# Self-Balancing Smart Robot


**Project By:-**

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# About

## What is self-balancing Robot

Self Balancing Robot is device that can balance itself from falling to the ground

Self balancing robot is the bot balance itself on two wheels, by constantly correcting its position. A Gyro sensor is used in self balancing robot, which continuously sends the robot orientation data to the controller. on the basis of this data controller command the motor to run forward or reverse to maintain the position of robot up straight.

# INTRODUCTION

## Overview

A **self-balancing robot** is a two-wheeled, inverted pendulum system that maintains stability using sensor feedback and motor control. It relies on a **gyroscope and accelerometer (MPU6050)** to measure its tilt angle and an **Arduino Nano** to process the data. A **PID (Proportional-Integral-Derivative) algorithm** adjusts the speed and direction of **NEMA 17 stepper motors** via **A4988 motor drivers** to keep the robot balanced.

For remote control, an **HC-05 Bluetooth module** enables wireless communication with a smartphone. The frame, built using **MDF board and threaded rods**, provides structural support.This project is widely used in **robotics education, autonomous systems, and assistive technology**. It demonstrates key concepts in **control systems, embedded programming, and mechatronics**

# Working Principle

- **MPU6050 Sensor** measures the robot's tilt angle and angular velocity.
- **Arduino Nano** processes this data and applies a **PID (Proportional-Integral-Derivative) control algorithm**.
- **Stepper Motors (NEMA 17)** are controlled via **A4988 drivers** to move forward or backward to maintain balance.
- **HC-05 Bluetooth Module** enables remote control via a smartphone.

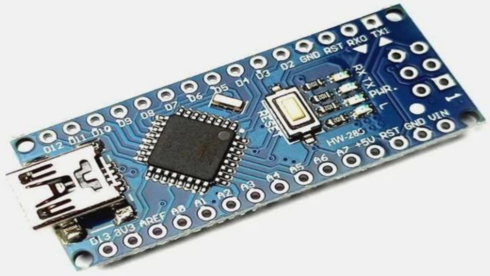
# Components Required

| Components | QTY. |
|---|---|
| **Arduino Nano** | **1 pcs** |
| **MPU605 Gyro sensor** | **1 pcs** |
| **Nema 17 Stepper motors** | **2 pcs** |
| 100mm Wheels | 2 pcs |
| **A4988 Stepper driver IC** | **2 pcs** |
| **HC-05 Bluetooth module** | **1 pcs** |
| **Lipo Battery 2200mAH** | **1 pcs** |
| 4mm MDF board | 4 pcs |
| 150mm M5 threaded rods | 4 pcs |
| some nuts and bolts | few |

**Total Budget = Rs.5,740**

# Arduino Nano v3

**Price** : 233

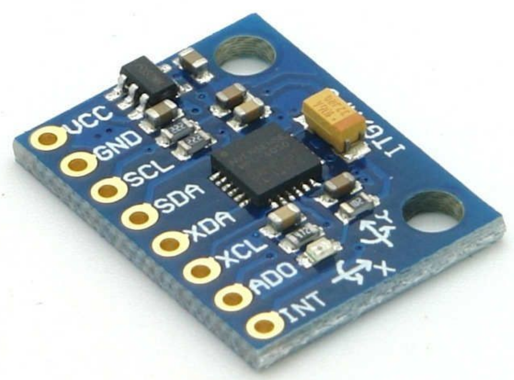


## Key Feature

- **Microcontroller:** ATmega328P
- **Operating Voltage:** 5V
- **Input Voltage:** 6-12V (via Vin pin)
- **Digital I/O Pins:** 14 (6 PWM outputs)
- **Clock Speed:** 16 MHz
- **Flash Memory:** 32 KB (2 KB used by bootloader)
- **USB Interface:** Mini-USB for programming and power

# MPU605
# Gyro Sensor

**Price** : 168.64




## Key Feature

- **Gyroscope Range:** ±250, ±500, ±1000, ±2000°/s
- **Accelerometer Range:** ±2g, ±4g, ±8g, ±16g
- **Communication:** I2C (SDA, SCL)
- **Operating Voltage:** 3.3V – 5V
- **Motion Processing Unit (MPU):** Built-in Digital Motion Processor (DMP)
- **Low Power Consumption**

