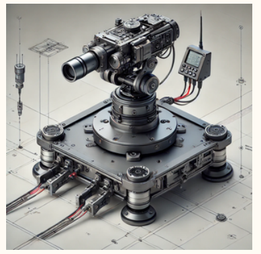
GYROAIM

Source- AI

INTRODUCTION



In modern defense and surveillance systems, precision and real-time control are critical for enhancing operational effectiveness. **This project, GyroAim: A Gyroscope-Driven Helmet with Gun/Turret Control System**, introduces an innovative solution that integrates advanced sensor technology with IoT connectivity to provide hands-free control of a mounted gun or turret.

The system consists of a gyroscope-equipped helmet that captures the head movements of the operator, translating these into real-time positional data. This data is transmitted wirelessly to a turret-mounted mechanism, where servo motors align the direction of the gun or laser pointer accordingly. The system offers intuitive control, increased responsiveness, and enhanced targeting accuracy.

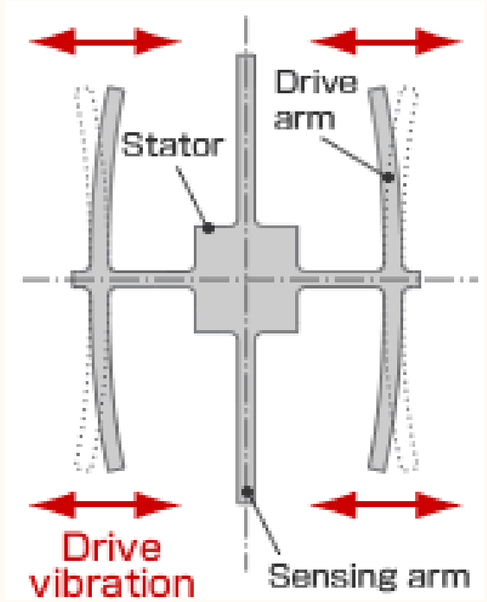
This innovative approach not only simplifies control mechanisms but also serves as a stepping stone for further advancements in automated and semi-automated targeting systems.

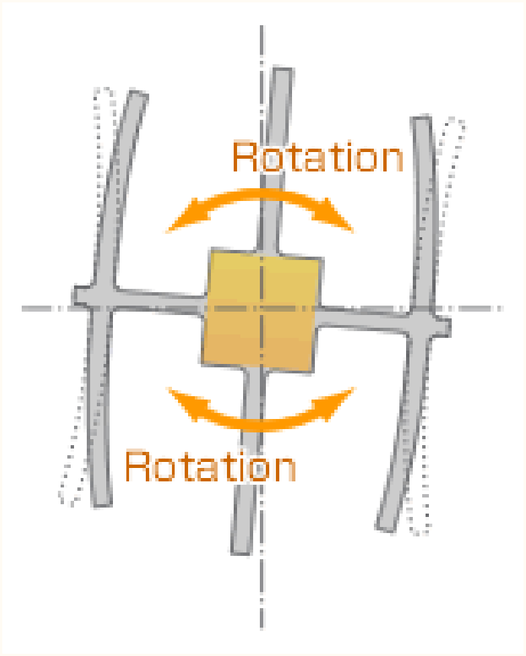
MATERIAL REQUIRED

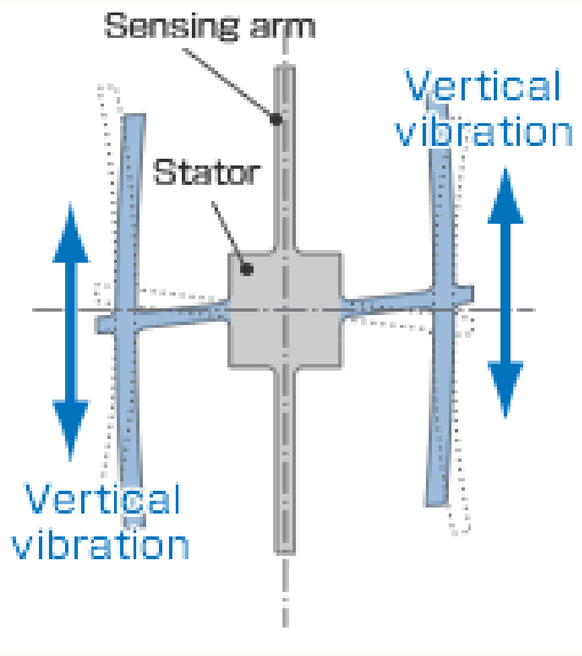
- Gyroscope and Accelerometer
- 2 Servo Motor
- Laser & Trigger button
- 2 ESP32 Microcontroller
- Turret design

