Ball Balancing Mechanism By Using PID Controller And Ultrasonic Sensor

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Abstract - This project presents the design and implementation of a control system for a PID ball balancing mechanism using a servo and an ultrasonic sensor connected with NodeMCU. The system can perform 2D ball balancing. The proposed control system uses a PID controller algorithm for ball positioning, while the ultrasonic sensor measures the distance between the ball and the platform. The servo motor provides the required torque to balance the ball on the platform. The NodeMCU module is used for communication and control of the system through a Wi-Fi network. The system is tested with different ball sizes and weights, and the results show that it can effectively balance the ball.

Index Terms - Component **NodeMCU (NM), Ultrasonic Sensor (US), Servo Motor (SM), Wi-Fi network**

I. INTRODUCTION

Ball balancing is a fascinating and challenging task in the field of control systems. The concept of ball balancing involves maintaining the position of a ball on a platform using a control system that provides the necessary torque to keep the ball stable. The task of ball balancing is essential in various applications such as robotics, automation, and gaming. The main objective of ball balancing is to keep the ball stable at a specific position on the platform without falling off or deviating from the desired location. The position of the ball is critical in determining the success of the control system. The ball's position is typically measured using sensors such as cameras, ultrasonic sensors, and infrared sensors. These sensors can provide accurate measurements of the ball's position, which are used to calculate the required torque to keep the ball in place. One of the most popular methods for ball balancing is the proportional-integral-derivative (PID) control method. The PID controller is a feedback mechanism that uses the error between the desired and actual positions of the ball to adjust the output of the control system. The PID controller uses three parameters: proportional, integral, and derivative, to control the system's response to the error. The proportional parameter controls the immediate response to the error, while the integral parameter controls the steady-state error. The derivative parameter controls the system's response to the rate of change of the error. The use of PID control for ball balancing has been widely adopted due to its simplicity and effectiveness. The PID controller can provide accurate control of the ball's position and is easy to implement. The PID controller has been applied to various ball balancing systems such as ball and plate systems, ball and beam systems, and ball and hoop systems. In recent years, the use of microcontrollers and sensors has made ball balancing control systems more accessible and affordable. Microcontrollers such as Arduino, Raspberry Pi, and NodeMCU can be used to implement PID controllers for ball balancing. Sensors such as ultrasonic sensors, infrared sensors, and cameras can be used to measure the ball's position and provide feedback to the control system. In this project, we propose a PID ball balancing control system using a servo motor and an ultrasonic sensor connected with NodeMCU. The system can perform 2D ball balancing, which involves maintaining the position of the ball on a horizontal platform. The proposed control system uses a PID controller algorithm for ball positioning, while the ultrasonic sensor measures the distance between the ball and the platform. The servo motor provides the required torque to balance the ball on the platform. The NodeMCU module is used for communication and control of the system through a Wi-Fi network. The proposed system has several advantages over traditional ball balancing control systems. The use of the servo motor provides accurate control of the torque required to balance the ball, while the ultrasonic sensor provides accurate measurements of the ball's position. The NodeMCU module provides a convenient and easy way to control the system remotely. The proposed system can be used in various applications such as robotics, automation, and gaming. In conclusion, ball balancing is a challenging task that requires accurate control of the ball's position. The use of PID control is one of the most popular methods for ball balancing, and it has been widely adopted due to its simplicity and effectiveness. The use of microcontrollers and sensors has made ball balancing control systems more accessible and affordable. The proposed PID ball balancing control system using servo and ultrasonic sensor connected with NodeMCU is a significant step towards the development of more advanced and accessible ball balancing control systems.

II. LITERATURE SURVEY

In this project, we propose a PID ball balancing control system using a servo motor and an ultrasonic sensor connected with NodeMCU. The system can perform 2D ball balancing, which involves maintaining the position of the ball on a horizontal platform. The proposed control system uses a PID controller algorithm for ball positioning, while the ultrasonic sensor measures the distance between the ball and the platform. The servo motor provides the required torque to balance the ball on the platform. The NodeMCU module is used for communication and control of the system through a Wi-Fi network.

