

# HOW LIDAR WORKS



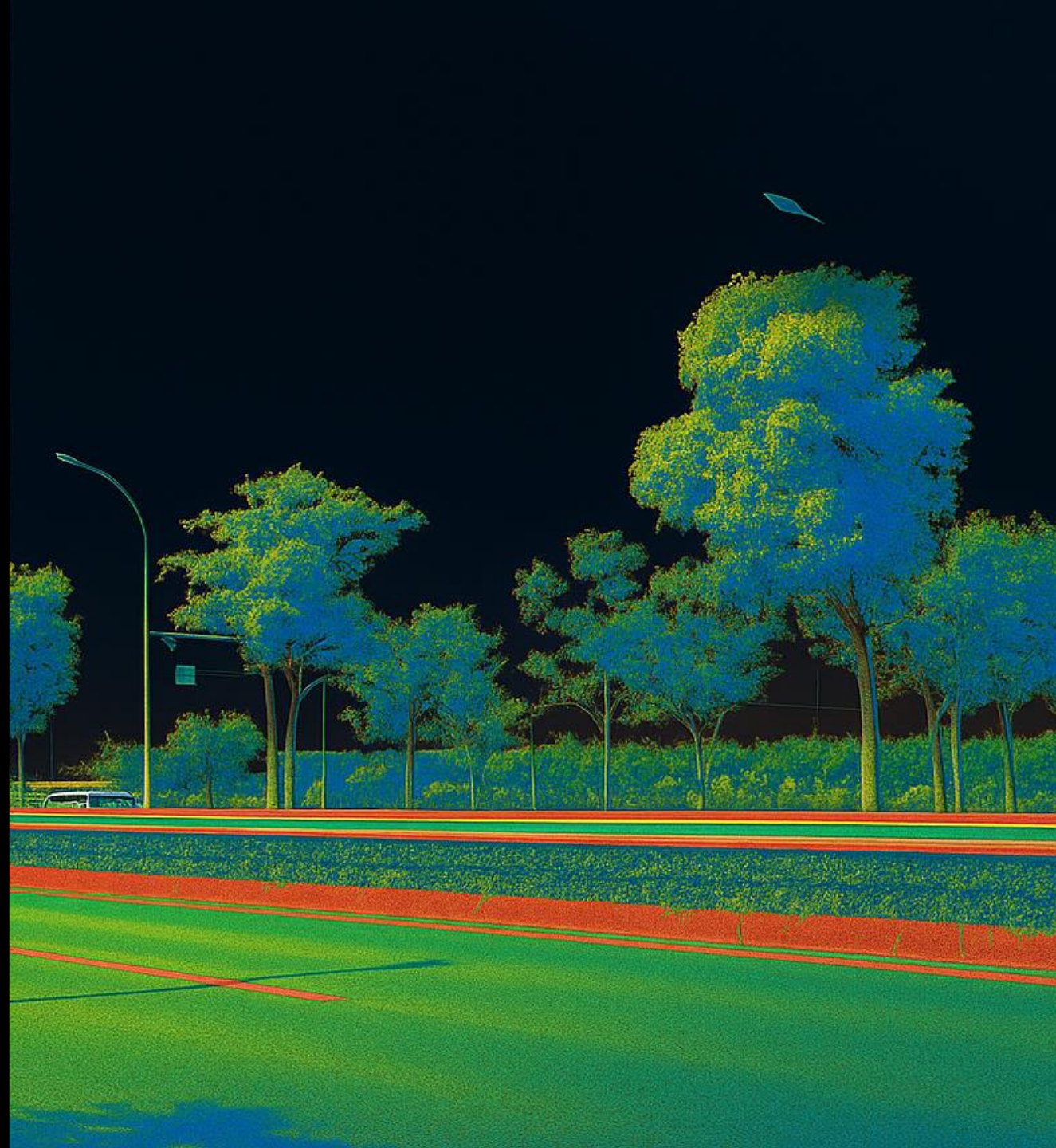


REAL  
WORLD  
LOOKS  
LIKE

CAMERA

REAL  
WORLD  
LOOKS  
LIKE

LIDAR



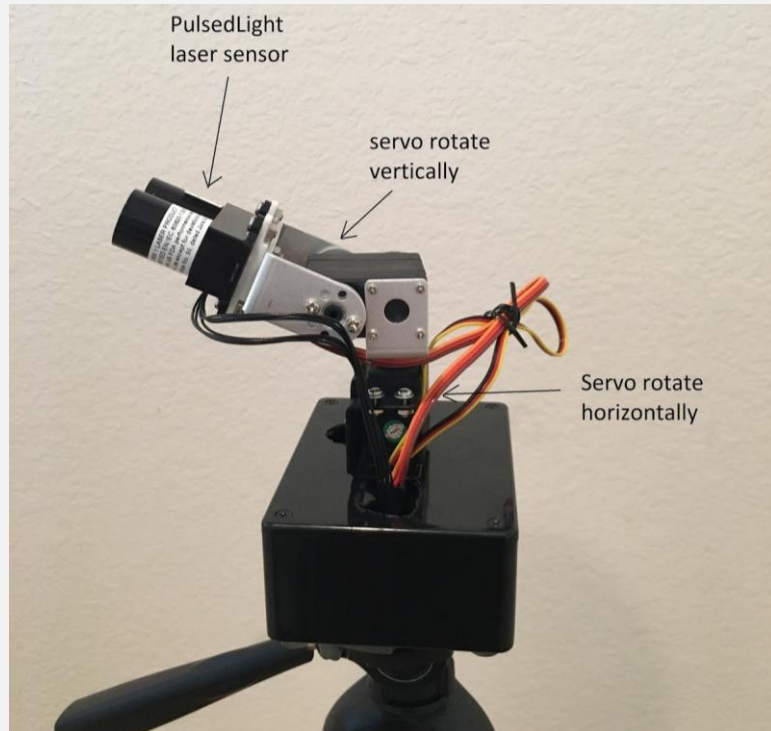


**1D LiDAR**

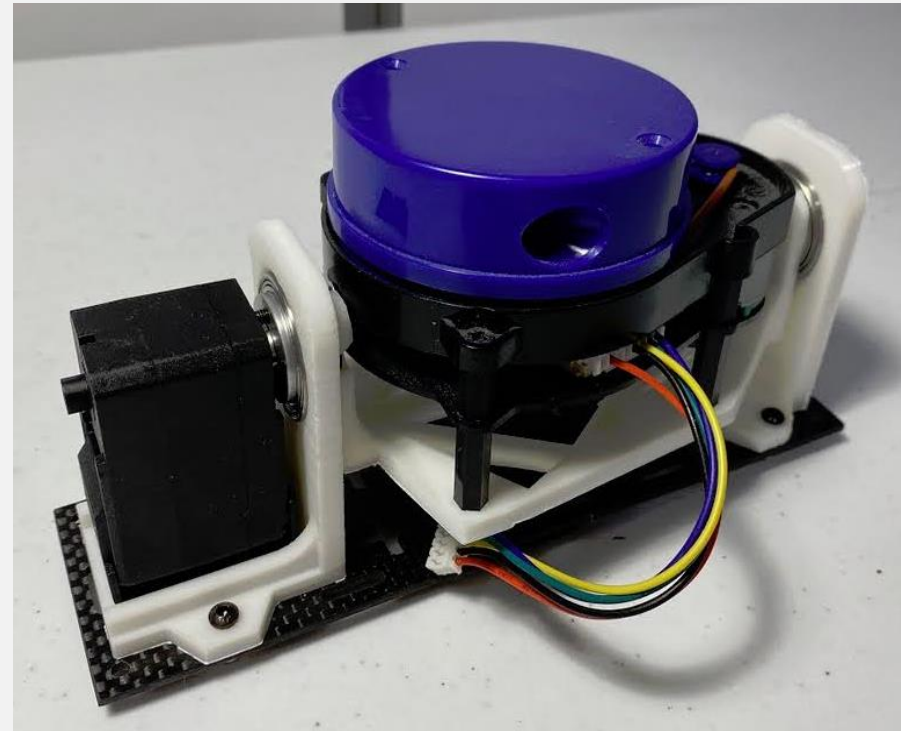
**2D LiDAR**

**3D LiDAR**

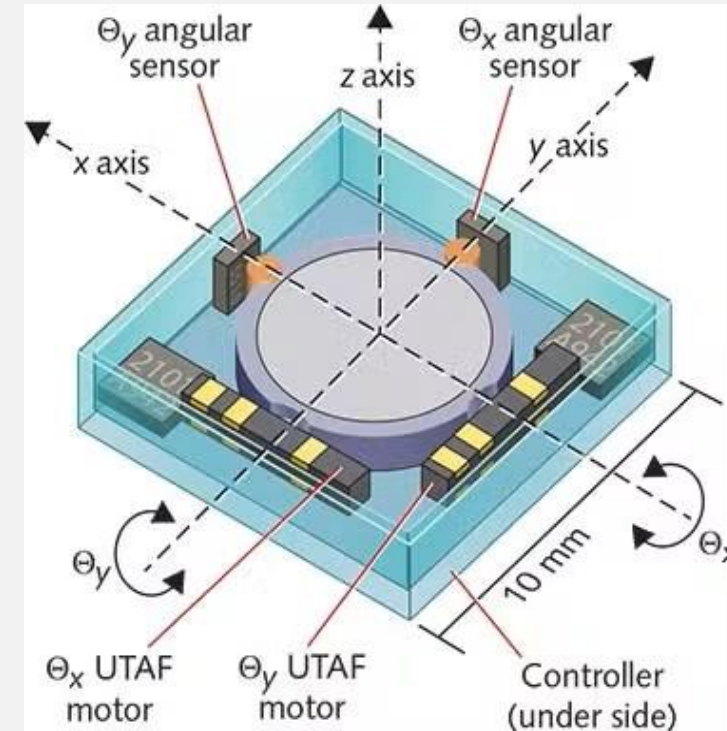
# 1D to 3D LiDAR Approaches



- 1D LiDAR + 2 Servo Motors

