

## Robotic Legs Using Arduino UNO and MPU-6050

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### Abstract

Robotic legs are a crucial device for people suffering with different illnesses. Some of the diseases include MS (Multiple Sclerosis), paralysis, severe muscle weakness, or loss of balance. To address this issue we have come up with a prototype that would help make their life better. The system was developed using an Arduino UNO board as the Atmega 328 Controller board to interface all sensors and actuators. The core of our prototype is based on the concept of an exoskeleton. MPU-6050 sensors placed on the hands of the individual convert parameters like finger bend and hand position angle into inputs which are then processed by the Atmega 328 controller. The controller interprets these signals according to the tilts along 3 axes and converts them into angles using code for giving input to servo motors.

**Keywords:** Arduino Uno, Robotic Legs, Exoskeleton, MPU-6050.

### 1. Introduction

As the world uncovers different type of diseases, robotics comes forward with a helping hand in most of them. Mobility is a basic human right and is needed by every human to perform his/her tasks individually. Our project gives a prototype model to help increase the patient's mobility with the help of technology. The project's ideology is this: Take input from MPU-6050 → Convert it into angle → Give output to Arduino UNO → Arduino send input to servo motors → Servo motors move w.r.t the angle received. We used thin steel plates, nuts and bolts for the basic assembly of the prototype. Rubber pads were attached to the feet. Servo motors (SG90) model was used to allow movement in knees. MPU-6050 are used to measure tilts. The prototype only replicates the movement in knees as servo motors are only attached in knees. By limiting movement, the weight is reduced, code is simplified, cost remains low. The primary objective of this work is to develop a functional robotic leg prototype capable of controlled knee motion and to acquire practical experience in the integration of embedded systems, sensors, and

actuators. This project also establishes a foundation for future enhancements in intelligent prosthetic devices and advanced humanoid robotic systems. Servo motors help in movement of the legs by taking input from the MPU-6050. SG90 model was chosen because it had enough torque to move the legs and was cheaper. Also, the servo motors don't move beyond 180 degrees so it is easier for defining the limiting angles in the code to match it with the degree of freedom and maximum angle capacity of human knees. The MPU-6050 is a 6-axis motion sensor with 3-accelerometer and 3-gyroscopic system integrated in it. It detects and gives input of the motion to Arduino using I2C communication. The SDA and SCL pins are used for data transfer and using I2C clock pin.

#### 1.1. Algorithm

The algorithm consists of the following steps:

- Initialization of servo motors and the MPU6050 sensor and setting default positions.
- Reading the orientation and motion data from

the MPU6050.

- Generating PWM signals to control the angles of servo motors.
- Adding time delays for smooth motion.
- Testing and monitoring the movement of each knee joint.

## 2. Methodology

The prototype was made using readily available and cost-efficient materials to create an affordable learning model. The following are the materials used and the reason to select them[1]

- We used thin steel plates, nuts and bolts for the basic assembly of the prototype. This not only reduced[2] the weight of the project but also put enough pressure on the servo motors to function more smoothly.
- Rubber pads were attached to the feet for avoiding repair of steel because of wear and tear. The rubber also [3]helped absorb the vibrations from servo motors when they had reached the limit angle and stayed there. They also acted as a supporting feature up to somewhat extend to keep the exoskeleton from falling down.
- Servo motors- SG90 model was chosen at it was cheaper than other servos as well as provided great precision for controlling angles[4].
- MPU-6050 is also a cheap alternative of movement sensors in the market and is easily available. It has many uses but is prominently used to controlling movement[5] of motors in mobile robots. It detects the movement along al 3 axis and then calculates the angle by using the function predefined in the code.

The angle can be calculated using the formula:

$$\theta = k(T_{on} - T_{min})$$

where:

- $\theta$  = angular displacement of servo (degrees),
- $T_{on}$  = ON time of PWM signal (ms),
- $T_{min}$  = minimum pulse width (ms),
- $k$  = proportionality constant as shown in Figure 1 Values of angles detected by MPU-6050 by using serial monitor,

Figure 2 Graph plotted by MPU-6050 by using serial plotter[9].

