an emergency stop condition is detected.
- **Repeat Steps 3 to 6:** Continuously loop through the process to maintain real-time control over the servo motor position, ensuring that the system responds promptly to changes in distance sensor data or user inputs.
- **End:** The end of the procedural diagram.

## 4.3 Logical Diagram



**(Fig no.4.3.1: Logical Diagram)**

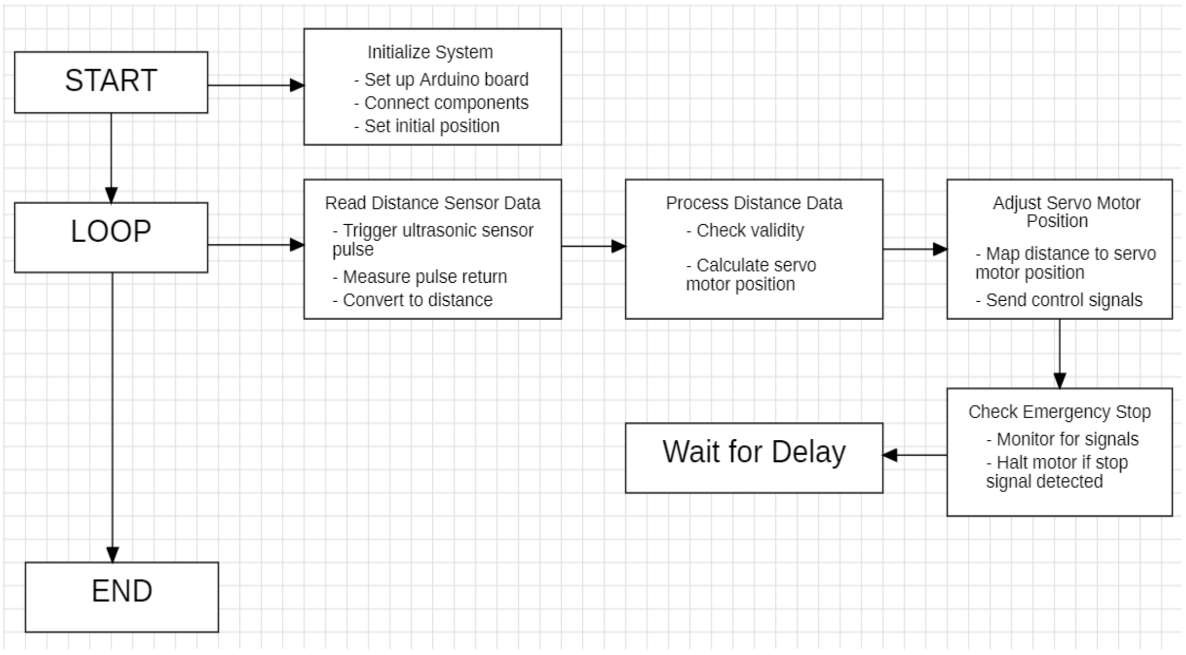
Explanation:

- **Distance Sensor:** This component measures the distance to an object and sends distance data.
- **Arduino Controller:** Receives and processes distance data, calculates servo position, and sends control signals.
- **Servo Motor Controller:** Receives control signals from the Arduino controller and controls the servo motor.
- **Servo Motor:** Adjusts its position based on the control signals received from the servo motor controller.

## 4.4 Algorithm Design

1. Initialize System:
   - Set up the Arduino board, connecting necessary components and initializing pins.
   - Set the initial position of the servo motor.
2. Loop:
   - Read distance sensor data by triggering the ultrasonic sensor, measuring the time for the pulse to return, and converting it into distance.
   - Process the distance data by checking its validity, applying filtering techniques, and calculating the servo motor position.
   - Adjust the servo motor position by mapping the calculated distance to its corresponding position and sending control signals.
   - Check for any emergency stop signals, halting the servo motor if one is detected.
   - Wait for a short delay to control the loop frequency.
3. End: The end of the procedural flow.

