PROGRESS REVIEW 10: ILR09

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Team I
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1. Individual Progress

With the revised scope and task allocation, the main area for me to work on for this PR was integration, testing and setup of our old (kit version) Oculus Prime platform. The main tasks I was involved in were:

a. Integration and testing : App, Communication, Planner, Visualization tool, Navigation
b. Hardware and software setup for Oculus Prime
c. Literature study : Multi-agent planning algorithms for simultaneous parking

a. App-Communication-Planner-Visualization tool-Navigation integration

The major goal for this PR was to show full functionality of the system with a single platform. We had been incrementally working towards this goal since mid-February. Up till the last PR, we had integrated the communications-planner-UI pipeline. The next step was to integrate the app and test multiple times for two vehicles. Pranav and I tested and debugged to ensure reliable functionality.

After one phase of integration, Dorothy and I worked on the launch file that Pranav had created earlier to launch all nodes. We sorted out several issues with the communication script as well, while testing. Some exceptions came up when a vehicle received a 'GOODBYE' message before it had been assigned an ID itself. Similarly, we caught many other exceptions while testing extensively. The resulting code was very reliable and we are confident that it will work with any number of vehicles (scalable) behaving in different ways in the network. At this point, even if a vehicle sends messages not expected at a particular time in our given setting, the system will function in a proper way. Dorothy has merged the nodes for communication and optimal spot selection, which made it easy to test and debug.

Pranav had meanwhile tested his navigation script with mapping. We worked on integrating and testing the entire system with navigation. We successfully demonstrated the same in this PR, and the sequence of events was as follows:

1. The stationary platform with the UI starts up and becomes vehicle ID = 5.
2. It reflects itself in the UI at the entry queue.
3. A new vehicle (mobile platform) joins the queue and becomes vehicle ID = 6, which is reflected on the UI.
4. The user of the vehicle sends a 'Park' command from the smartphone app.
5. The vehicle, based on the status of the parking lot, which is empty right now, selects the spot closest to the exit which is communicated to the network.
6. The UI reflects this selection while the vehicle navigates to the spot, avoiding obstacles on its way.
7. When the vehicle reaches the parking spot, the 'parked' status is sent to the smartphone app which then enables the return button.
8. The UI reflects this by displaying a circle over the vehicle ID in the spot.
9. Similarly, the 'Return' command is given by the user from the app and the vehicle starts navigating to the exit spot.
10. After reaching the exit, it sends the status to the user and the app displays 'returned' status.

Figure 1. Integrated system

b. Hardware/Software setup for Oculus Prime (kit version)

Two weeks ago, I had started re-assembling the old platform to restore functionality. I was facing an issue while powering the Intel board, apparently none of the power sources I used gave it enough current to power on. On discussing the issue with Shivam, it was found that the board was missing a RAM and that could be the reason for it not booting up. We also needed a WiFi card and antennae for the platform to easily use WiFi and Bluetooth, eliminating the need for USB adapters for the same. All remaining components were ordered. Meanwhile I worked on electrical assembly of the MALG and Power PCB (both of them were damaged previously and new ones had arrived). Hardware assembly is now complete with the motherboard and SSD. I believe that when the motherboard is powered with the Power PCB (through the LiPo battery), it should turn on properly. One of the connectors, a Molex extension connector could not be found in lab inventory and had to be ordered. When it arrives, testing of the assembled platform can begin.