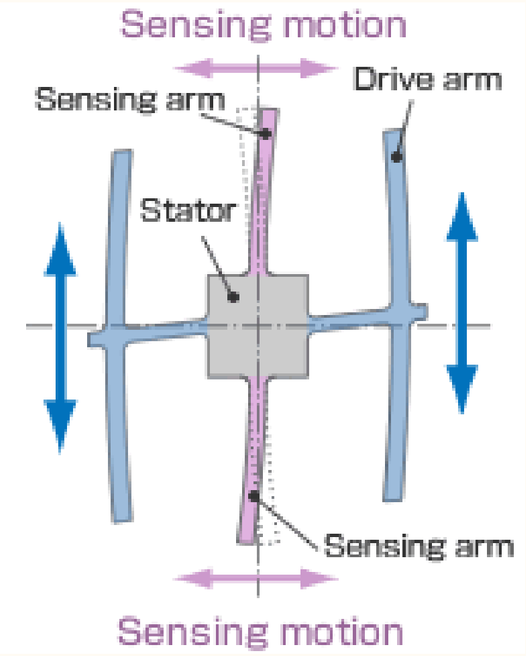
GYROSCOPE

- The gyroscope measures angular velocity, i.e., the rate of rotation around an axis.
- A vibrating structure inside the gyroscope experiences a shift when the device rotates. This shift, due to the Coriolis force, is proportional to the angular velocity.
- Measured in degrees per second, angular velocity is the change in the rotational angle of the object per unit of time.







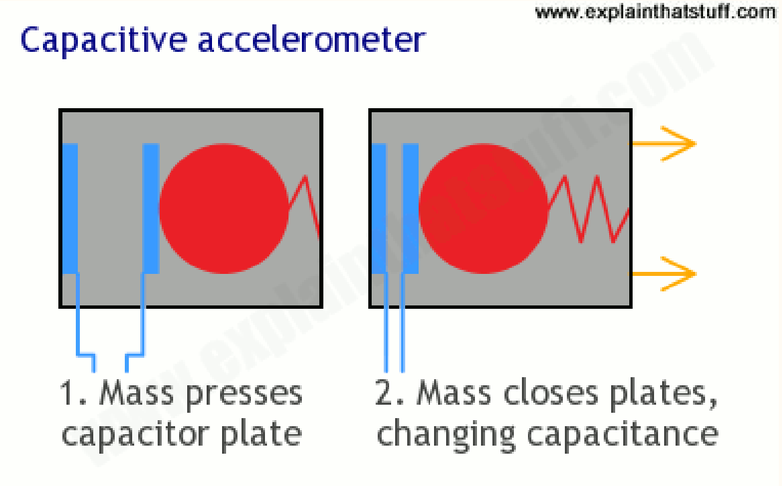


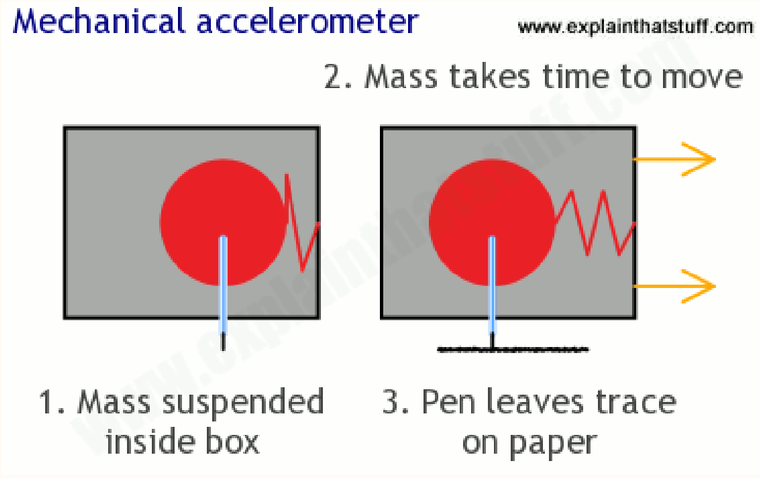
Normally, a drive arm vibrates in a certain direction