# Nema 17 Stepper Motor

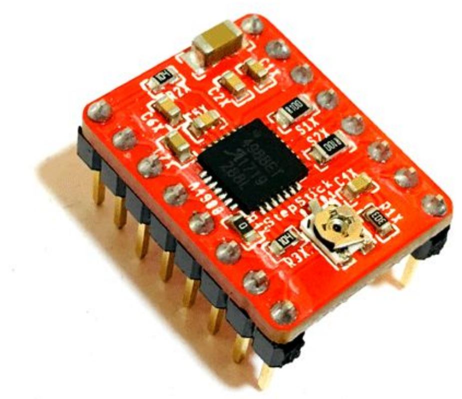
Price : 1092


## Key Feature

- **Step Angle:** 1.8° (200 steps per revolution)
- **Holding Torque:** 0.3–0.6 Nm (varies by model)
- **Voltage:** 12V–24V (depends on winding configuration)
- **Current Rating:** 1A–2A per phase
- **Bipolar (4-wire) or Unipolar (6-wire) configuration**

**Price** : 109

# A4988 Stepper driver

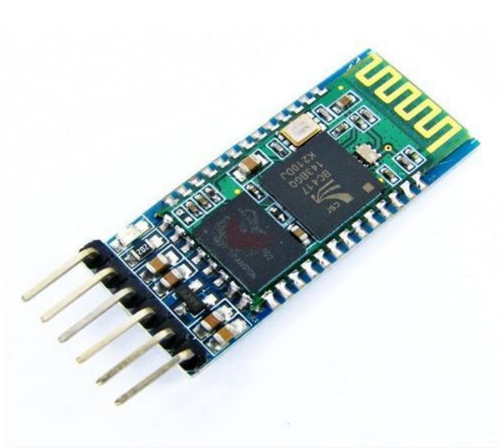


## Key Feature

- **Operating Voltage:** 8V–35V (for motor)
- **Logic Voltage:** 3.3V–5V (for microcontroller)
- **Current Control:** Up to 2A per coil (with proper cooling)
- **Microstepping Modes:** Full, 1/2, 1/4, 1/8, 1/16 steps
- **Thermal Protection & Overcurrent Protection**

# HC-05 Bluetooth module

**Price** : 385



## Key Feature

- **Operating Voltage:** 3.3V (but 5V tolerant on RX pin)
- **Communication Protocol:** UART (Serial)
- **Default Baud Rate:** 9600 (configurable)
- **Range:** Up to 10 meters (in open space)

# 4mm MDF board

**Price** : 200

## Key Feature

- **Thickness:** 4mm (lightweight but sturdy)
- **Material:** Compressed wood fibers with resin
- **Surface:** Smooth, easy to paint or drill
- **Strength:** Strong but not waterproof (requires sealing for moisture resistance)
- **Weight:** Lighter than plywood, making it ideal for small robots