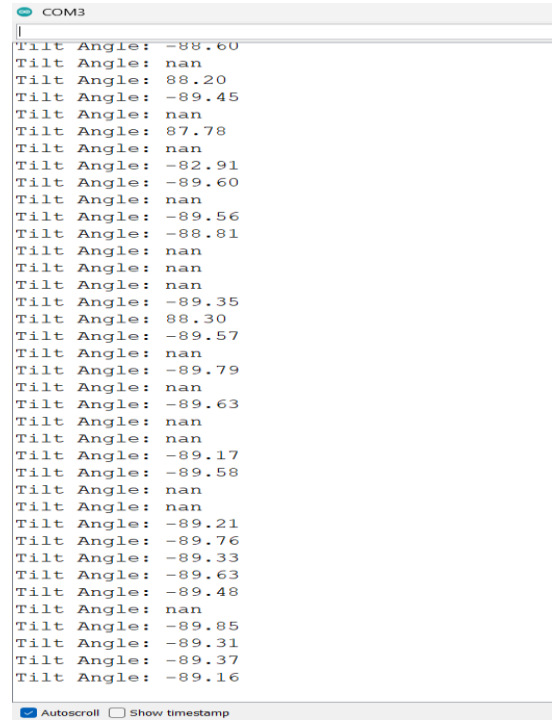
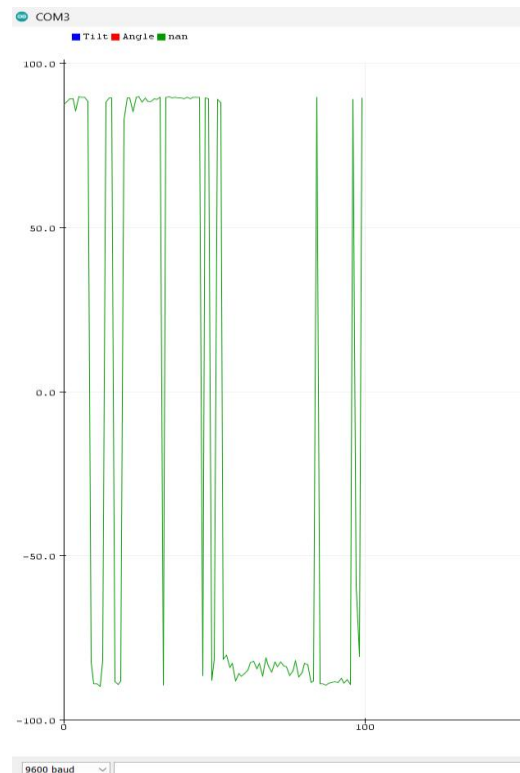


Figure 1 Values of angles detected by MPU-6050 by using serial monitor



## Figure 2 Graph plotted by MPU-6050 by using serial plotter

### 3. Results And Discussion

#### 3.1.Results

The overall result of the robotic leg prototype using Arduino UNO and MPU-6050 is rather exceptional. The servo motors work hand-in-hand with MPU-6050 to give smooth operation. The increase in delay timings helps in reducing[6] jerks and acts as a safety feature to help servo motors from getting destroyed because of constant push through and vibrations. The MPU-6050 is a great sensor for getting movement calculations but the delay makes overall walking algorithm very slow. This acts as a blessing in disguise for the patients[7].

#### 3.2.Discussion

A motor with higher torque would support the structure in a better way. Heavier material which is durable can be used in the actual model for making the exoskeleton steady. The backward angle of the knees could be increased for more flexibility. Servo motors can be added[8] at ankles to make movement better and also would increase the DOF of the robot. Heavier components increased torque requirements and reduced movement efficiency. Therefore, lightweight materials[10] and optimized mechanical design are recommended for future improvements in the prototype[11 – 20].

#### Conclusion

The prototype is able to perform gait movement as well as move freely however the user tilts the MPU-6050. The project highlights the growing importance of sensor-based robotics in solving real world problems and reducing human effort. If done on a bigger scale, the prototype could help disabled people walk on their own terms again instead of predefined gait movement in the exoskeleton available in the market.

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