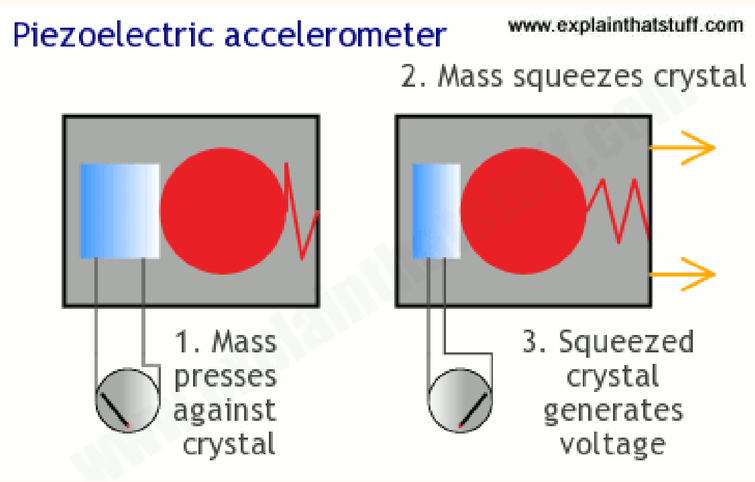
Souce-https://www.epsondevice.com/crystal/en/techinfo/column/sensor/gyro.html

ACCELEROMETER

An accelerometer sensor works by detecting acceleration through a small mass attached to a spring, where the displacement of the mass relative to the sensor housing, caused by acceleration, is measured and converted into an electrical signal proportional to the acceleration force.







Source-https://www.explainthatstuff.com/accelerometers.html

BLOCK DIAGRAM

Gyroscope& accelerometer

ESP32 (Microcontroller)

Trigger circuit

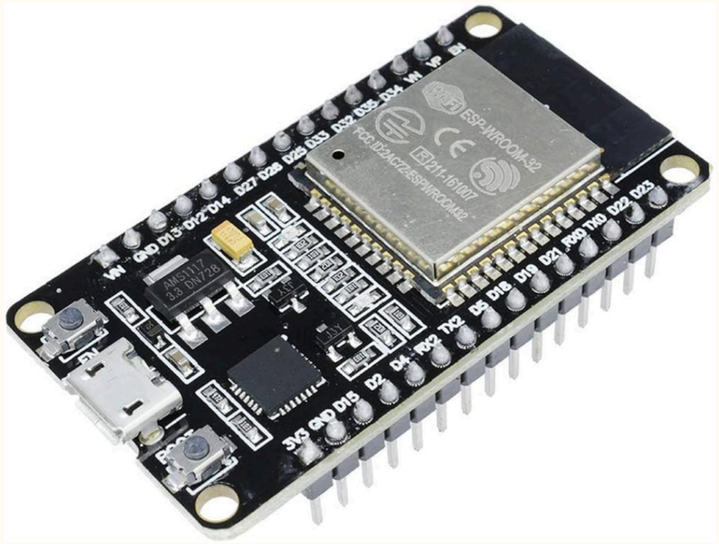
wifi_communication

Laser(mock gun) controller

ESP32 (Microcontroller)

