ILR 06 – Progress Review 7

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TEAM DAEDALUS

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1. Individual Progress

I undertook the following tasks:

1. Trade study for proximity sensors
2. Redesign of proximity detection PCB board

1. Trade study for Proximity Sensors

The results from the Fall Validation Experiment lead us to the conclusion that developing a proximity detection subsystem for objects less than 0.5 m away from the platform with Infra-Red (IR) sensors was not a robust solution. As a result, I decided to conduct a trade study of proximity sensors that could possibly be integrated with the platform. The results of the trade study are depicted in Table 1.

Parameter	Weight Factor (%)	SHARP IR Sensor* GP2Y0A21YK	Lidar Lite V2*	Parallax- Laser Range Finder*
Accuracy	20	2	5	4
Robustness	25	2	5	4
Availability	40	5	1	4
Cost	10	4	2	2
Range	5	3	5	4
Total**	100	3.45	3.1	3.8

**scoring is done out of 5*

***The total is calculated as a weighted sum of the scoring*

Table 1- Trade study for proximity sensors

Hence, the team has decided to go ahead with testing the Laser Range Finder (LRF) module from Parallax. The sensor comes with an integrated CMOS camera and a laser system. It has a built in processor which calculates the range by optical triangulation using simple trigonometry between the centroid of laser light, camera, and the object. The actual sensor is depicted in figure 1.

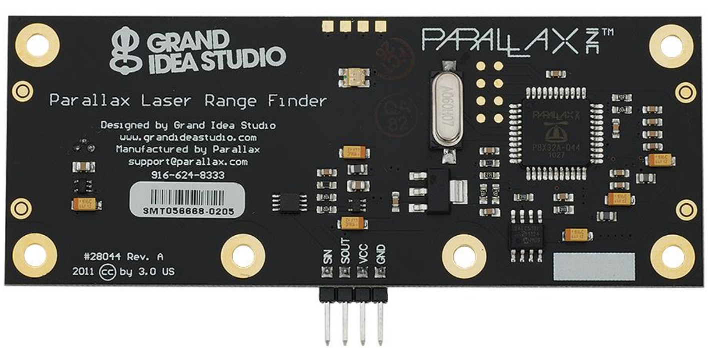

Figure 1- Parallax Laser Range Finder

2. Redesign of Proximity Detection PCB Board

During the fall semester, the team designed a proximity detection PCB to integrate 3 IR sensors and Arduino Nano. The designed PCB performed really well and also served as a source to power additional components like USB hubs.

Additional components, like the USB hub, had not been taken into account during the design of the first iteration of the PCB as it was assumed that they would be powered by either USB or through Oculus Prime's power distribution board. Further shortcomings of the board included not having LEDs for diagnostics and dedicated fuses for lines powering the USB hubs. In addition to this, the PCB lacked additional connectors for powering other devices. The old PCB board is depicted in figure 2.

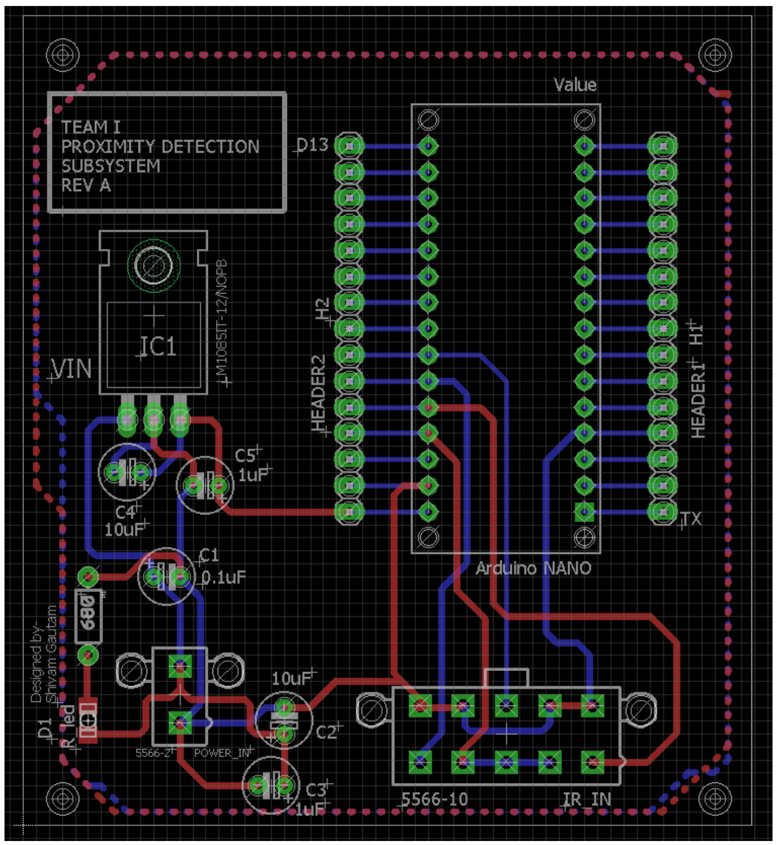

Figure 2- Old Proximity detection PCB

To mitigate this problem, I decided to redesign the PCB to include the following-

