

Open Source LIDAR

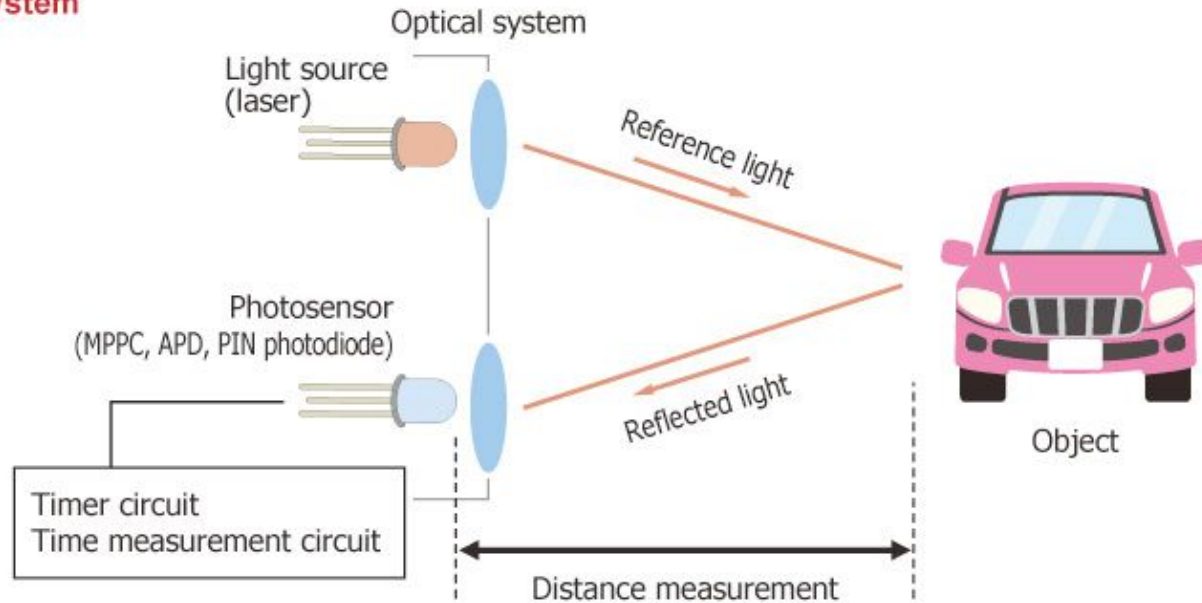


Light Seekers

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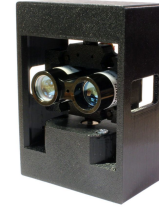
LIDAR Background

> TOF system



Evaluation of Alternative Solutions

Xaxxon's OpenLIDAR



OSLRF-01



TIDA-01187

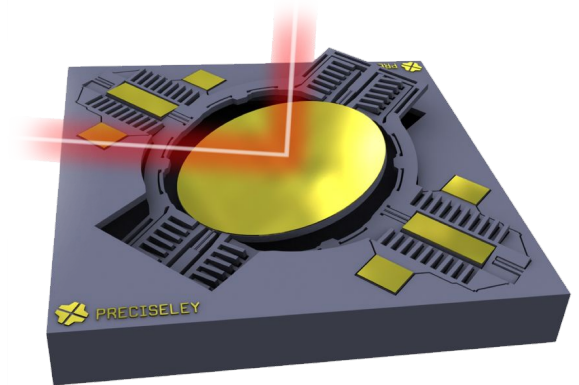


Open Source LIDAR Unruly

UNRULY

Problem Background

- Research group's MEMS mirror is difficult to use.
- Commercial product do not have non-uniform sampling rate
- MEMS mirror create low and high speed areas of sampling
- We need to copy this capability



Needs Statement

- Sample space in a non-uniform manner
- Help research group to create novel LIDAR



Goals And Objectives

Goal 1: Recreate a working Lidar system based on OpenTOFLidar

Goal 2: Develop a non-uniform sampling system

Goal 3: Create reconfigurable lidar system

Specific Design Needs

- Increased sampling range
- Increased sampling rate

Possible Solutions for Non-uniform Sampling:

Region of Interest(ROI):

1. Uses object detection algorithms to identify areas of interest
2. Scan at a higher rate for objects expected to be more important/complex

Exciting but beyond the time scope of project.

