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Team B: Arcus
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Individual Progress

My individual progress last week was split between systems engineering tasks and engineering development. On the systems and planning side, I drove the milestone planning and initial work breakdown structure that provided much greater clarity to the order in which we would attack each task in our gantt chart, attached below. Our gantt chart is still a living document; as we learn more about each subsystem, we continue to add tasks and dependencies as required. Prior to this week, there were still a few unknowns both on the hardware and software side of the project. On the hardware side, we had to finalize the choice of the RGB sensor and determine our direction with multispectral or hyperspectral imaging. We finalized on a single RGB camera, the mvBlueFox-MLC200wG. We also decided to eliminate the integration of an additional imaging sensor for this semester, opting instead to design our mapping software with sensing modularity in mind, simplifying the integration for future development next semester. The simplification of the hardware has also simplified software roles, providing greater clarity towards the work breakdown on software development.

As far as engineering development is concerned, I've been supporting Clare in her role as lead mechanical design engineer, helping with CAD tasks and advising on best approaches for mechanical architecture, design methodologies, and CAD strategy.

I've approached the electrical design of the vehicle with a heavy emphasis on relying on off-the-shelf, tested components and only designing custom PCBs as necessary. With this approach, we found the there were many electronics existing in the hobby multirotor market that were robust to hobbyists, and thus nearly indestructible for our purposes. I found that we could simplify the power distribution board to simply regulating the system voltage of 14.8V from the Lithium-Polymer (LiPo) batteries out to 12V for the Velodyne Puck LiDAR and 19V for the Gigabyte Brix computer. With the lessons learned and practice from the prior PDB project assignment, I've nearly completed the first-draft schematic of the PDB, designed for power and space efficiency. Maitreya is also helping with the evaluation of this schematic to make sure it fulfills all of our requirements.

With the rest of the team I have also begun digging into learning about current research for live 3D SLAM algorithms, and how we could develop our own mapping pipeline for our purposes. We have found a few different algorithms, many of which whose authors are here on campus. LOAM is a recent LiDAR + IMU SLAM algorithm developed at CMU that demonstrates impressive results in a research YouTube video.

We have been comparing this algorithm to BLAM! and Google Cartographer, both recently-released SLAM packages that promise similar things-- real-time 3D SLAM with good loop closure.

Challenges

The main challenge on electrical, software, and mechanical development was a bit of uncertainty in hardware and mapping software approaches as we dove deeper into learning about each subsystem. Although minor, we found that these uncertainties clouded the immediate next steps to complete subsequent milestones. These included uncertainties in the final sensor selection for the system, software architecture, and oddly enough, the involvement of our project advisor in the project itself. Since the project is deeply involved with her research, we needed to clarify the work breakdown between not just our team, but also her technical involvement with the project. This resulted in understanding her own personal objectives for the project, and solidifying her role as mentor, while she performs research into autonomous exploration algorithms. Understanding this work split, as well as solidifying all of the hardware requirements, allowed us to much more quickly understand the finer subtasks involved with researching electrical and software components.

Another major challenge for myself and my team is understanding current SLAM algorithms, and how current algorithms are able to achieve real-time localization and mapping in 3D. Taking Computer Vision while learning about these topics has been immensely useful, this has furthered my understanding of feature detection, homographies, and structure from motion algorithms that power many of these SLAM algorithms.

Teamwork

Luckily, Angad is on our team, and is leading the software development efforts on Arcus. He has been instrumental towards understanding the sensor calibration, bringup, and initial SLAM algorithm testing on the bag data that we had collected while at LaFarge. As our subject-matter-expert on software for our team, he’s been able to help the rest of us understand the software architecture, and lead how we might breakdown future tasks, given a few different approaches to the mapping problem. Beyond software development, he is also working on sensor calibration and vehicle computer bringup.

Clare is developing the mechanical architecture and mounting components of the vehicle, currently taking all of our off-the-shelf components and drawing them in Solidworks. I'll be working with her to develop how the sensors and components will attach, and how we might design the system for weight efficiency, sensor and battery modularity, and robust mounting for sensor data accuracy.

Maitreya worked on the Pixhawk flight controller bringup, as well as aided Angad in sensor calibration and bringup efforts. Due to his background in electrical and computer engineering, he's also verifying and aiding in the design of the first pass of the power distribution board.

Plans

Per the tasks laid out by the conceptual design review, we're tracking well on completing them for our milestone for progress review 3. I'll be working on schematic capture of the PCB, and release it for DFM review, as well as internal review by our team and the course TAs. I'll also be continuing support of the mechanical tasks with Clare. We'll finalize our approach to the SLAM state estimation and mapping components of the system, and have a software work breakdown before the progress review.