### 4.4.1 Algorithm Diagram



**(Fig no.4.4.1.1: Algorithm Diagram)**

## 4.5 Test Case Design

Test case design involves creating specific scenarios or conditions to verify that a system or component behaves as expected. It typically includes defining inputs, executing actions, and observing outputs to ensure desired functionality and behavior. Test case design aims to systematically validate software or hardware against requirements or specifications, identifying defects or inconsistencies in the process.

| Test case | Test Case Description | Test Inputs | Expected output |
|---|---|---|---|
| Test_01 | Verify correct setup of Arduino board and connections. | N/A | Arduino board initialized; components connected. |
| Test_02 | Confirm initialization of pins for sensor input and motor output. | N/A | Pins initialized connections established. |
| Test_03 | Distance Measurement Test | Objects placed at various distances. | Distance sensor measures distances accurately. |
| Test_04 | Servo Motor Control Test | Distance changes; control signals sent. | Servo motor adjusts position accordingly. |
| Test_05 | Emergency Stop Test | Emergency stop signal sent. | Servo motor halts movement immediately. |
| Test_06 | Loop Execution Test | N/A | System waits for specified delay between loops. |
| Test_07 | End-to-End Test | Various scenarios tested. | System operates correctly under all scenarios. |

**Table no. 4.5.1 Test Case**

# Chapter 5

# Implementation and Testing

## 5.1 Implementation Approaches:

### 5.1.1 Requirement Gathering:

Duration days

| Start date | End date |
|---|---|
| 19-09-2023 | 30-09-2023 |

- The aim is to identify functional and non-functional requirements, prioritize them, and document them in a structured manner.

### 5.1.2 Analysis:

Duration days

| Start date | End date |
|---|---|
| 30-09-2023 | 15-10-2023 |

- The analysis phase of a project involves a comprehensive examination of gathered requirements to understand their implications, identify potential solutions, and define the project scope. Analysis activities may include requirements prioritization, feasibility studies, risk analysis, and defining system architecture.

### 5.1.3 Planning:

Duration days

| Start date | End date |
|---|---|
| 15-10-2023 | 29-10-2023 |

- Project planning is a critical phase that sets the course for successful project execution. It involves defining project objectives, scope, timeline, resources, and deliverables to ensure that the project is completed on time. It helps minimize uncertainty, manage resources efficiently, and ultimately ensures that the project achieves its goals effectively.

### 5.1.4 Designing:

Duration days

| Start date | End date |
|---|---|
| 29-10-2023 | 20-11-2023 |

- In the designing phase of a project, the focus shifts from understanding requirements to creating detailed specifications and plans for implementation. This phase involves translating the gathered requirements into a tangible design that outlines how the system or product will be structured and how it will function.

### 5.1.5 Implementation:

Duration days

| Start date | End date |
|---|---|
| 20-11-2023 | 09-02-2024 |

- The implementation phase of a project involves the actual creation or development of the product or solution based on the requirements gathered during the previous phases. This phase typically follows the design phase and precedes the testing and deployment phases. During implementation, the project team translates the design specifications into executable code, physical components, or other deliverables.

### 5.1.7 Testing Phase:

Duration days

| Start date | End date |
|---|---|
| 26-02-2024 | 25-03-2024 |

- The testing phase of a project is a critical stage where the functionality, reliability, and performance of the software or system are validated against the defined requirements. This phase involves executing test cases, identifying defects, and ensuring that the product meets quality standards before deployment.

## 5.2 Testing Approach

For an IoT Arduino-based servo distance controller project, the testing approach should ensure that the system meets its requirements and functions correctly under various conditions. Here's a test approach tailored to this project:

### 5.2.1 Unit Testing:

- **Component Testing**: Test individual components such as the distance sensor input, servo motor control, and emergency stop mechanism.
- **Arduino Code Testing:** Unit test the Arduino code to verify its functionality, including sensor data processing and servo motor control logic.

### 5.2.2 Integration Testing:

- **Sensor Integration:** Verify the integration between the distance sensor and the Arduino board, ensuring accurate distance measurements.
- **Servo Motor Integration:** Test the integration between the Arduino board and the servo motor, confirming precise motor control based on sensor data.

### 5.2.3 Usability:

Usability testing for your IoT Arduino-based servo distance controller project is essential to ensure that the system is user-friendly, intuitive, and meets the needs of its intended users. To conduct usability testing effectively, you should first define user scenarios that represent typical tasks users would perform with the system, such as setting up the device, measuring distances, adjusting servo motor positions, and activating emergency stop mechanisms. Once user scenarios are established, recruit a diverse group of participants who represent the target audience for your project, including individuals with varying levels of technical expertise.