Subsampling:

1. Scan the area once to identify general clusters
2. Scan a second time with more dynamic rates for the specific elements in the clusters themselves.

This method is simple but requires two scans to complete.

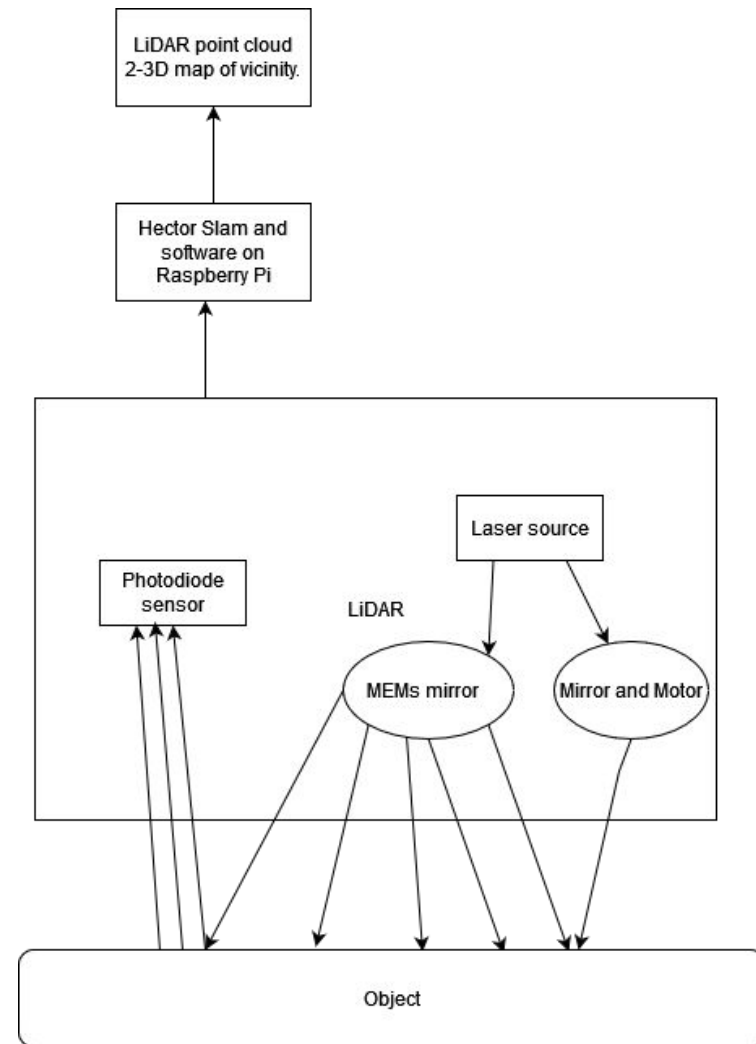
System Design

- Lidar

- Laser source
- Spinning mirror
- Photodiode sensor
- Electronic and optical components mounted on custom PCB board

- Post Processing

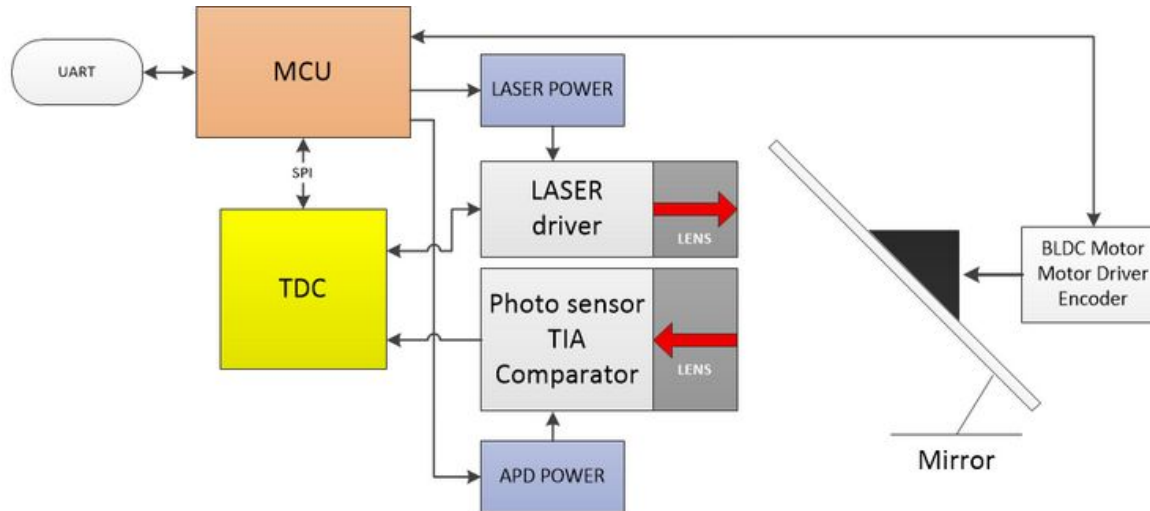
- Hector SLAM/ROS to read and process lidar data
- Generate 2d/3d point cloud