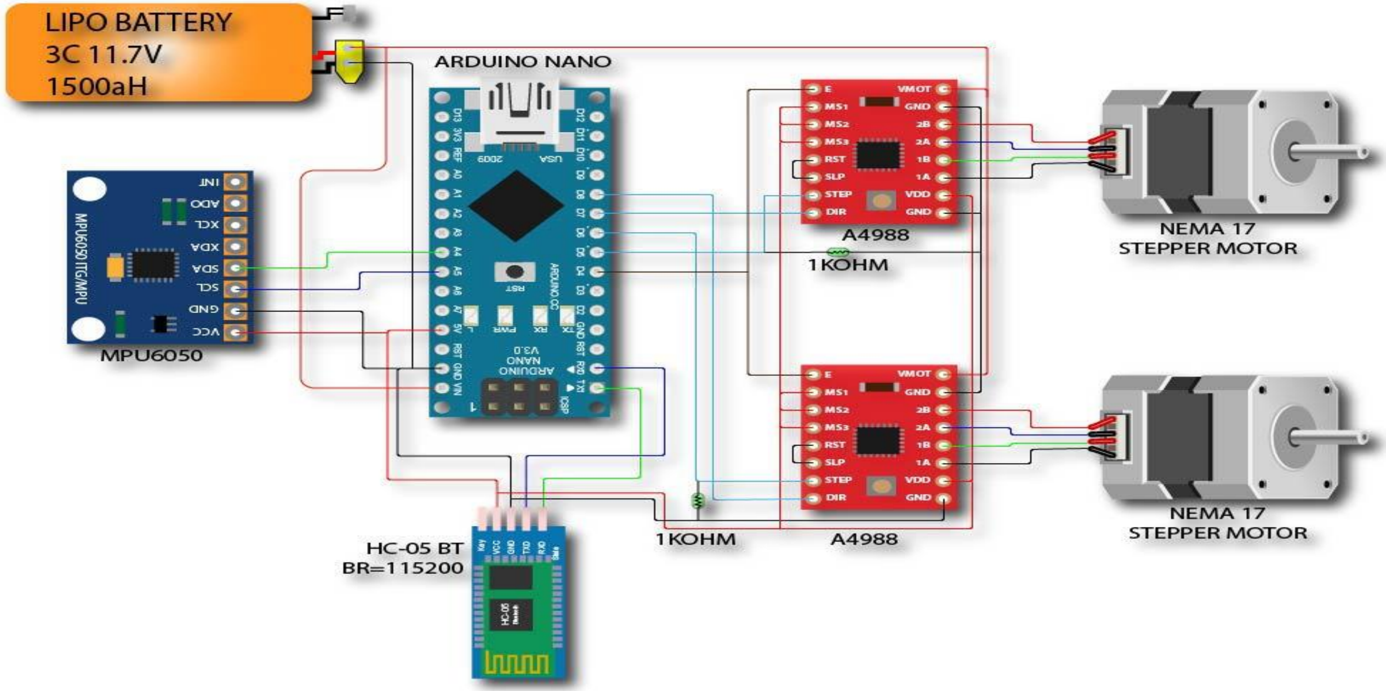
Price : 169

# 150mm M5 threaded rods

## Key Feature

- **Diameter:** 5mm
- **Length:** 150mm
- **Thread Pitch:** Typically 0.8mm (standard for M5)
- **Material:** Often made of **steel or stainless steel** for durability and strength
- **Use:** Provides adjustable length in assemblies, used with nuts and washers for securing components

# Circuit Diagram



# Building Process

**Step 1: Gather Components:** Arduino Nano, MPU6050, NEMA 17 motors, A4988 drivers, HC-05, wheels, MDF board, rods, nuts & bolts.

**Step 2: Assemble the Frame**

- Cut **MDF board** and use **M5 threaded rods** for a sturdy frame.
- Attach **100mm wheels** to **NEMA 17 motors**.

**Step 3: Connect the Electronics**

- **MPU6050** → Connect via **I2C (SDA, SCL)**.
- **A4988 Drivers** → Connect motors via **DIR & STEP pins**.
- **HC-05 Bluetooth** → Connect **TX/RX** for remote control.
- Use **12V battery for motors**, **5V for logic**.