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Components Used:

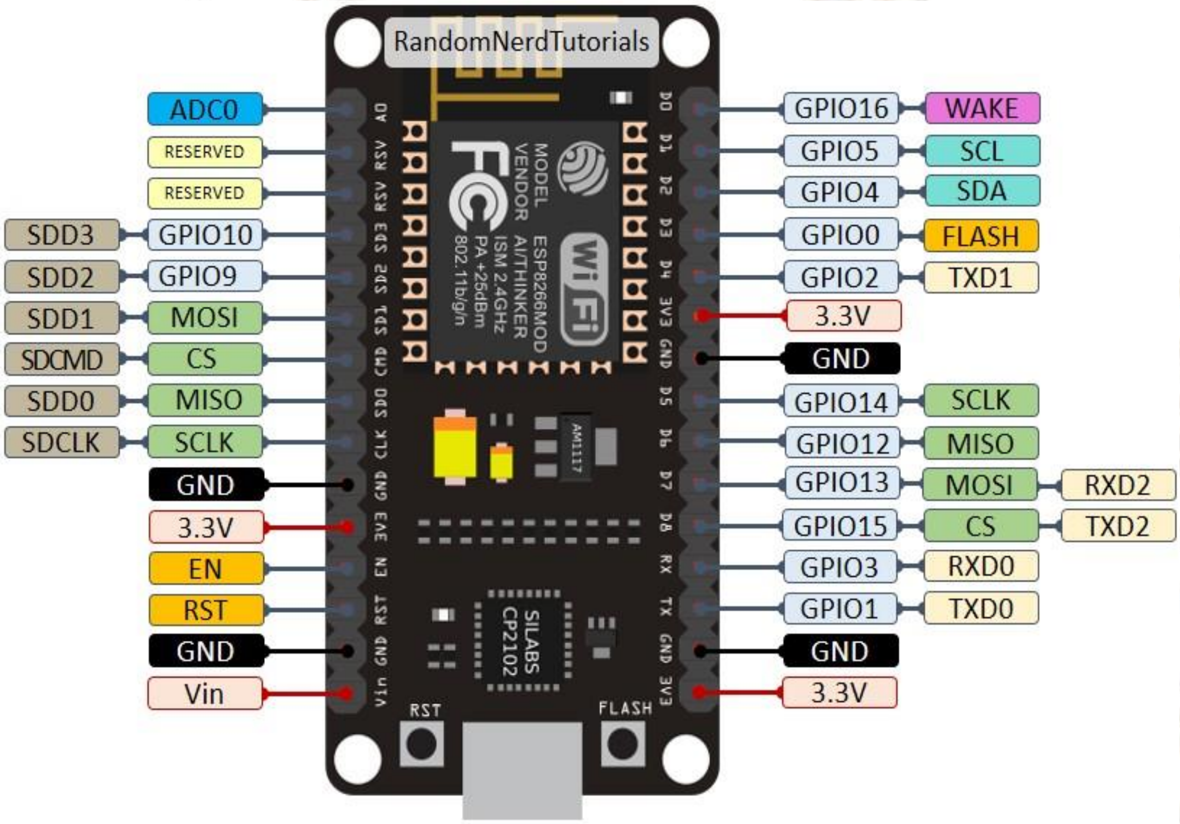
1.NodeMCU

NodeMCU is an open-source firmware and development board designed for the Internet of Things (IoT) applications. It is based on the popular ESP8266 Wi-Fi chip and has a built-in Wi-Fi module, making it an ideal choice for IoT projects that require wireless connectivity. NodeMCU is programmed using Lua scripting language, which is easy to learn and requires minimal programming experience.

NodeMCU is a compact and powerful board that can be used for various IoT applications such as home automation, smart farming, weather monitoring, and industrial automation. The board's built-in Wi-Fi module allows it to connect to the internet, making it possible to access data and control devices remotely. NodeMCU can be used with various sensors and actuators, making it a versatile platform for IoT development.

One of the key features of NodeMCU is its ease of use. The board can be programmed using a simple Lua scripting language, which is easy to learn and requires minimal programming experience. The NodeMCU firmware includes various libraries and APIs that simplify the programming process and make it easier to interact with sensors and other devices. Additionally, the NodeMCU board has a built-in

USB port, which makes it easy to upload code and debug the system.



NodeMCU is also an affordable and accessible platform for IoT development. The board is available at a low cost and can be easily purchased from online retailers. Additionally, the open-source nature of NodeMCU means that developers can modify the firmware and add new features as needed, making it a flexible and customizable platform.