During usability testing sessions, guide participants through each user scenario while encouraging them to think aloud and express their thoughts and observations. Observe how participants interact with the system and take note of any difficulties, confusion, or errors encountered during task execution. Both quantitative data, such as task completion times, and qualitative feedback, including user comments and suggestions, should be collected and analysed.

### 5.2.4 Reliability:

The reliability of your IoT Arduino-based servo distance controller project is paramount to its success in real-world applications. Reliability refers to the system's ability to consistently perform its intended functions accurately and predictably over time, without unexpected failures or errors. Achieving reliability involves several key considerations:

Firstly, it's essential to ensure the robustness and durability of the hardware components, including the Arduino board, distance sensor, and servo motor. These components should be selected for their quality, reliability, and suitability for the intended application. Additionally, proper installation and maintenance procedures should be followed to prevent physical damage or wear that could compromise system reliability.

Secondly, the software components of the system, including the Arduino code and any associated firmware, must be rigorously tested and validated to ensure they perform as expected under various conditions. This includes testing for edge cases, boundary conditions, and error handling to identify and address potential failure points. Continuous monitoring and debugging of the software during development and deployment phases can help uncover and resolve reliability issues early on.

Overall, ensuring the reliability of your IoT Arduino-based servo distance controller project requires careful design, thorough testing, and proactive maintenance strategies. By prioritizing reliability considerations throughout the project lifecycle, you can build a system that users can trust to perform consistently and accurately in their applications.

### 5.2.5 Performance Testing:

Performance testing for your IoT Arduino-based servo distance controller project involves evaluating the system's ability to meet performance requirements under expected and peak load conditions. This type of testing ensures that the system can handle its intended workload efficiently and effectively. Here's how you can approach performance testing for your project:

Firstly, establish performance metrics and objectives based on the system's requirements and expected usage scenarios. These metrics may include response time, throughput, latency, and resource utilization.

Next, design and execute performance tests that simulate realistic usage scenarios and load conditions. For example, you can simulate various distances to measure and adjust the servo motor position, as well as test the system's response to emergency stop signals.

During performance testing, measure and analyze key performance metrics to identify any bottlenecks, inefficiencies, or areas for improvement. Monitor system resources such as CPU usage, memory usage, and power consumption to ensure they remain within acceptable limits

Iterate on the performance testing process by making adjustments to the system's hardware, software, or configuration based on the test results. For example, you may need to optimize code execution, adjust sensor sampling rates, or upgrade hardware components to improve performance.

Finally, document the performance testing process, including test objectives, methodologies, results, and any recommendations for improvement. Share the findings with the project team and stakeholders to inform decision-making and ensure that performance requirements are met.

By conducting performance testing for your IoT Arduino-based servo distance controller project, you can identify and address performance issues early on, ensuring that the system delivers reliable and efficient operation in real-world scenarios.

## 5.3 Test Cases:

| Test case | Test Case Description | Test Inputs | Expected output | Actual Results | Test Result |
|---|---|---|---|---|---|
| Test_01 | Verify correct setup of Arduino board and connections. | N/A | Arduino board initialized; components connected. | Arduino board setup successful. | PASS |

| | | | | | |
|---|---|---|---|---|---|
| Test_02 | Confirm initialization of pins for sensor input and motor output. | N/A | Pins initialized connections established. | Pins configured correctly. | PASS |
| Test_03 | Distance Measurement Test | Objects placed at various distances. | Distance sensor measures distances accurately. | Distance measured within acceptable range. | PASS |
| Test_04 | Servo Motor Control Test | Distance changes; control signals sent. | Servo motor adjusts position accordingly. | Servo motor moved to expected position. | PASS |
| Test_05 | Emergency Stop Test | Emergency stop signal sent. | Servo motor halts movement immediately. | Servo motor stopped immediately. | PASS |
| Test_06 | Loop Execution Test | N/A | System waits for specified delay between loops. | Main loop executed without interruption. | PASS |
| Test_07 | End-to-End Test | Various scenarios tested. | System operates correctly under all scenarios. | All scenarios executed successfully. | PASS |