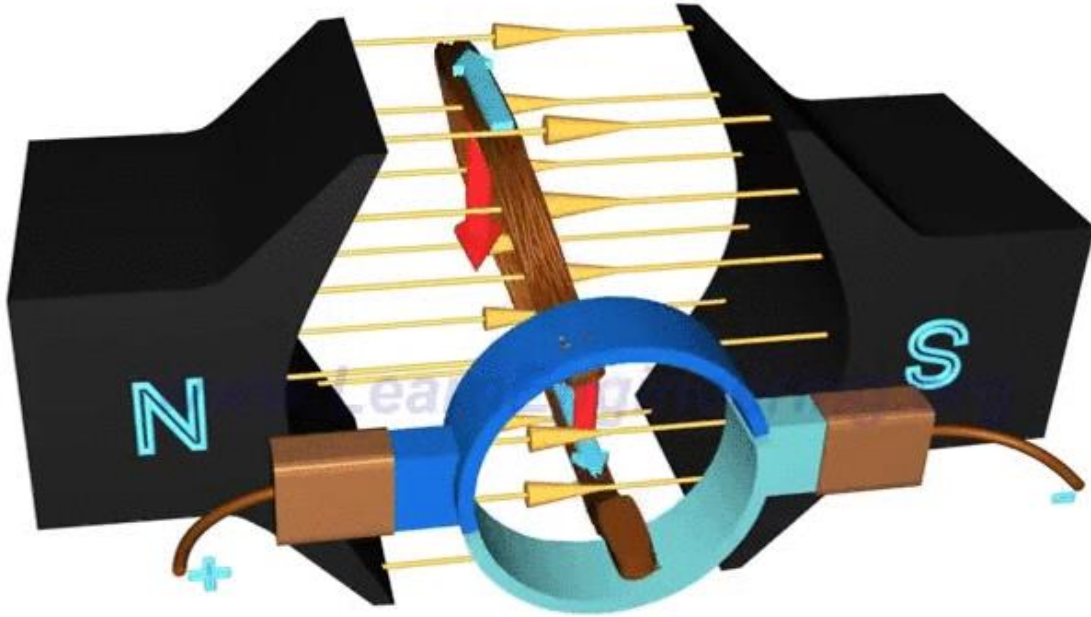


- 2D LiDAR + Servo Motor



- 1D LiDAR + MEMS Mirror

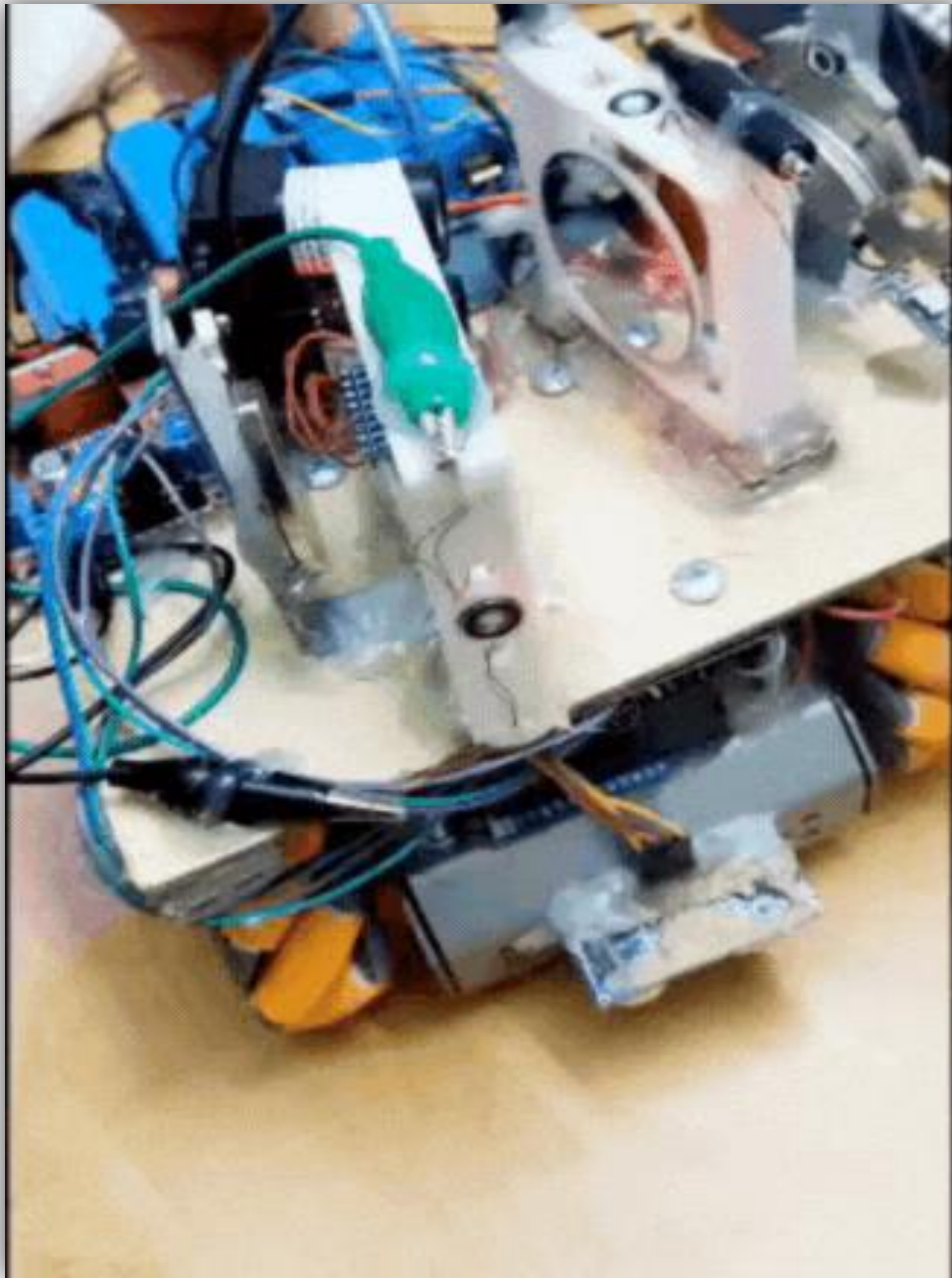
# The Spark of Inspiration



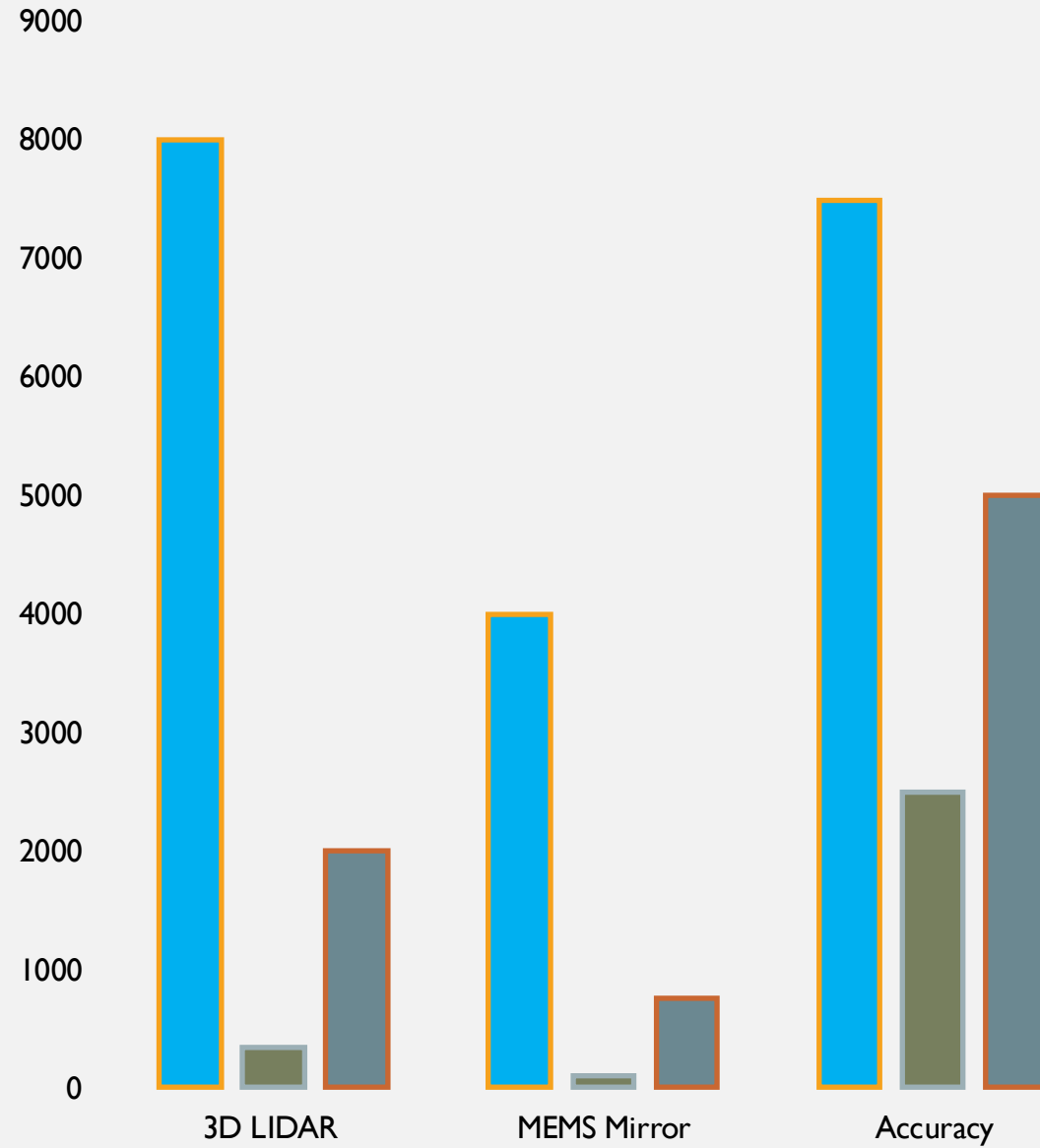
DC Motor Working Mechanism



MEMS Mirror Desing Inspired By the DC Motor