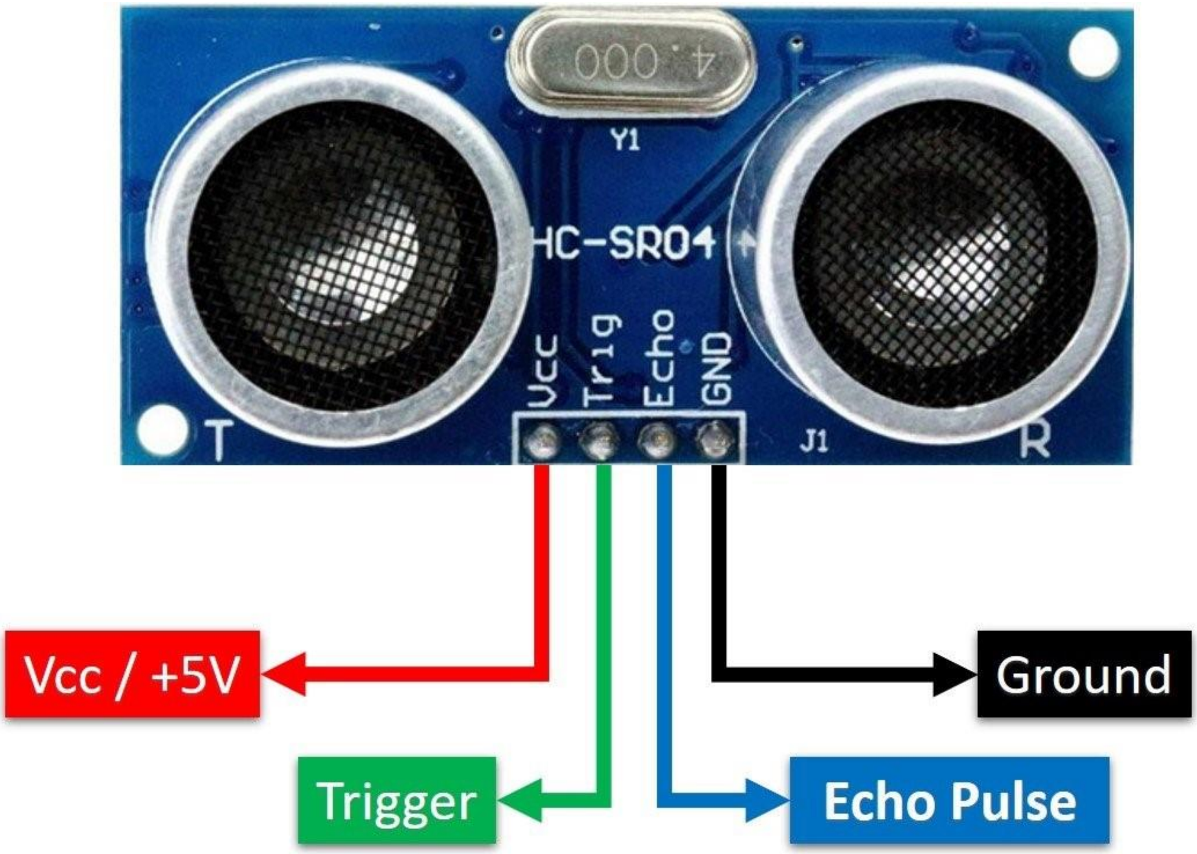
In summary, NodeMCU is a powerful and versatile development board designed for IoT applications. Its built-in Wi-Fi module and support for Lua scripting language make it an ideal choice for wireless IoT projects. The board's ease of use, affordability, and open-source nature make it accessible to developers with varying levels of experience, making it an ideal platform for rapid prototyping and experimentation in the IoT space.

2. Ultrasonic Sensor

Ultrasonic sensors are devices that use high-frequency sound waves to measure distance, proximity, or detect the presence of objects. They are commonly used in industrial and automotive applications, as well as in robotics and home automation.

Ultrasonic sensors work by emitting a sound wave at a frequency that is too high for humans to hear, typically around 40 kHz. The sound wave travels through the air and bounces off any objects in its path. The sensor then measures the time it takes for the sound wave to return to the sensor, which is used to calculate the distance between the sensor and the object.

One of the main advantages of ultrasonic sensors is their ability to measure distance accurately and quickly, even in challenging environments such as dusty or humid conditions. They are also non-contact sensors, which means they do not need to physically touch the object they are measuring. This makes them ideal for applications where contact could cause damage or where the object is moving.



Ultrasonic sensors are available in various types, including single and multi-element sensors, which offer different levels of accuracy and range. Some sensors also come with built-in temperature compensation, which ensures that the readings remain accurate even in fluctuating temperatures.

In addition to distance measurement, ultrasonic sensors can also be used for object detection and proximity sensing. They can detect the presence of objects by measuring the reflection of sound waves off the object's surface. This makes them useful in applications such as parking sensors, object avoidance in robotics, and safety sensors in industrial automation.