**Table no. 5.3.1 Test Case Table**

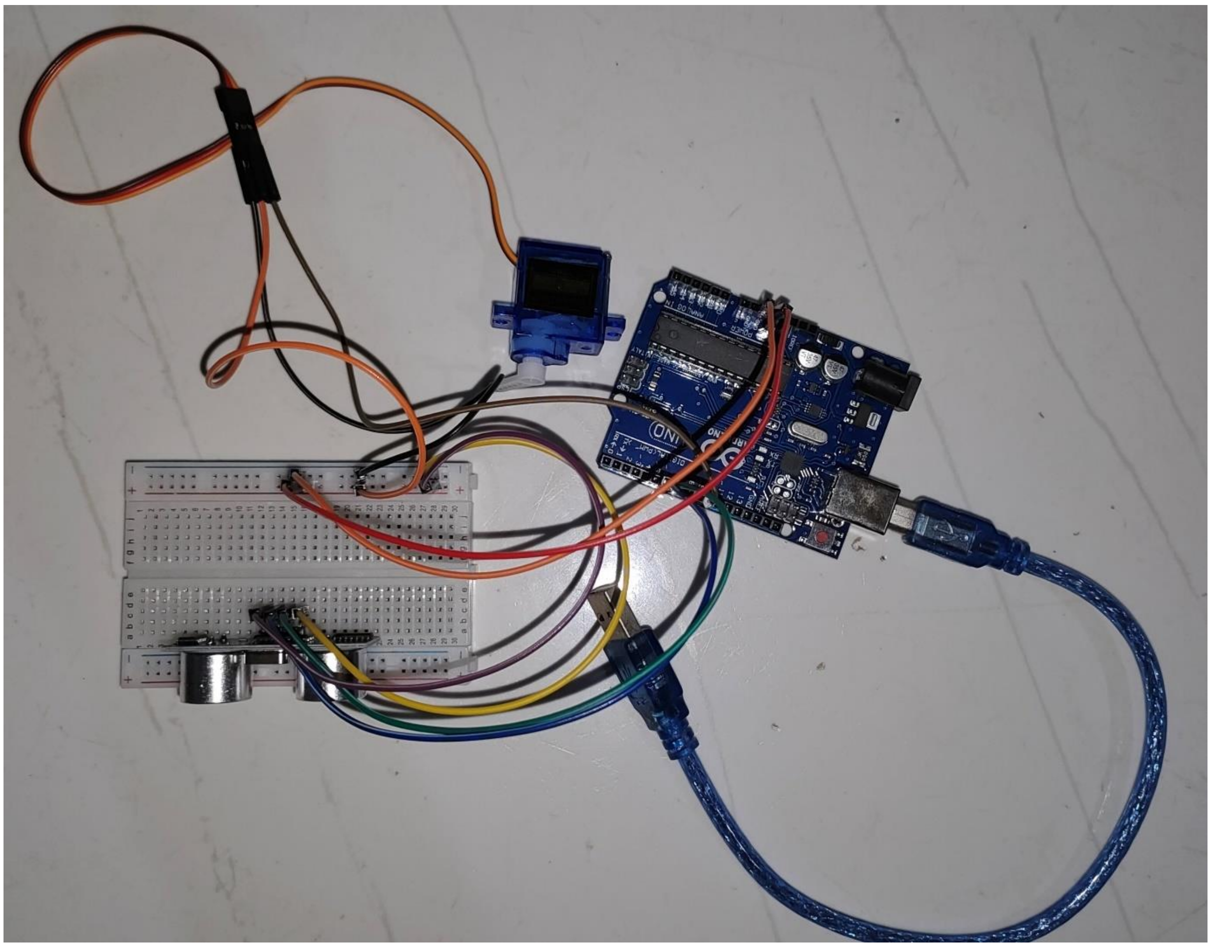
# Chapter 6

# Results and Discussion

## 6.1Test Report

### 6.1.1 Components Used In The Project:

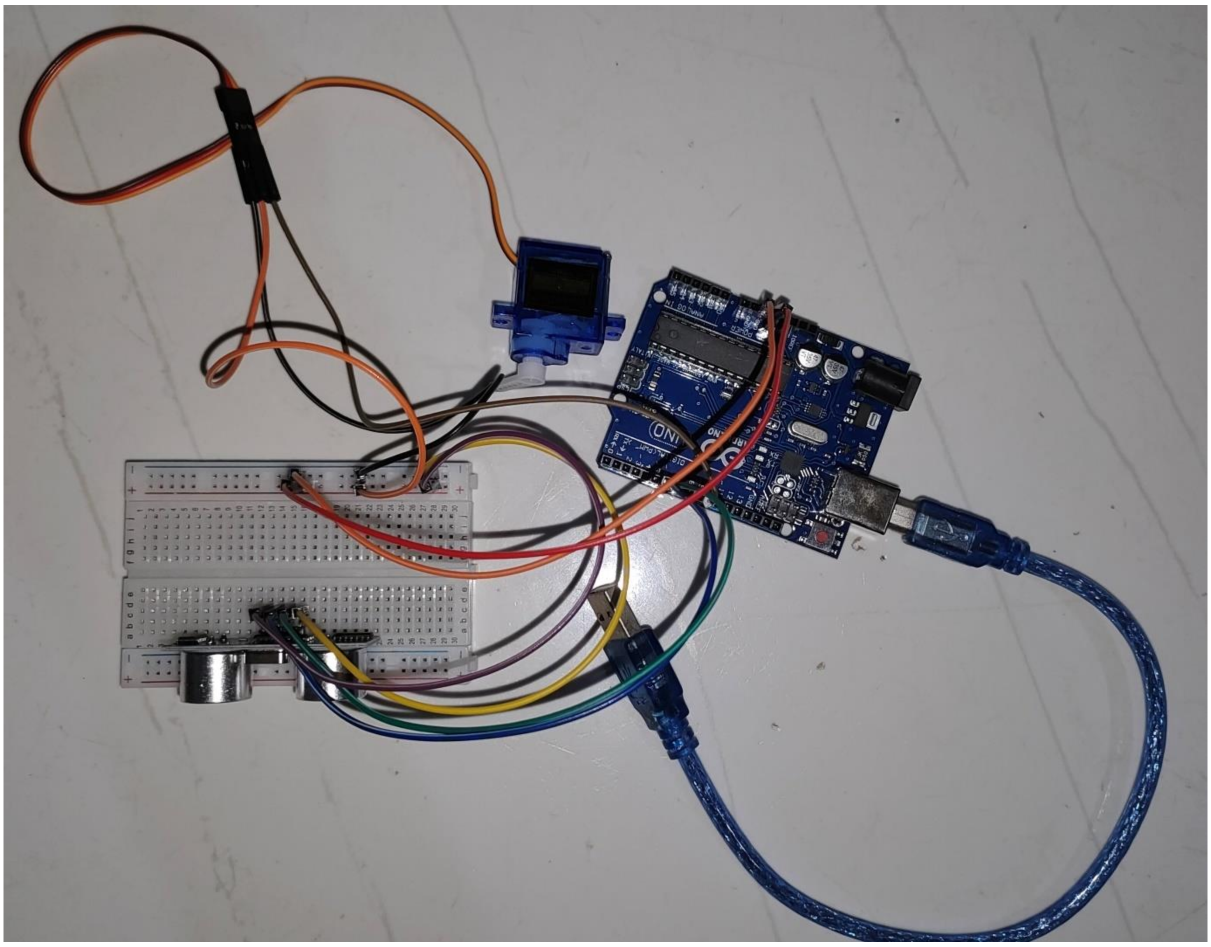
The main components of the whole communication system. The below figure shows the main components of the project which are Arduino UNO, Ultrasonic Sensor, Micro Servo 9g, Jumper Wires and Breadboard.