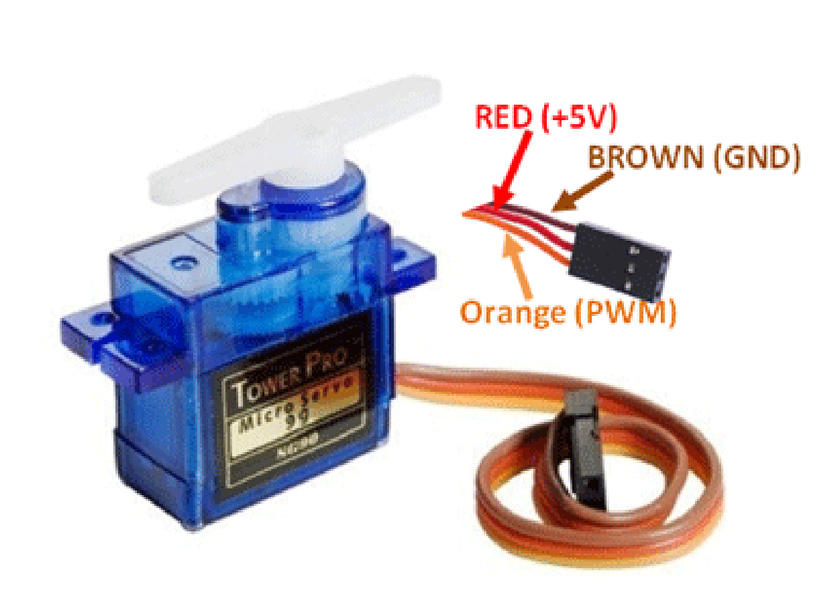
Turret servo controller

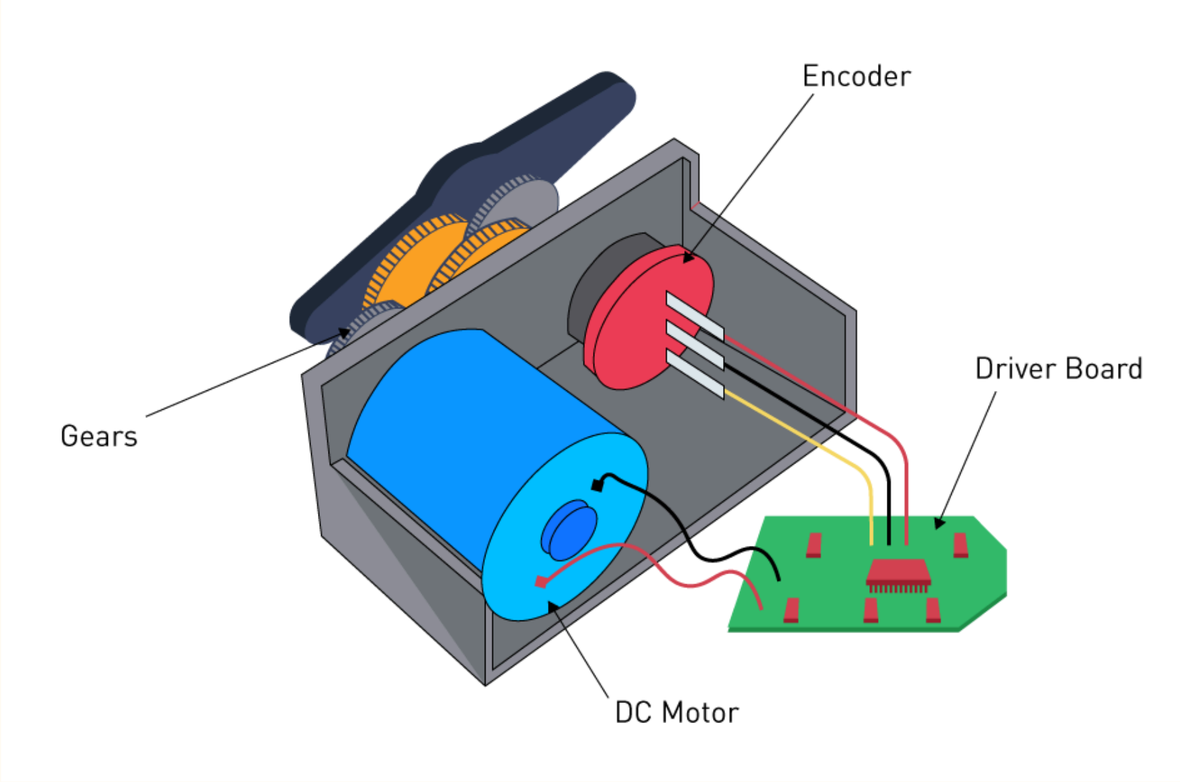
ESP32



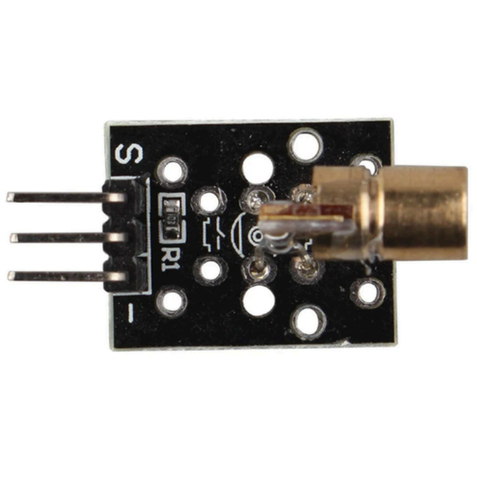

ESP32 DEV. BOARD PINOUT
EN
SensVP ADC1_0 GPIO36
SensVN ADC1_3 GPIO39
ADC1_6 GPIO34
ADC1_7 GPIO35
XTAL32 Touch9 ADC1_4 GPIO32
XTAL32 Touch8 ADC1_5 GPIO33
DAC1 ADC2_8 GPIO25
DAC2 ADC2_9 GPIO26
Touch7 ADC2_7 GPIO27
HSPI_CLK Touch6 ADC2_6 GPIO14
HSPI_MISO Touch5 ADC2_5 GPIO12
HSPI_MOSI Touch4 ADC2_4 GPIO13
GND
VIN
GPIO23 MOSI VSPI_MOSI
GPIO22 SCL
GPIO1 U0_TXD CLK3
GPIO3 U0_RXD CLK2
GPIO21 SDA
GPIO19 MISO VSPI_MISO
GPIO18 SCK VSPI_CLK
GPIO5 VSPI_CS
GPIO17 U2_TXD
GPIO16 U2_RXD
GPIO4 ADC2_0 Touch0
GPIO2 ADC2_2 Touch2 CS
GPIO15 ADC2_3 Touch3 HSPI_CS
GND
3.3V
ESP-WROOM-32
EN
BOOT
Power
GND
EN
GPIO
SPI
I2C
ADC
DAC
Touch
UART
Control
PWM