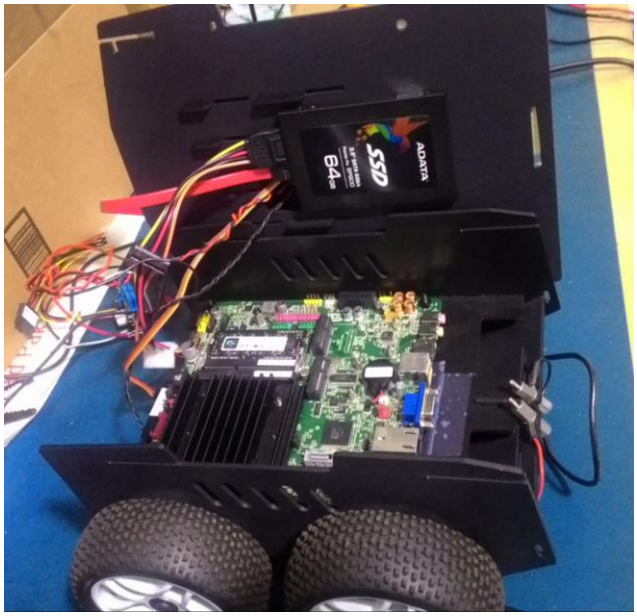

Figure 2. Platform interior with Intel DN2800MT and SSD

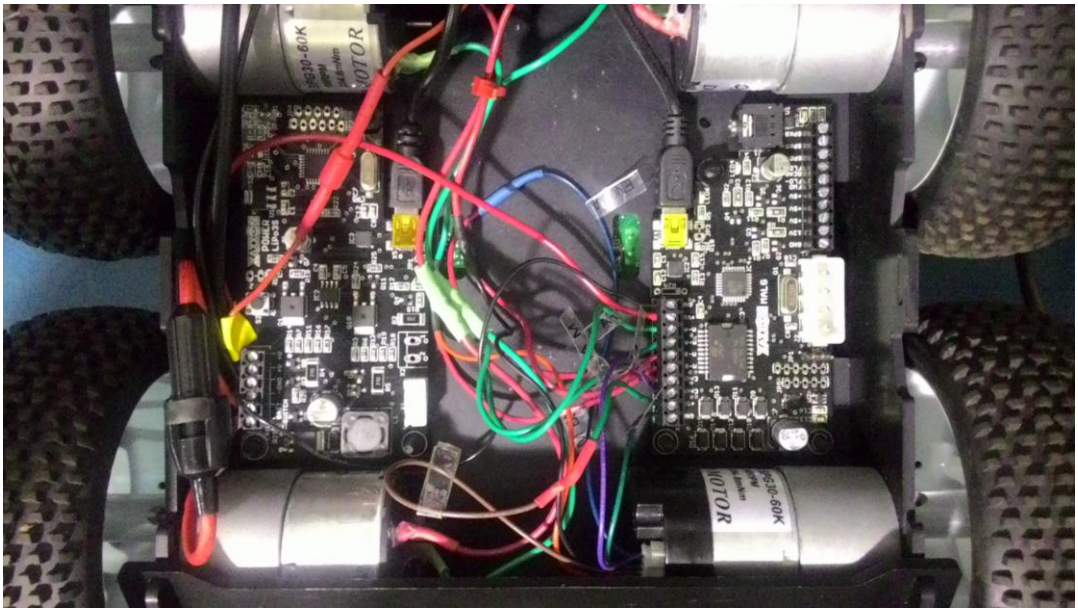

Figure 3. Platform underbelly with MALG and Power PCBs

On the software end, the full version system image needs to be installed on the motherboard which contains Oculus Prime Server version 0.704, Xubuntu 14.04.3 and ROS Indigo.

c. Literature study

We are now in the last stages of integration, and Shivam, Pranav and Mohak are working on the stand-alone simulation environment for a large scale parking environment with 100 cars.
Dorothy and I have decided to take up one of our desirable requirements, which is quite an interesting problem. This involves parking of more than one car simultaneously in the parking lot.
I have read several research papers to gain some background in planning. [1] was a good resource to understand how multi-agent systems function and gave an overview of the steps involved in global planning of multiple robots as follows:

1. Allocate goals to agents.
2. Refine goals into subtasks.
3. Schedule subtasks by adding resource allocation (possibly including the agents) and timing constraints.
4. Communicate planning choices (of prior steps) to recognize and resolve conflicts.
5. Execute the plans.

All five phases are interleaved by the Partial Global Planning framework and its extension, generalized PGP, where each agent has partial knowledge of the plans of other agents using a specialized plan representation. In this method, coordination is achieved as follows. If an agent A informs another agent B of a part of its own plan, B merges this information into its own partial global plan. Agent B can then try to improve the global plan by, for example, eliminating redundancy it observes.
Such an improved plan is shown to other agents, who might accept, reject, or modify it. This process is assumed to run concurrently with the execution of the (first part of the) local plan.

I am further looking into this idea and exploring many others, to get a clear understanding of what would work best for our system and is feasible to implement in the time frame available.

2. Challenges

One technical challenge remained powering up the Intel motherboard. The board requires an 8-19V power supply. The power LED on the board isn't coming up despite appropriate voltage on the power leads. The solution to this was completing the hardware setup so that it could be powered through the LiPo. Integration involved some ROS issues, with launch files, etc. but they were sorted out and we ended up becoming more familiar with how ROS works. Further, in the Fall semester, we had not utilized Github for version control. This had created issues in integration. This semester, git is being used and getting familiar with it took some time.

3. Teamwork

I worked with Pranav on integration related tasks. I also worked with Dorothy on integration and testing of the app to UI functionality. Pranav helped get familiar with the mapping and navigation of Oculus Prime. Dorothy wished to get some experience with hardware, so she worked with me in hardware assembly of the old platform. Pranav, Shivam and Mohak created the environment structure and the overall architecture of our Simulator. They setup and mapped the mock parking lot to test the localization and navigation of the platform. Mohak and Shivam worked on the multi-heuristic planners for the Simulator.

4. Plans

For all our future tasks, we'll be following the critical schedule. We need to have a beta version of our Simulator ready by the end of this week. This would be a working version with some heuristics implemented on the planners and the vehicles being rendered in the environment. Pranav will be working on the integration and testing of the simulator. We expect the simulator to go under multiple iterations before it's fully done. Dorothy and I would be working on testing the auto-park system with multiple platforms. In parallel, we will start work on the global planner for the physical system in order to achieve the functionality of multiple platforms parking simultaneously.