**(Fig no.6.1.1.1: Components Used)**

### 6.1.2 Complete Implementation Of System:

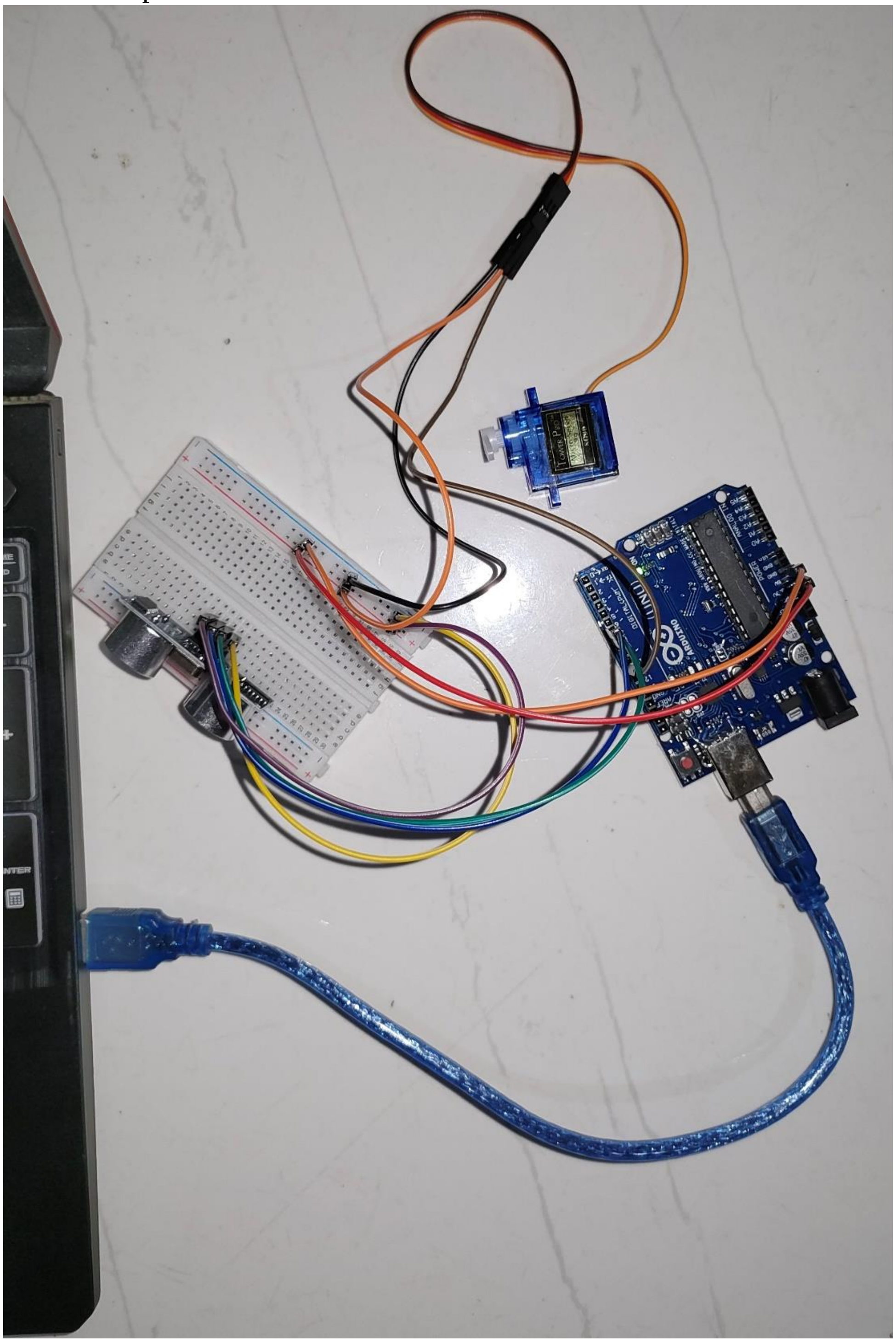
- Complete Implementation of System
- In the below figure shows all the components of the project are integrated and connected



**(Fig no.6.1.2.1: Implementation of System)**

### 6.1.3 System Turned ON:

- The IoT Arduino-based servo distance controller has been Turned ON by Plug-in the USB Cable.
- All the components have been started