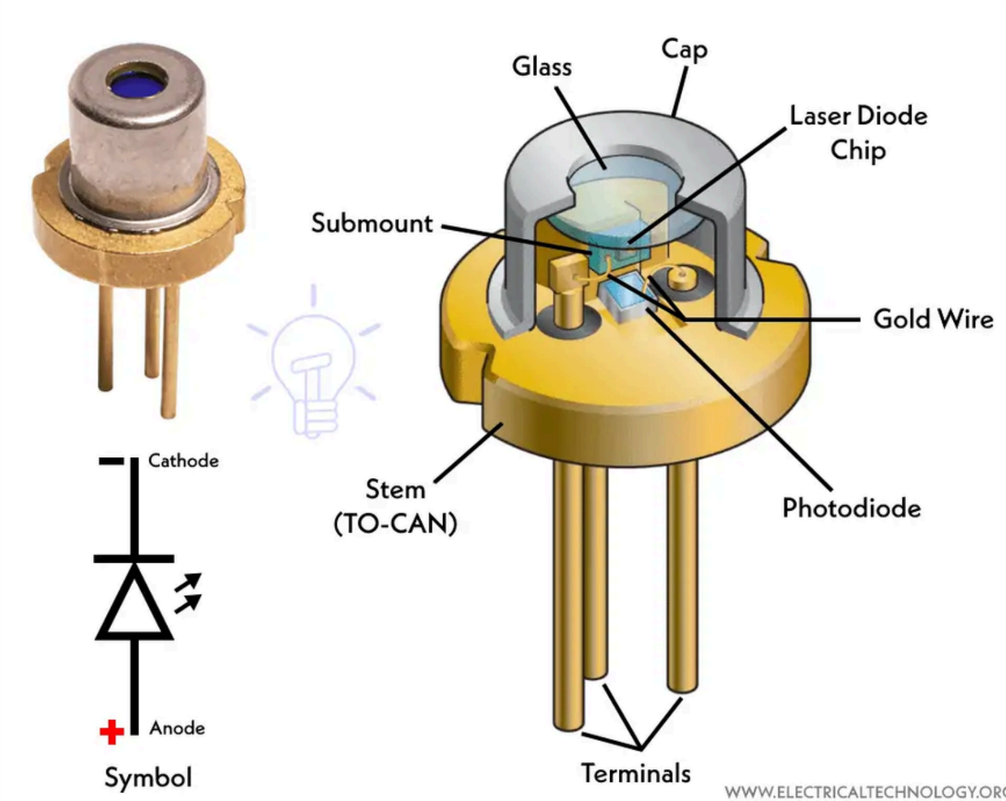
SERVO SG90


RED (+5V)
BROWN (GND)
Orange (PWM)
TOWER PRO
Micro Servo
9G

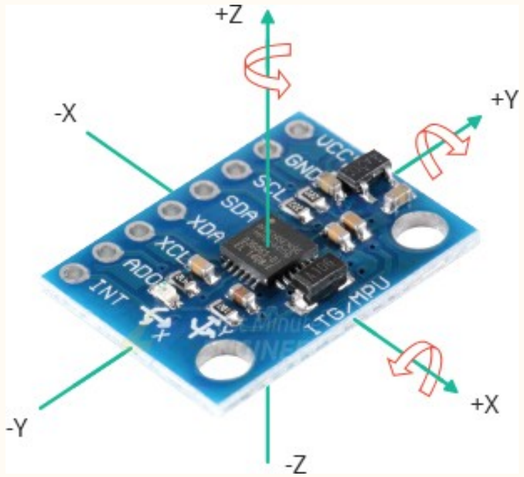

Encoder
Driver Board
Gears
DC Motor