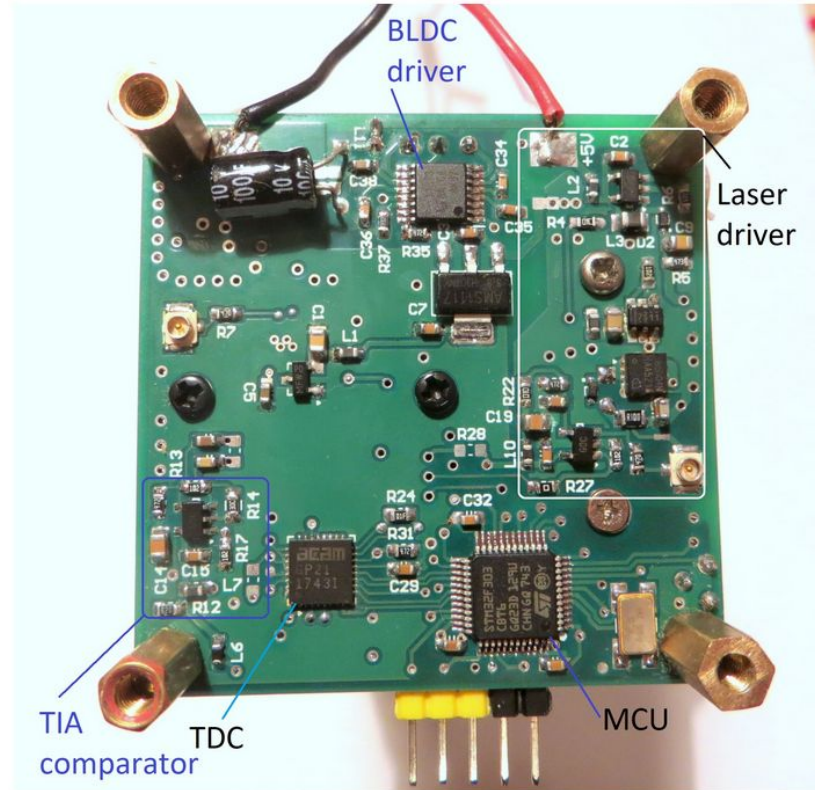
Low Level Block Diagram

Author configures MCU to run through the IAR Embedded Workbench.

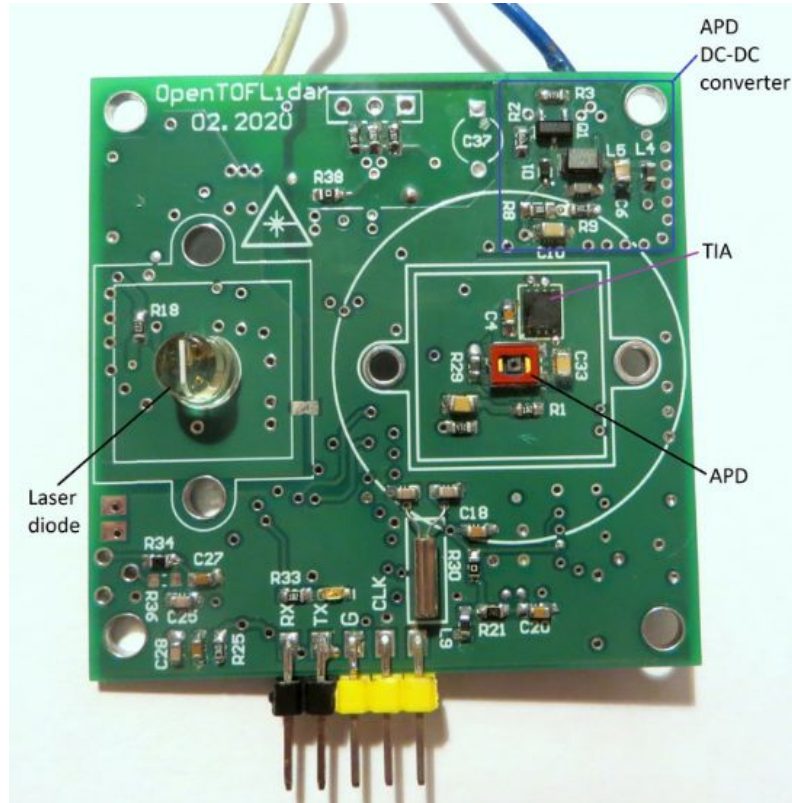
We will flash the firmware on the MCU through Keil uVision.



