**College of Engineering**

**Mechanical and Mechatronics Engineering Department**

**MECA 440- Microcontrollers for Mechatronics**

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**Final Project**

PID Light Tracker using Arduino

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# Project Description

The goal of this project is to build a robot capable of autonomously tracking a light source using PID (Proportional-Integral-Derivative) control with 2 degrees of freedom. The robot will be equipped with two servo motors that control its yaw and pitch movements, allowing it to adjust its orientation and track the light source accurately. The system will include components such as a robot chassis, servo motors, a light sensor, a microcontroller, and a power supply. The microcontroller will process the sensor readings, calculate the appropriate servo movements using the PID control algorithm, and generate the control signals for the servo motors. By implementing this project, you will create a robot that can track a light source with precision and learn about concepts such as PID control, sensor integration, and servo motor control.

This light-tracking robot project offers a practical application of PID control principles and robotics. The robot's ability to track a light source using servo motors and a light sensor showcases the integration of hardware and software components. Through the development process, you will gain insights into assembling the robot chassis, attaching servo motors, connecting the light sensor, and programming the microcontroller. Additionally, you will have the opportunity to calibrate and fine-tune the PID parameters to optimize the tracking performance. This project provides a hands-on learning experience in control systems, sensor integration, and robotics, enabling you to deepen your understanding of these concepts and explore further applications in the field of robotics and automation.

# Functional Specifications

1. **Chassis Design:**
   1. The robot chassis was designed to accommodate both servo motors, light sensor modules, and the microcontroller, along with the wire managing techniques.
   2. The material chosen for the design was 3d printed PLA( Polylactic acid) as it offers a lightweight yet sturdy build to allow for easy movement of the Servo Motors without putting too much load on the gears of the motors along with stable directing of the tilt tracking mechanism.
   3. The light sensor modules had to be physically on the surface of the mechanism to fine tune their sensitivity via the potentiometer knob on the module as well as not hindering the proper receiving of the signal from the light source.

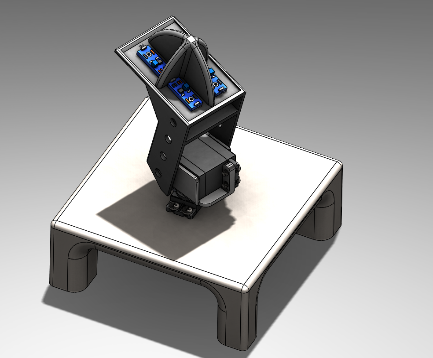


Figure 1: 3d Model of The Design

1. **Servo Motors:** 
   1. Two servo motors will be used for controlling the yaw and pitch movements of the robot.
   2. The servo motors had to ensure sufficient range of motion to cover a wide field of view for effective light source tracking. The motors must be responsive and precise in their movements.
   3. That’s why the choosing of 2 Mg995 Servo Motor which deliver higher torque values along with precise angle movements capable of the range of motion.
2. **LDR Sensor Modules**
   1. The light sensor will be responsible for detecting the intensity of the light source.
   2. The capability of providing accurate readings that correspond to the light intensity detected by the sensor was crucial. Thus, the choosing of LDR modules was a better option than normal LDR sensors as it offers the variability in the sensor’s sensitivity and allows for optimum calibration under any conditions.
3. **Microcontroller**
   1. The choice of microcontroller was dependent on easiness of control, programming, and applying fundamental PID control algorithms, therefore the choice of the Arduino Uno was a better choice than for example and Arduino nano which sometimes causes unexpected problems.
4. **PID Control Algorithm**
   1. The PID control algorithm was implemented to calculate the optimum angle movements for the servo motors based on the difference of the averages of the top and bottom sensors along with the right and left sensors. This ensured proper functionality and produced the most accurate readings from the sensors. Especially, that this system works on 2 Degrees of Freedom and any slight deviation or inaccuracies might cause the system respond differently then intended to.
   2. Fine-tuning parameters of PID( proportional , integral, derivative) gains was done to achieve smoothness and fluidity of the system’s functionality.
5. **Power Supply**
   1. An external power supply was used to provide stable and sufficient voltage for the Servo Motors, LDR modules, and the Arduino UNO microcontroller.
   2. The choice of an external power supply was important to ensure stable voltage is being delivered to the LDR’s and to eliminate any chance of disturbances due to technical restrictions.

# Block Diagram

**LDR module**

**LDR module**

**LDR module**

**LDR module**

**Arduino UNO**

**Mg995 Servo Motor**

**Mg995 Servo Motor**

**Power Supply**

# Flow Chart

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# Principle of Operation

# Schematic Diagram

# Bill of Quantity

# Results and Conclusion