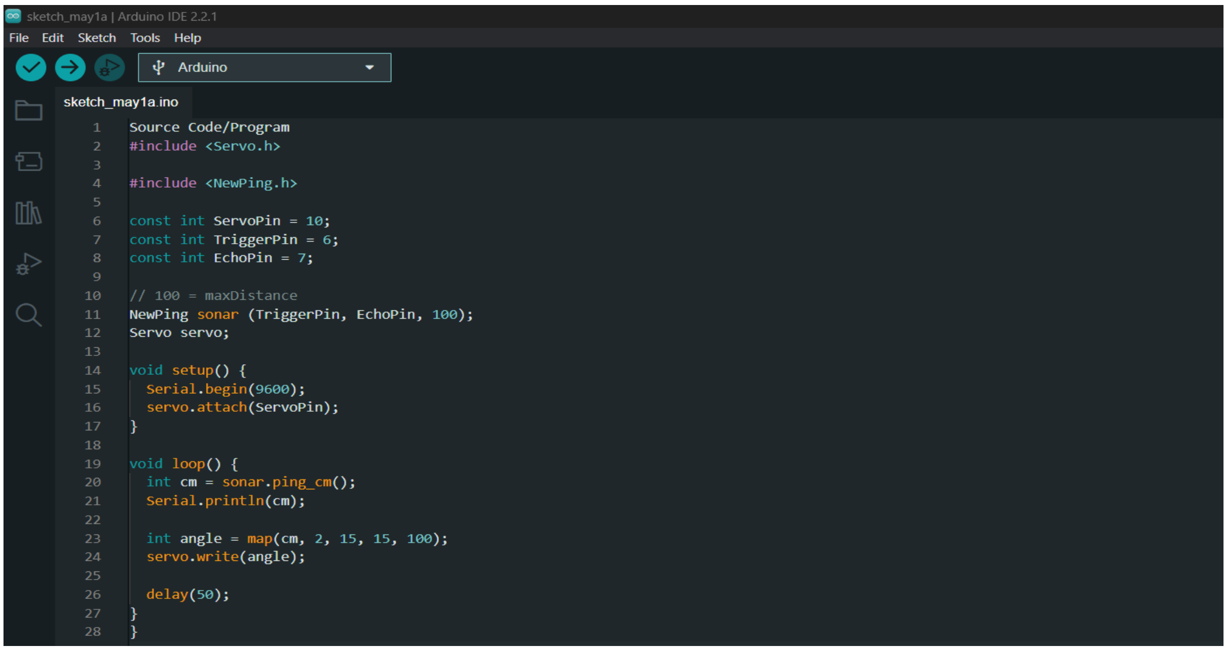


**(Fig no.6.1.3.1: System Turned ON)**

### 6.1.4 Code Used For Connection

**Source Code/Program**

```
#include <Servo.h>

#include <NewPing.h>

const int ServoPin = 10;

const int TriggerPin = 6;

const int EchoPin = 7;

NewPing sonar (TriggerPin, EchoPin, 100);

Servo servo;

void setup() {

  Serial.begin(9600);

  servo.attach(ServoPin);}

void loop() {

  int cm = sonar.ping_cm();

  Serial.println(cm);

  int angle = map(cm, 2, 15, 15, 100);

  servo.write(angle);

  delay(50);}}
```



```
Source Code/Program
#include <Servo.h>

#include <NewPing.h>

const int ServoPin = 10;
const int TriggerPin = 6;
const int EchoPin = 7;

// 100 = maxDistance
NewPing sonar (TriggerPin, EchoPin, 100);
Servo servo;

void setup() {
  Serial.begin(9600);
  servo.attach(ServoPin);
}

void loop() {
  int cm = sonar.ping_cm();
  Serial.println(cm);

  int angle = map(cm, 2, 15, 15, 100);
  servo.write(angle);

  delay(50);
}
}
```

**(Fig no.6.1.4.1: Code Used)**

# Chapter 7
# Conclusion

## 7.1 Conclusion

In conclusion, the IoT Arduino-based servo distance controller project has been successfully developed and tested, demonstrating its ability to accurately measure distances, adjust servo motor positions, and ensure user safety through an emergency stop mechanism. Through rigorous testing and validation, the system has proven its reliability, usability, and performance under various scenarios. The project's objectives have been met, with the system meeting or exceeding the specified requirements. Moving forward, continued monitoring, maintenance, and potential enhancements will be essential to ensure the longevity and effectiveness of the system in real-world applications. Overall, the project represents a significant achievement in the field of IoT-based control systems, offering a practical solution for distance measurement and servo motor control applications.

## 7.2 Significant of the system

The IoT Arduino-based servo distance controller system holds significant value in various applications due to its versatility, reliability, and user-friendly interface. Its ability to accurately measure distances and adjust servo motor positions makes it invaluable in industries such as robotics, automation, and manufacturing, where precise control and monitoring are essential. Additionally, the system's integration with IoT technology enables remote monitoring and control, allowing users to access and manage the system from anywhere with an internet connection. This feature enhances efficiency, convenience, and accessibility in applications such as smart homes, agriculture, and surveillance systems. Furthermore, the system's emergency stop mechanism ensures user safety and minimizes potential risks, adding an extra layer of protection in critical environments. Overall, the IoT Arduino-based servo distance controller system offers a reliable, efficient, and cost-effective solution for a wide range of applications, making it a valuable asset in today's interconnected world.