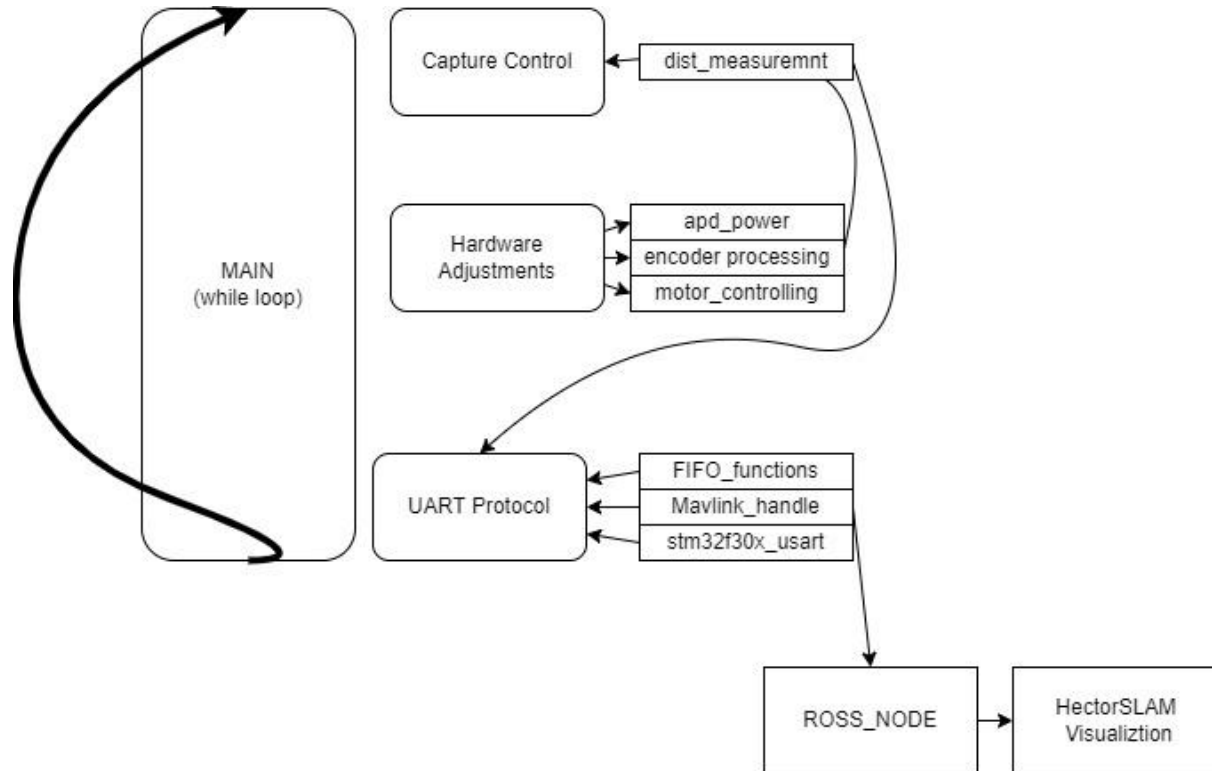
PCB Design Flow (Top)



PCB Design Flow (Bottom)