## Converted Lidar vs 3D Lidar



# Magnet Field Calculations

## Magnet Field Inside the Solenoid

$$B = \mu \cdot n \cdot I = \mu_0 \mu_r \cdot \frac{N}{L} \cdot I$$

- $B$ : Magnetic field in Tesla
- $\mu_0$ : Permeability of free space =  $4\pi \times 10^{-7}$
- $\mu_r$ : Relative permeability of the solenoid core (e.g., 500–6000 for iron)
- $N$ : Number of wire turns
- $L$ : Length of the solenoid (m)
- $I$ : Current through the wire (A)

## Magnet Force Between Solenoid and Magnet

$$F = \nabla(\vec{m} \cdot \vec{B})$$

- $\vec{m}$ : Magnetic dipole moment of the permanent magnet
- $\vec{B}$ : Field from the solenoid

## The Big Problem was The Heat Coming From the Cobber Wire !!

- Why **not increasing**  $N$  (number of wire turns) ??
- Why **not increasing** Current through the wire ??
- Why **not decreasing** the Length of the solenoid ??

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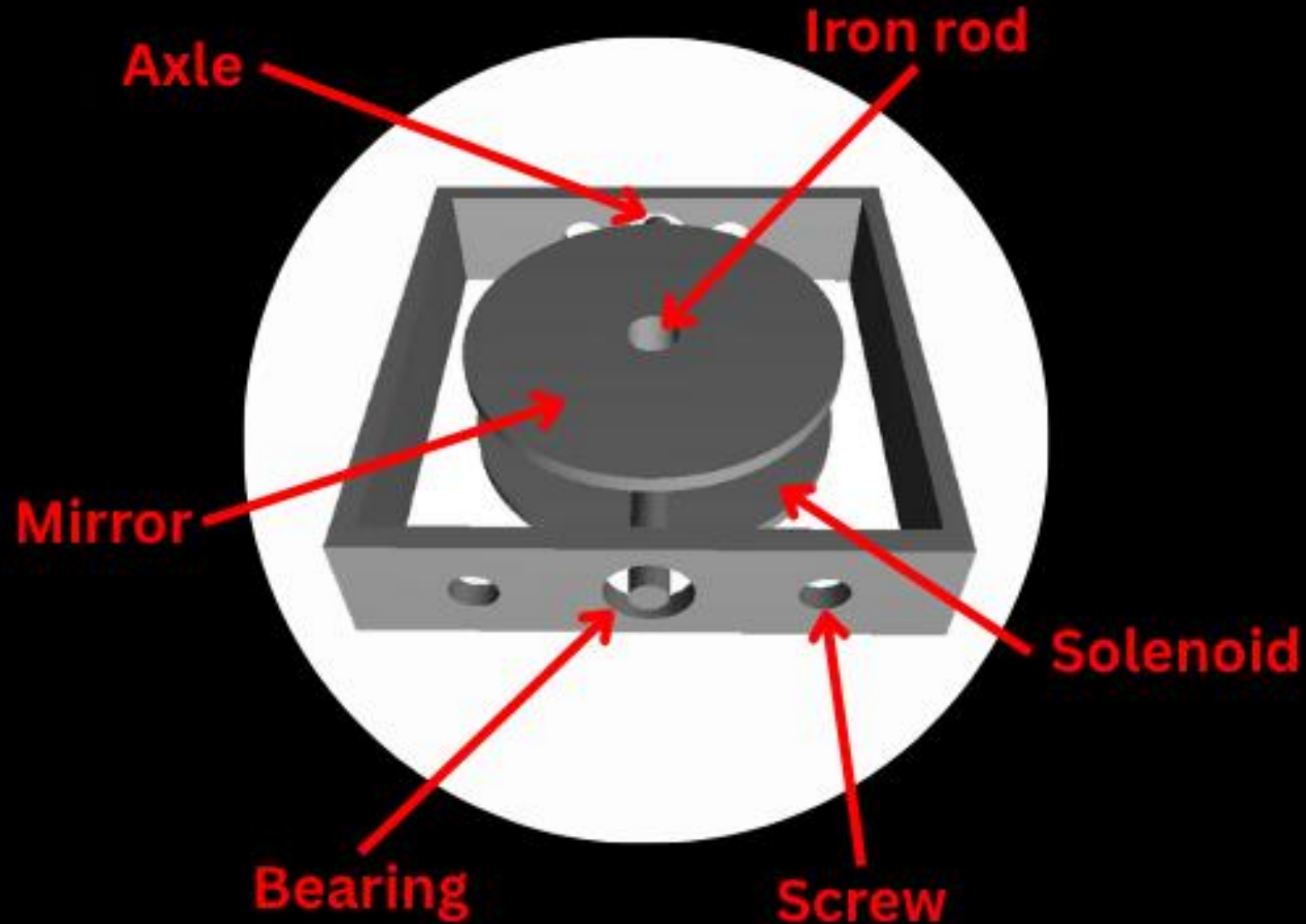
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$$R = \rho \cdot \frac{L}{A}$$