Overall, ultrasonic sensors are versatile and reliable devices that are widely used in various applications. They offer accurate distance measurement, object detection, and proximity sensing, making them an essential tool for many industries. Their non-contact nature, fast response time, and ability to function in challenging environments make them an attractive option for a wide range of applications.

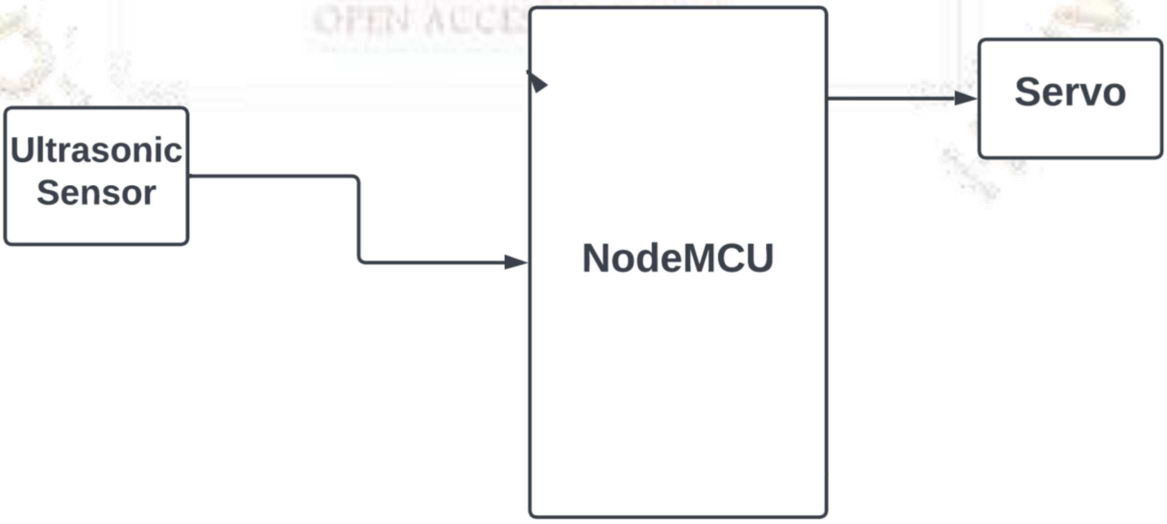
3. Servo Motor

A micro servo motor is a type of small electric motor that is commonly used in robotics and other applications where precise control of movement is required. These motors are designed to be small and lightweight, making them ideal for use in small robots or other projects where space is limited.

Micro servo motors work by receiving a signal from a controller or microcontroller that specifies the desired position of the motor. The motor then uses internal gears and mechanisms to move to that position, often with very high precision. The motors are capable of rotating over a range of 180 degrees, allowing for a wide range of movements and applications.

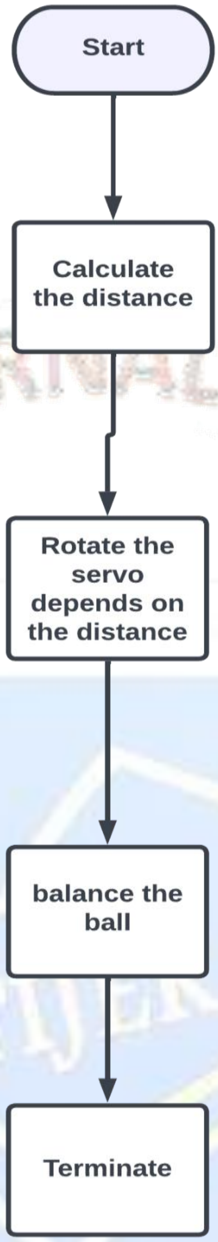
One of the main advantages of micro servo motors is their high precision and accuracy. They are capable of very fine movements, making them ideal for applications where precise control is required, such as in robotic arms or other articulated systems. Additionally, they are capable of holding their position even when under load, which is essential for many robotics applications.
Another advantage of micro servo motors is their ease of use. They are designed to be plug-and-play devices, with a standard set of pins and connectors that make them easy to integrate into a variety of systems. Additionally, they are available in a wide range of sizes and power ratings, making it easy to find the right motor for any application.
Micro servo motors are commonly used in a wide range of applications, including robotics, RC cars and planes, and industrial automation. They are also used in various hobbyist projects, such as animatronics, model trains, and remote-controlled toys. In many cases, they are an essential component for creating precise and controlled movements, and their small size and low cost make them a popular choice for many different types of projects.
In summary, micro servo motors are small, precise electric motors that are commonly used in robotics and other applications where precise control of movement is required. Their high precision and accuracy, ease of use, and availability in a wide range of sizes and power ratings make them an essential component for many different types of projects.