Firmware



Firmware - Main.C

```
while (1)
{
    if (TIMER_ELAPSED(timer_1ms))
    {
        START_TIMER(timer_1ms, 1);
        capture_ctr_data_processing();
        uart_driver_process();
        mavlink_long_packet_sending_process();
    }

    if (TIMER_ELAPSED(timer_10ms))
    {
        START_TIMER(timer_10ms, 10);

        apd_power_voltage_controlling();
        encoder_proc_perodic_handling();
    }

    if (TIMER_ELAPSED(timer_100ms))
    {
        START_TIMER(timer_100ms, 100);
        LED_GPIO->ODR^= LED_PIN;

        hardware_set_laser_voltage(current_laser_volt);
        hardware_set_apd_comp_voltage(apd_comp_threshold_mv);
        motor_ctrl_handling();
        dist_measurement_handler();
    }
}
```

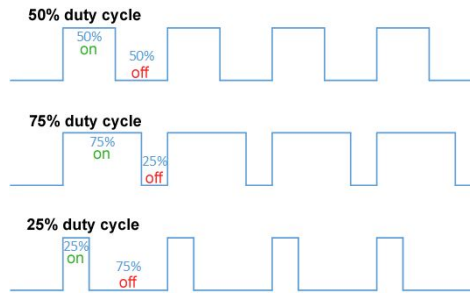
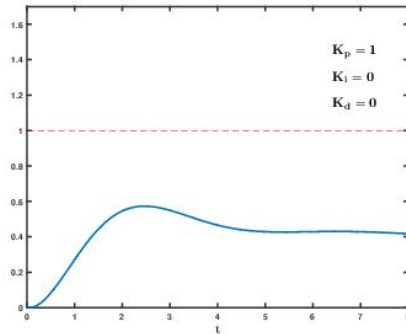
- Processes Data
- Sends Data through mavlink protocol
- Adjust Voltage based on light intensity
- Adjust Encoder if tick is out of range
- Flashes LED
- Sets Laser and Photodiode voltage
- Time of Flight
- Handle Motor Speeds

Firmware - Capture Controlling & Distance

- Captures the rotation of the encoder
- Initializes some timers for the encoder
- Keep track of the encoder periods and cycles, captures timer and encoder interrupt
- Periodically called to capture data from the lidar

Firmware - Encoder & Motor

- Code from the Spec Sheet
- Simple Cycles for getting data from the encoder and setting PWM cycles for the motor controlling
- P loop for feedback from Encoder to control Motor