Where:

- $R$ : Resistance in ohms ( $\Omega$ )
- $\rho$ : Resistivity of the material ( $\Omega \cdot \text{m}$ )
  - For **copper**,  $\rho \approx 1.68 \times 10^{-8} \Omega \cdot \text{m}$
- $L$ : Length of the wire (in meters)
- $A$ : Cross-sectional area of the wire (in  $\text{m}^2$ )
  - For a round wire:  $A = \pi \cdot r^2 = \frac{\pi \cdot d^2}{4}$

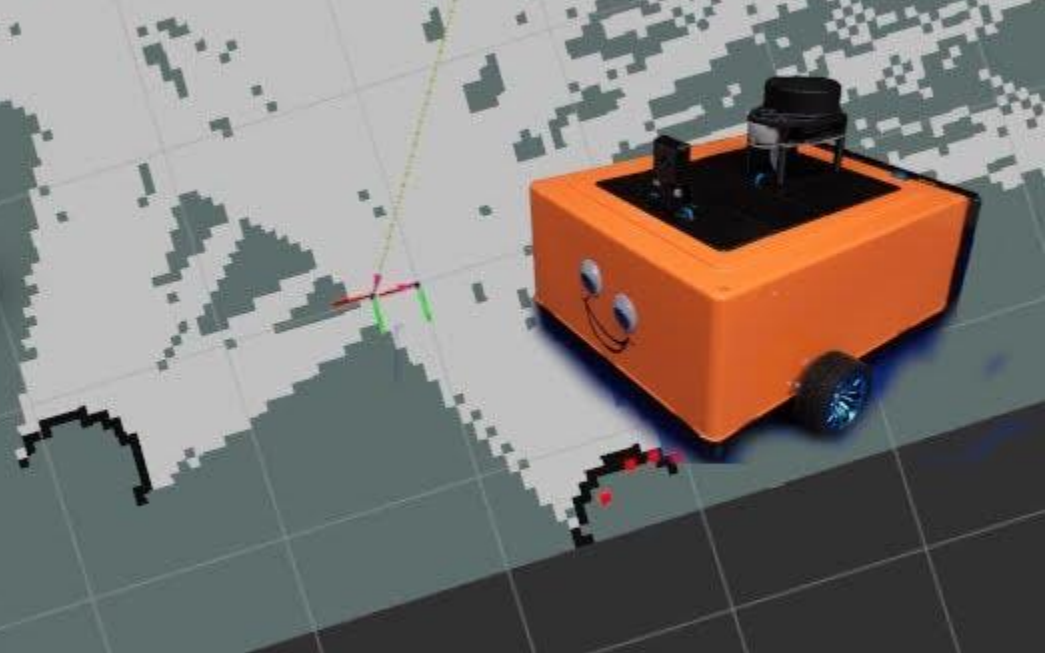
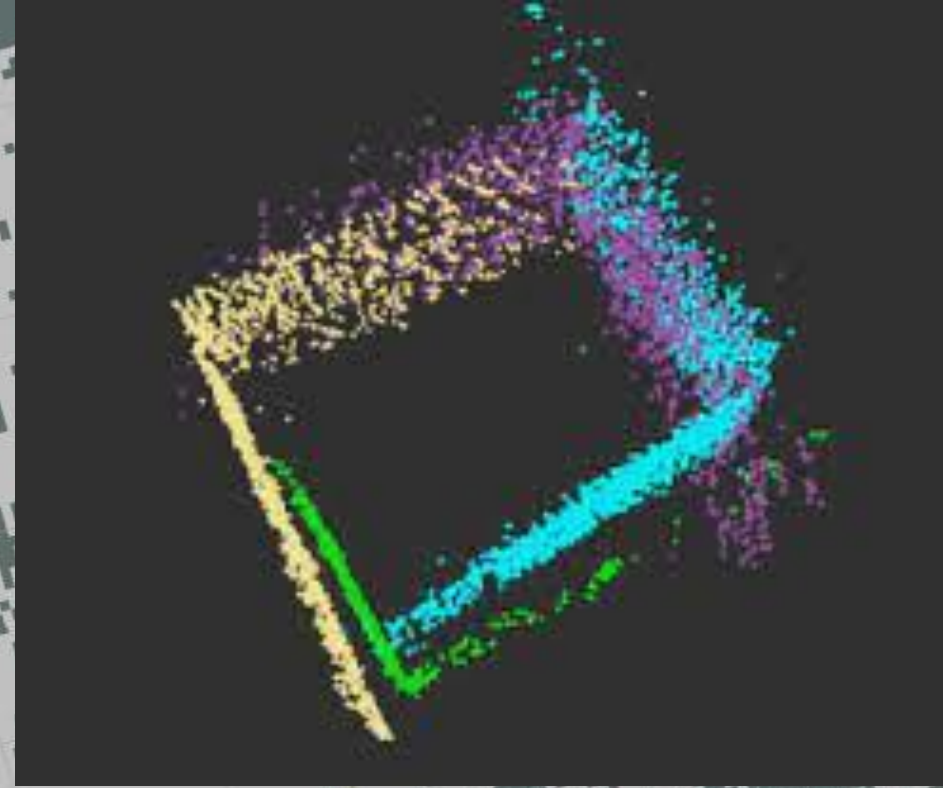
# MEMS Desing Components