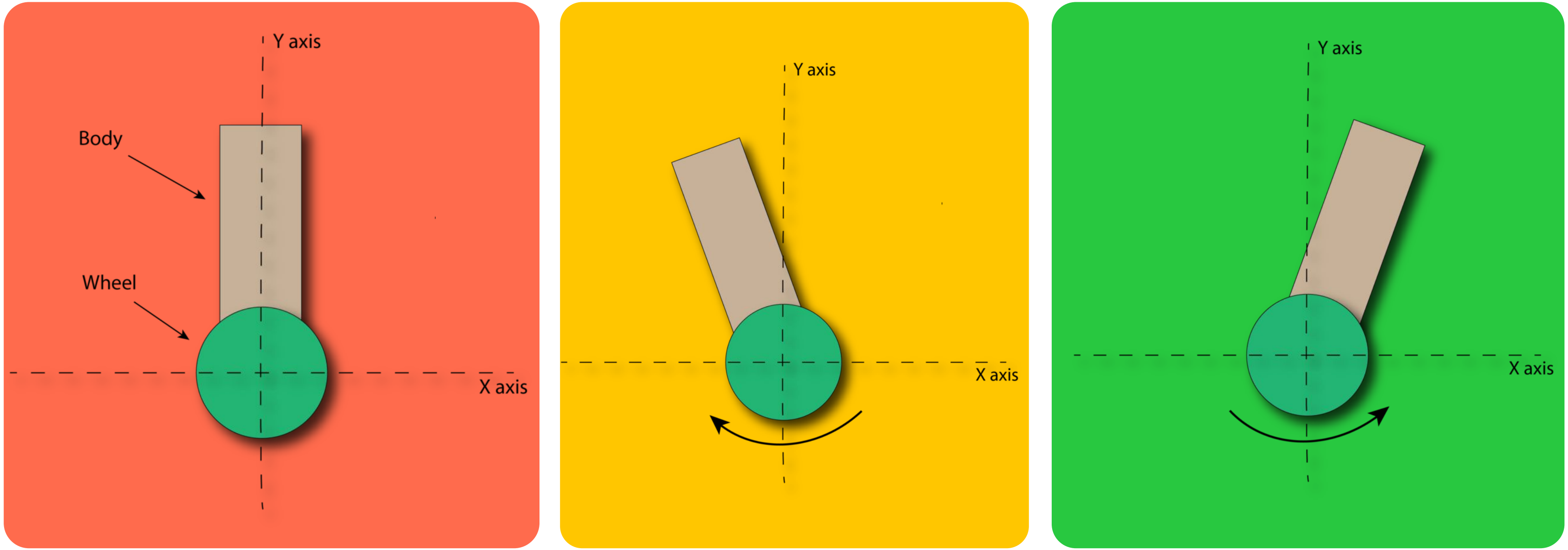
**Step 5: Upload Code to Arduino:**

- Install **MPU6050 & PID libraries** in **Arduino IDE**.
- Read **gyro data**, calculate **tilt angle**, adjust **motor speed via PID**.
- **Fine-tune PID** values for stability.

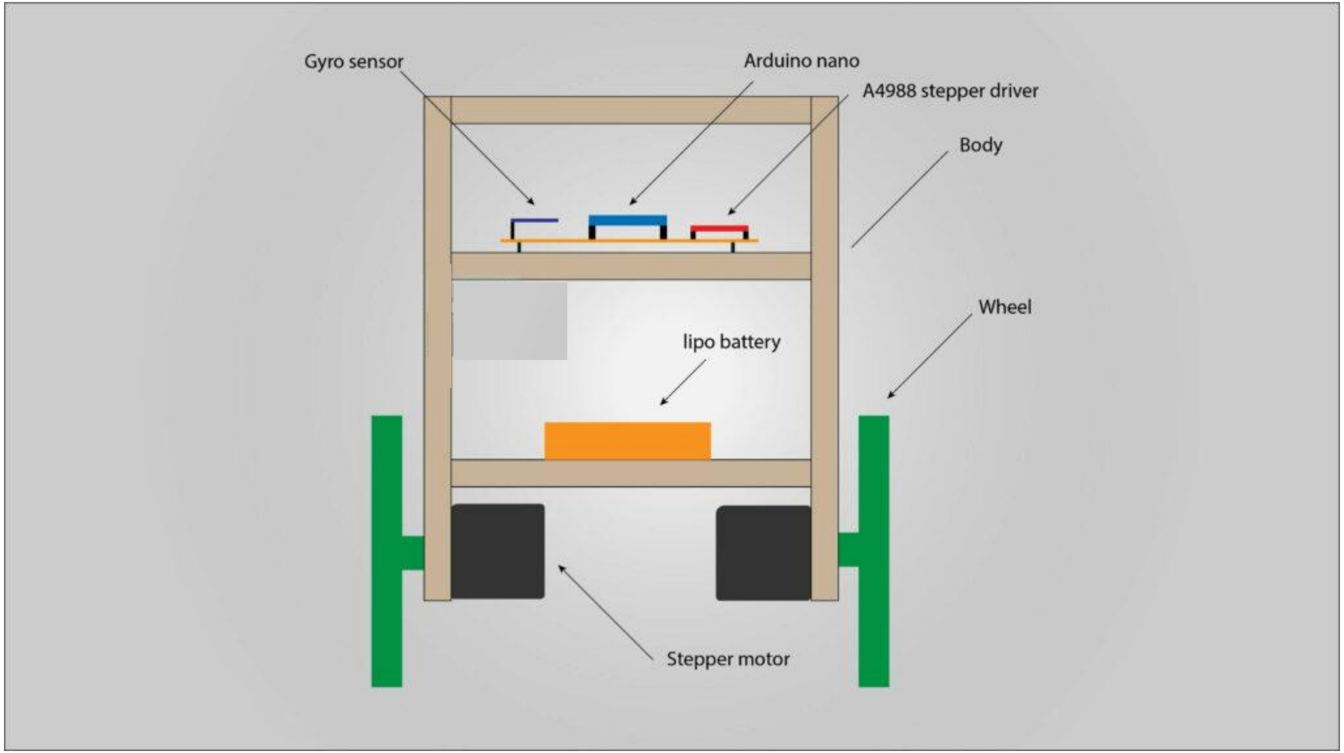
**Step 6: Testing & Optimization:**

- Place on **flat surface** and power on.
- Adjust **PID parameters** for better balance.
- Use **HC-05 for smartphone remote control**.

# Body



# Physical Structure



# Conclusion

In conclusion, our self-balancing line-following robot effectively combines dynamic balance and autonomous navigation, showcasing the capabilities of advanced robotic systems in intricate settings. This project lays a solid foundation for future advancements in areas like IoT integration, enhanced navigation, and obstacle avoidance, signaling exciting possibilities for the field of robotics.

Thank you for your attention.