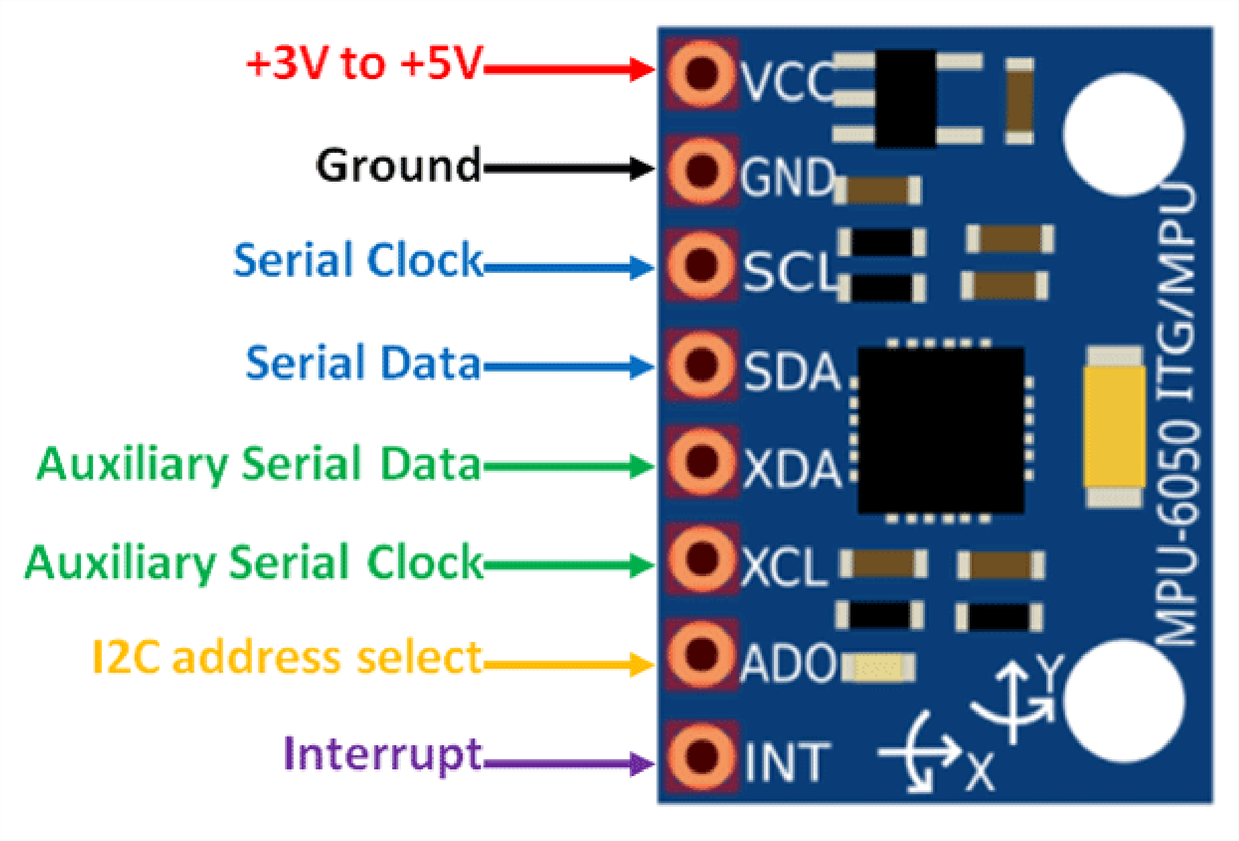
LASER DIODE


S
R1
-


Glass
Cap
Laser Diode Chip
Submount
Gold Wire
Stem (TO-CAN)
Photodiode
Terminals
Cathode
Anode
Symbol
WWW.ELECTRICALTECHNOLOGY.ORG