- A dedicated connector for the USB hub
- A dedicated fusing for the line powering the USB Hub
- LEDs for diagnosing power for board and subcomponents.
- Additional connectors for power components that might be added to the platform.
- Changing Voltage Regulator from LM7805 to LM1084 (Higher current rating -5A)

The redesigned PCB is depicted in figure 3.

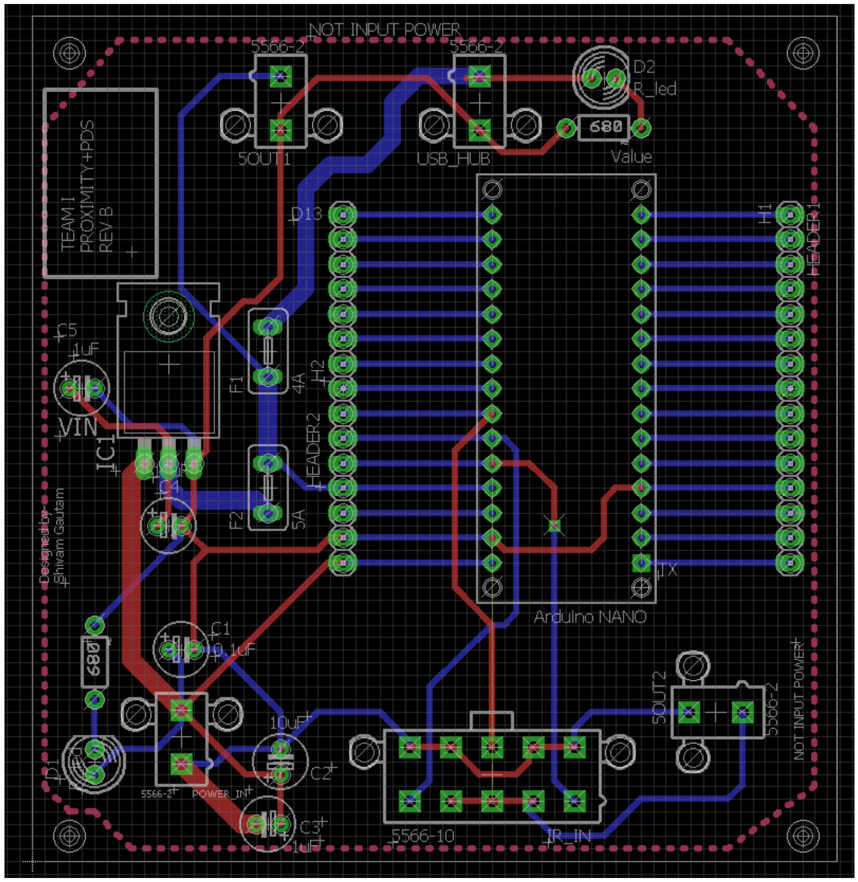

Figure 3- Redesigned PCB for proximity detection

I decided against routing the power for the Single Board Computer (SBC) through the PCB as this would increase the footprint of the PCB. The SBC requires 4A of current and therefore including a switching regulator would have increased the area of the board which in turn would have decreased the ease of integration. To solve this problem, I decided to go for an off-the-shelf switching regulator- the CC BEC by Castle Creations (Figure 4).

Figure 4- CC BEC Power Regulator

The PCB still supports three analog sensors and is compatible with the Parallax LRF. Depending on the performance of the LRF, a decision will be made to integrate either the LRF or the IR sensors with the platform.

2. Challenges

One of the key challenges I faced was designing the power distribution system for the PCB. A lot of options exist for selecting regulators, which offer similar capabilities. To eliminate this problem, I decided to use the TI Workbench for selecting electronic components. The workbench takes in requirements with respect to the input voltage, output voltage and output current and displays possible IC solutions. The analysis includes a graphical comparison of the footprint of the component to the efficiency. A screenshot of the TI workbench is shown in figure 5.