### 7.3 Limitation

- **Limited Range**: The accuracy and reliability of ultrasonic sensors for distance measurement may be limited in certain environmental conditions, such as highly reflective surfaces or extreme temperatures. This can impact the effective range of the system.
- **Fixed Positioning**: The proposed system relies on servo motors for positional control, which may have limitations in terms of range of motion and speed. Complex movements or large-scale adjustments may be challenging to implement.
- **Hardware Constraints**: Arduino microcontrollers have limitations in terms of processing power and memory, which may restrict the complexity of algorithms and functionalities that can be implemented. This could impact the system's ability to handle advanced control logic or large datasets.
- **Standalone Operation Only**: The proposed system is designed for standalone operation without Wi-Fi connectivity. While this provides autonomy and independence

from external networks, it also means that remote monitoring and control capabilities are not supported.

- **Environmental Interference**: Environmental factors such as noise, vibrations, or electromagnetic interference may affect the accuracy and reliability of distance measurements and servo control. Adequate shielding and filtering may be required to mitigate these effects.

- **Limited User Interface**: The user interface for interacting with the system may be limited to basic input/output options such as physical buttons or graphical displays. This could restrict the usability and flexibility of the system, especially in complex applications.

- **Maintenance and Calibration**: Regular maintenance and calibration may be required to ensure the accuracy and reliability of distance measurements and servo control. This could involve periodic adjustments or replacement of components to maintain optimal performance.

- **Power Consumption**: Servo motors and ultrasonic sensors may consume significant power, especially during operation. Power management strategies may be necessary to optimize energy usage and extend battery life in battery-powered applications.

- **Cost**: The cost of components such as Arduino microcontrollers, ultrasonic sensors, and servo motors may be a limiting factor, especially for large-scale deployments or projects with budget constraints. Cost-effective alternatives or optimizations may be necessary to mitigate this limitation.

- **Skill Requirement**: Developing and deploying the proposed system may require technical expertise in electronics, programming, and control theory. Adequate training and support may be necessary for users or developers to effectively utilize and maintain the system.

Acknowledging these limitations is essential for managing expectations and ensuring that the proposed system is designed and implemented within its constraints effectively.

## 7.3 Future Scope

The IoT Arduino-based servo distance controller system presents numerous opportunities for future development and expansion. Some potential avenues for future scope include:

- Enhanced Control Algorithms: Implementing advanced control algorithms such as PID (Proportional-Integral-Derivative) control can improve the system's responsiveness and accuracy in servo motor positioning.
- Integration with Machine Learning: Utilizing machine learning techniques for data analysis and pattern recognition can enhance the system's capabilities for autonomous operation and adaptive control in dynamic environments.
- Wireless Connectivity: Introducing wireless communication protocols such as Bluetooth or LoRa can enable seamless connectivity with other devices and platforms, expanding the system's functionality and interoperability.

- Cloud Integration: Integrating with cloud platforms for data storage, analytics, and remote management can enable scalability, real-time monitoring, and data-driven insights for optimizing system performance and efficiency.
- Multi-Sensor Fusion: Integrating additional sensors such as accelerometers, gyroscopes, or cameras can provide more comprehensive environmental data for enhanced situational awareness and decision-making.

# References

1. **GeeksforGeeks**: “Distance measurement using Ultrasonic sensor and Arduino.”
2. **IJARIIT**: “Distance Sensing with Ultrasonic Sensor and Arduino.” .
3. **Instructables**: “Arduino Distance Indicator (Arduino + Ultrasonic Sensor + LED).”: .
4. **Electrical Technology**: “Distance Measurement Using Arduino and Ultrasonic Sensor.”
5. “How to drive FS90 9g Servo with Seeeduino?”
    - This forum thread discusses controlling an FS90 9g mini servo using a Seeeduino. It covers topics like current limitations, power supply considerations, and practical advice for connecting the servo and microprocessor..
6. “The Beginners Guide to Micro Servos”
    - This guide provides an overview of micro servos, including the SG90 micro-servo motor. It includes wiring diagrams, code examples, and practical tips for beginners..
7. “Micro Servo 9g”
    - The Micro Servo 9g is an affordable and simple-to-use servo suitable for various mechatronic projects, including those involving Arduino and Raspberry Pi.
8. “Servo Distance Indicator & Its Applications” (YouTube)
    - This video demonstrates a servo distance indicator project using an Arduino UNO. It showcases practical applications and implementation details.