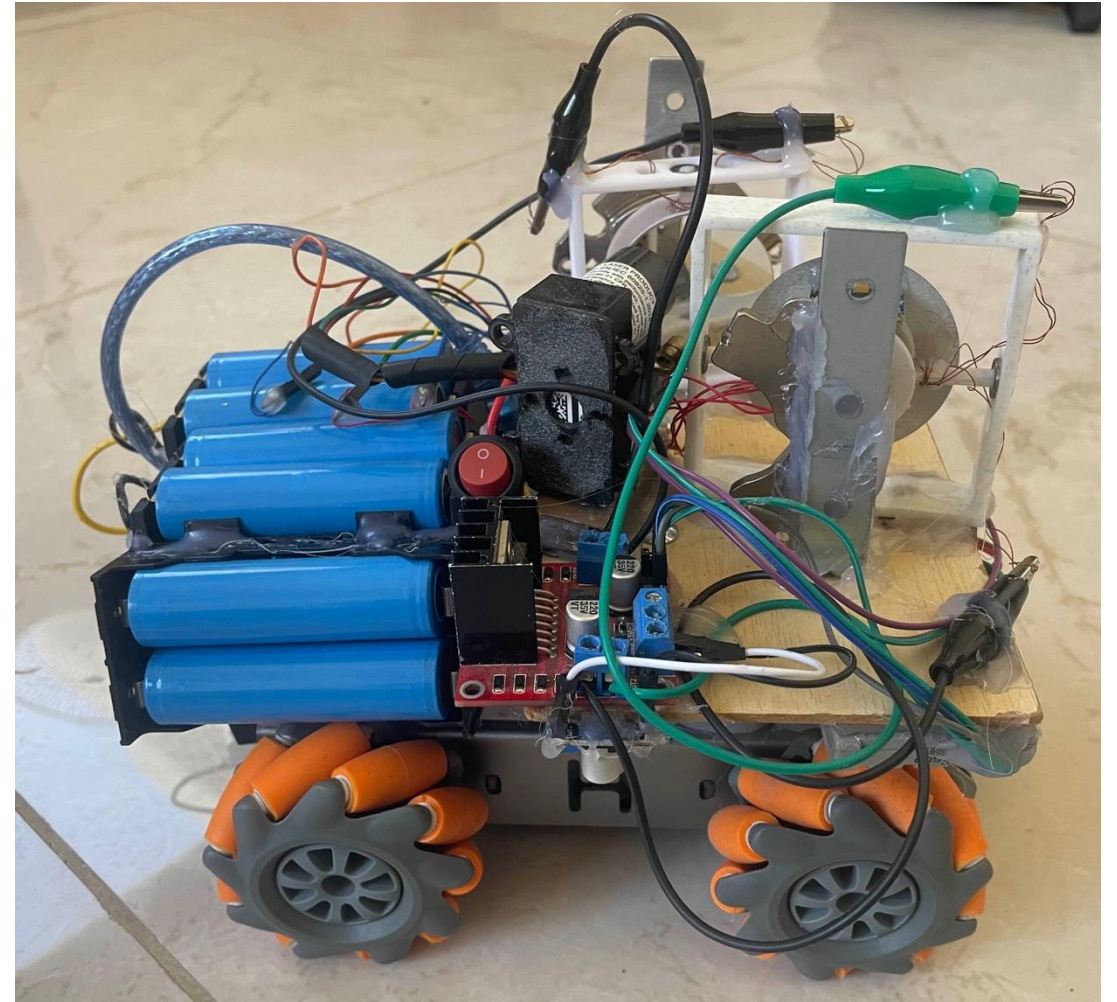
# SLAM

with

# slam\_toolbox



# *Robot Chassi Model*



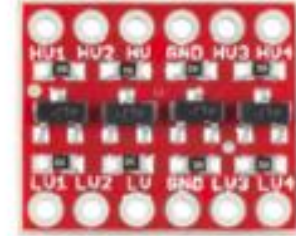
# Hardware Components



*ESP32-WROOM-32E*



*Arduino Mega 2560*



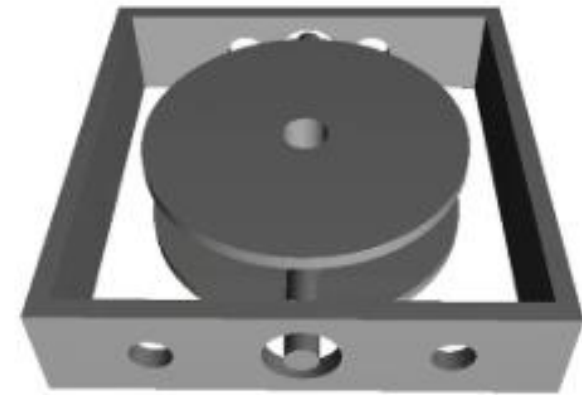
*Logic Level Converter*



*Garmin Lidar-Lite v3*



*Four Wheel Robot Chassis*



*MEMES Mirror Design*

# Hardware Components



MPU6050



Neodymium Magnet



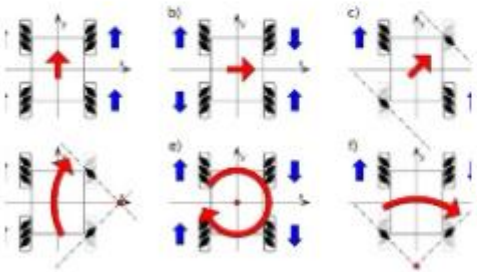
Boost converter



Ultrasonic



DC Motor for car



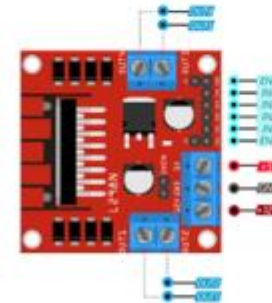
Mecanum Wheels Movement Direction



Mecanum Wheels



2-Channel Relay



H-Bridge L298n



Lithium Battery 3.7 Volt

## *Future Work*

- Replace the two separate mirror assemblies with a single 2-axis MEMS mirror that can tilt vertically and horizontally.
- Develop more precise mirror-control algorithms to reduce angle error and improve point-cloud accuracy.
- Optimize the SLAM pipeline parameters for faster map updates and lower drift.
- Implement real-time calibration of the mirror angles using feedback from the IMU.
- Test adaptive scanning patterns (e.g.\ denser scans in areas with more detail) to improve efficiency.
- Explore fusing camera images with the reflected LiDAR data to fill in gaps in the point cloud.
- Integrate GPS data to improve dead-reckoning accuracy and provide global positioning.
- Add a camera sensor and fuse its output in the SLAM pipeline to enhance map detail and localization.
- Evaluate performance in larger and more complex indoor/outdoor environments.
- Investigate lightweight on-board processing (e.g.\ running SLAM on a small SBC) to reduce latency.

*Thank You*