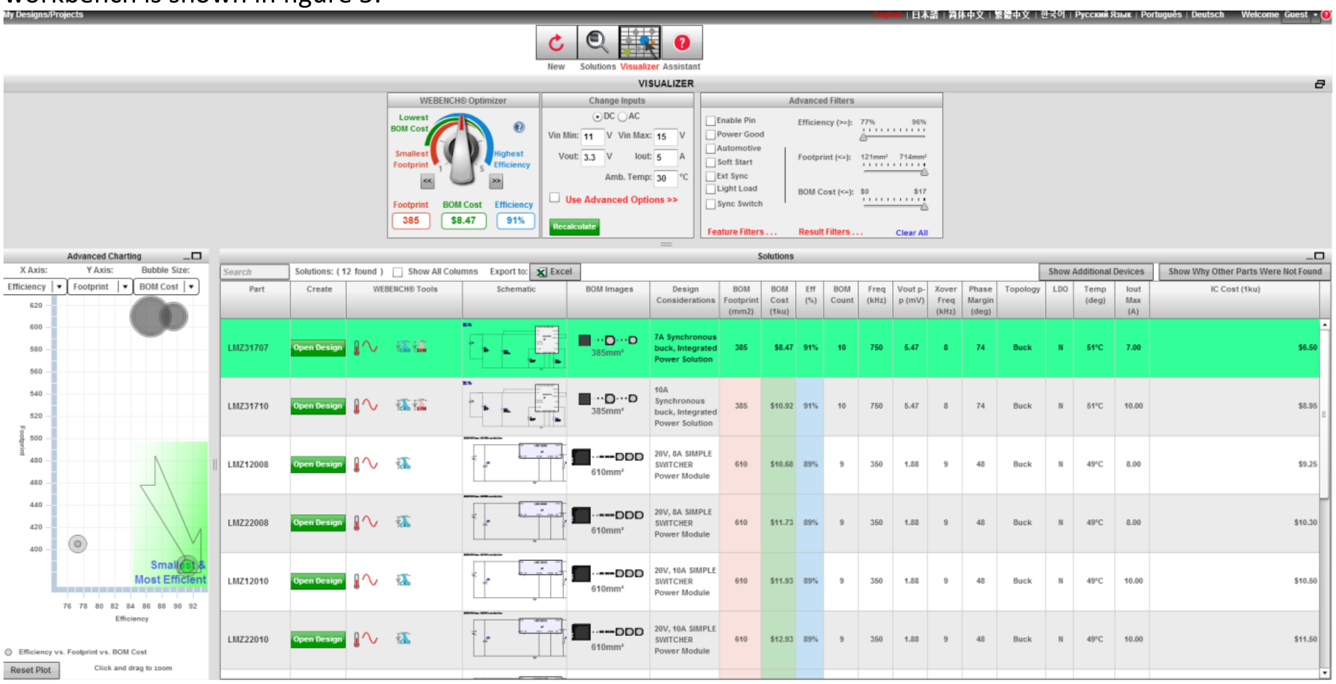

Figure 5- TI Workbench for selecting power regulators

Another key challenge was isolating the problem with the IR sensors. One of the three sensors showed erratic behavior while testing which made it difficult to isolate the problem. After testing the IR sensors individually, it was found that one of the three sensors would fluctuate between values less than 20cm to values greater than 40 cm after a random number of samples. As a result, I decided to look at other sensors.

One of the best sensors for this job included the Lidar Lite V2, a low cost LIDAR, which is more accurate and robust than the IR. However, the sensor is currently out of stock on all possible vendors. Hence, I decided to look at other options and eventually decided to go with the Parallax LRF.

A non-technical challenge I faced was redistribution of tasks equally amongst the team post the fall semester. This included defining the work packages as per the refined scope and requirements and then distributing the packages according to interest and competency.

3. Teamwork

As per the task distribution, Pranav and Dorothy worked on testing the mobile app to increase its robustness and ensure better connectivity with the SBC. Richa and Dorothy worked on designing the layout of the parking lot. They also worked together on testing simultaneous communication of the three XBees. Mohak was assigned the task of creating a map of the parking lot for which he studied the gmapping tool in ROS. He also worked on the multi-agent planner which ranks parking spots according to manhattan distance. I collaborated with Mohak on this task and discussed possible scenarios where we could add more complex metrics to the planner. Pranav worked on gaining a familiarity with the ROS navigation stack and also designed the user interface for the visualization tool.

4. Plans

During the coming weeks, I would be working on the perception subsystem and would be integrating the PCB as well as the LRF sensor with the platform. I'll also be working with Mohak on the Multi-Agent planner once the baseline algorithm has been implemented. Pranav would be working on the navigation of the platform using the API provided by Oculus Prime. He would also be working on the visualization tool used to show the active state of the parking lot. Mohak would be working on generating the map of the parking lot using the API provided by Oculus Prime. Richa and Dorothy would be developing on their work on the communication subsystem by testing it with multiple SBCs instead of laptops. Dorothy will coordinate with Richa to fabricate and assemble the mock parking lot designed by them. Our team has set a hard deadline for the 7th of February to complete all subsystem testing. We aim to begin system level integration after that date.