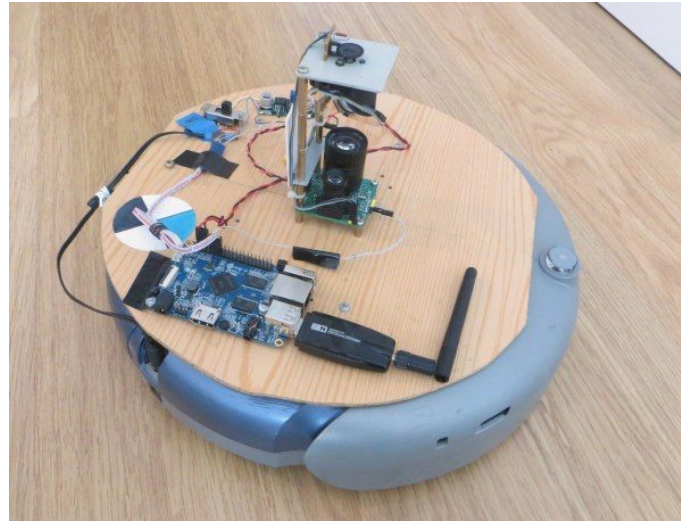


Design Testing & Validation

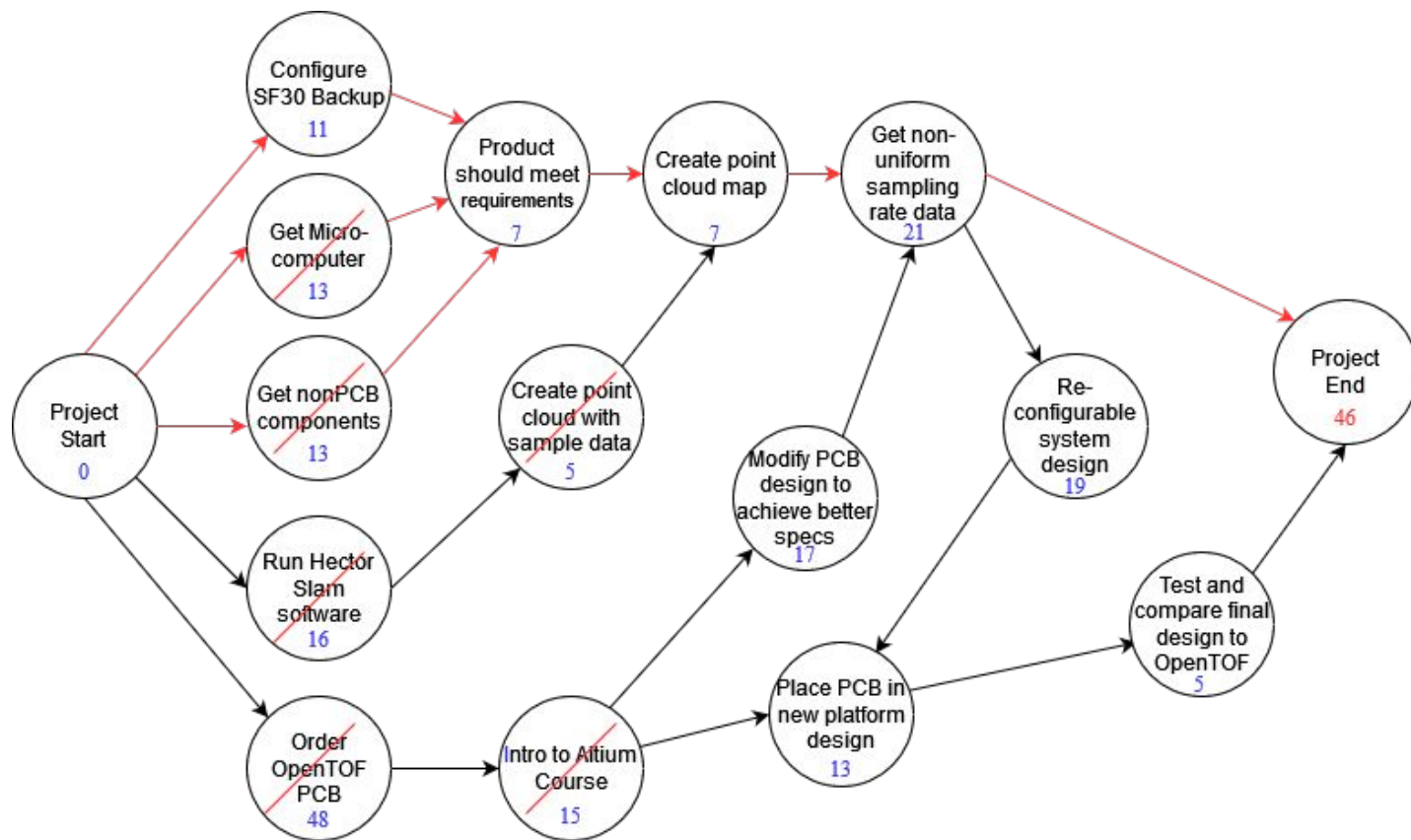
- Test SF30C Lightware Lidar system against OpenTOF specs.
 - Validate our model to Physical Distances
 - Validate final design against Reference OpenTOF System
 - Validate our Model's parameters to benchmark
 - Scanning speed: 15 scans/second
 - Resolution: ~ 1% of distance, but not better than ± 2 cm
 - Minimal distance: 5 cm
 - Maximal distance: ~25 m (white surface)
 - Angular resolution: 0.5 deg
 - Measurements frequency: ~11 kHz
 - Scanning angular range: ~230 deg, could be increased by changing mechanics
 - Power: 0.1 A at 5V (0.5 W). Start current could be bigger than 0.8 A.
 - Size: 50x50x120 mm