MPU 6050


+Z
-X
+Y
-Y
-Z
+X
VCC
GND
SCL
SDA
XDA
XCL
ADO
INT
ITG/MPU


+3V to +5V
Ground
Serial Clock
Serial Data
Auxiliary Serial Data
Auxiliary Serial Clock
I2C address select
Interrupt
VCC
GND
SCL
SDA
XDA
XCL
ADO
INT
MPU-6050 ITG/MPU
Y
X

PIN CONNECTION-HELMET

- **MPU6050 ↔ ESP32 NodeMCU**

MPU6050 Pin	ESP32 NodeMCU Pin	Description
VCC	3.3V	Power supply
GND	GND	Ground
SDA	GPIO 21	I2C Data Line
SCL	GPIO 22	I2C Clock Line

PIN CONNECTION-TURRET

🔧 ESP32 Pin Connection Table (2 Servos + 1 Laser Module)

Component	Pin	Connects To	Description
Servo 1	VCC	5V (VIN or Ext. 5V)	Power supply for Servo 1
	GND	GND	Ground (shared with ESP32 and other devices)
	Signal	**GPIO 12**	PWM control for Servo 1
Servo 2	VCC	5V (VIN or Ext. 5V)	Power supply for Servo 2
	GND	GND	Ground (shared)
	Signal	**GPIO 13**	PWM control for Servo 2
Laser Module	VCC	5V	Laser power supply
	GND	GND	Ground (shared with ESP32)

🔧 ALGORITHM

MPU6050 with ESP-NOW Transmission

1. Start the serial monitor and initialize I2C and MPU6050.
2. Set up ESP-NOW and add peer (receiver ESP32).
3. Calibrate the gyroscope to get X and Z axis bias.
4. Start the main loop:

- Read gyroscope values gx, gy, gz.
- Check for sensor freeze. If frozen for >2s, reinitialize MPU.
- Remove gyro bias, convert raw readings to degrees/sec.
- Integrate angular velocity over time to calculate angles (xAngle, zAngle).
- Constrain angles within valid range (0° to 180°).
- Create a data structure with angles.
- Send data via ESP-NOW to receiver ESP32.
- Delay for 50ms and repeat.

🔧 ALGORITHM

Servo & Laser Control Receiver (ESP32 B)

1. Start serial communication.
2. Set servo pins (GPIO 12 & 13) as PWM outputs.
3. (Optional) Set laser pin as output if controlled.
4. Set ESP32 to Wi-Fi Station Mode.
5. Initialize ESP-NOW and define receive callback function.
6. When data is received:

- Extract xAngle and zAngle.
- Map the angles to suitable servo duty cycles.
- Use ledcWrite() to move both servos to new angles.
- (Optional) Control the laser ON/OFF based on angle thresholds or conditions.

7. Continue listening and updating servo positions as new data comes in.

🔧GYRO DATA CONVERSION

- The MPU6050 sensor provides gyroscopic data in the form of raw values for angular velocity along the X, Y, and Z axes.
- These values represent the rate of rotation in LSB (Least Significant Bits) from the internal ADC of the sensor.

Angular Velocity (°/s) = Raw Data / Sensitivity

Corrected Rate = (Raw - Bias) / Sensitivity

Angle = Previous Angle + (Angular Velocity × Time Interval)

SERVO MOTOR CONTROL

- A servo motor is a rotary actuator that allows precise control of angular position.
- It operates based on a PWM (Pulse Width Modulation) signal.
- Typical servo motors rotate between 0° and 180° based on the PWM signal received.

- The pulse width (HIGH time) determines the angle:
  1 ms → 0°
  1.5 ms → 90°
  2 ms → 180°

- Pulse Width (μs)=1000+(180Angle)×1000

CONCLUSION

- Successfully designed and implemented a real-time motion-controlled servo system using MPU6050 and ESP-NOW.
- Achieved accurate angle tracking and wireless transmission of gyroscope data.
- Servo motors responded effectively to angular changes in real time.
- Demonstrated the use of IoT, Embedded Systems, and Wireless Communication in motion control applications.

Thank You