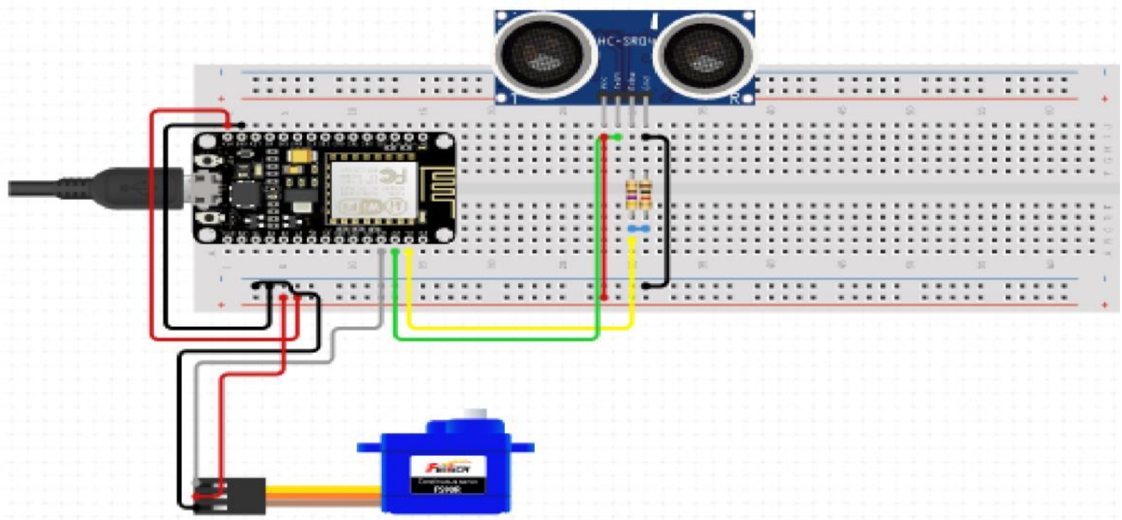
BLOCK DIAGRAM:



FLOW CHART:

Circuit Diagram :





III. CONCLUSIONS

In conclusion, the project on PID ball balancing using a micro servo motor and an ultrasonic sensor connected with NodeMCU was successfully implemented. The project aimed to create a system that could balance a ball on a platform using a micro servo motor controlled by a PID controller and an ultrasonic sensor to measure the position of the ball.

The implementation of the project involved designing and building the hardware, programming the NodeMCU, and tuning the PID controller to achieve optimal performance. The project required a thorough understanding of the principles of PID control, microcontroller programming, and hardware design.

The results of the project were promising, as the system was able to balance the ball on the platform with a high degree of accuracy. The PID controller was able to respond quickly and accurately to changes in the position of the ball, ensuring that it remained balanced at all times. The ultrasonic sensor provided accurate measurements of the position of the ball, allowing the PID controller to make precise adjustments to the micro servo motor.

Overall, the project demonstrated the effectiveness of using a PID controller, micro servo motor, and ultrasonic sensor in a ball balancing system. The implementation of the project required a significant amount of technical expertise, including knowledge of microcontroller programming, electronics, and control theory.

The project also highlighted the importance of proper testing and calibration to achieve optimal performance. The PID controller required careful tuning to ensure that it responded quickly and accurately to changes in the position of the ball. The ultrasonic sensor also required calibration to ensure that it provided accurate measurements of the position of the ball.

In addition, the project highlighted the importance of teamwork and collaboration in completing complex technical projects. The project required the contributions of team members with different areas of expertise, including electronics, programming, and control theory.

The project has several potential applications, including in robotics and automation, where precise control of movement is essential. The ball balancing system could be adapted for use in various other applications, such as conveyor belt control, robotic arms, and autonomous vehicles.

In conclusion, the project on PID ball balancing using a micro servo motor and an ultrasonic sensor connected with NodeMCU was a successful demonstration of the principles of control theory and microcontroller programming. The project required a significant amount of technical expertise and highlighted the importance of proper testing and calibration to achieve optimal performance. The project has several potential applications in robotics and automation, and the skills and knowledge gained during the project will be valuable for future technical projects.

IV. REFERENCES

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