Demonstration plan

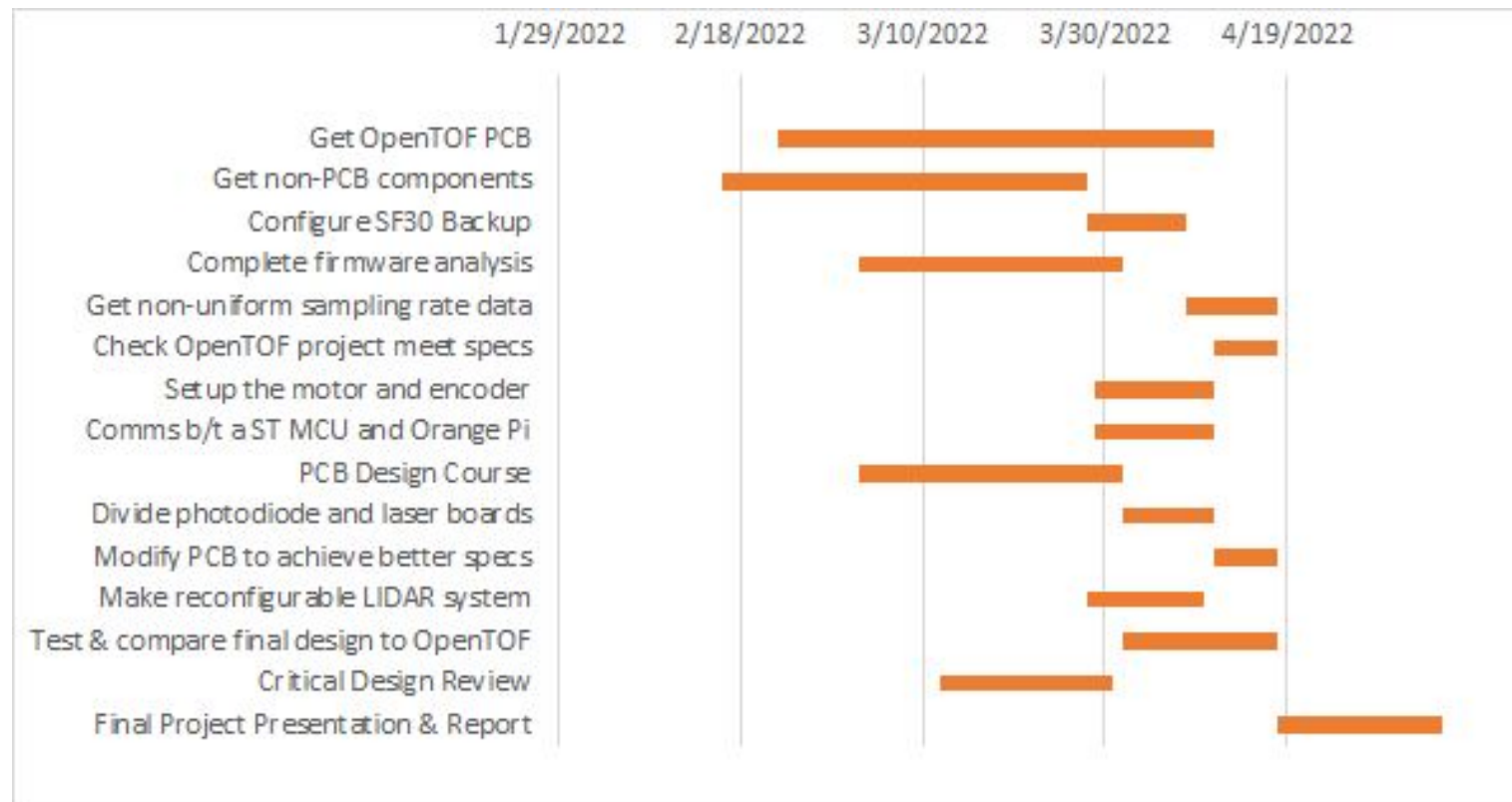
- 1) Wear laser safety glasses.
- 2) Screen record laptop when code is flashed.
- 3) Also video record motorized spinning mirror.



Schedule of Tasks



Schedule of Tasks



Project Management and Teamwork

- Two sub-teams
- Weekly meetings and occasional in-person meetings
- Key meeting notes and weekly meeting reports
- Github

Societal, Safety and Environmental Analysis

- Emerging applications in industry
- Potential harm of LiDAR laser
- Environmental issues with PCB manufacturing

Social, Political, Ethical Concerns

- Used for self-driving cars too early.



Manufacturability, Sustainability, and Economics

- PCB had a MOQ of 5.
- 27 days to ship all PCB components.
- Correspondence with Engineer.
- PCB uses some lead.

