Individual Lab Report #03

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Individual Progress:

In the past two weeks, the top priority goal for our team is to finish the first prototype of the manipulator, in order to demonstrate and test the capability of the grasping subsystem. Major tasks involved are mechanical design and assembly, electronics system design and implementation, motor configuration, control and parameter tuning, implementation of the communication interface between microcontroller and onboard computer, as well as the ROS driver for remote control using joystick.

I spent most of the time working on the electronics system design and implementation, as well as the configuration and control of Dynamixel motors. For the electronics system, I did a through analysis of the power consumption need and the current rating of each subsystem, computed the minimum battery capacity required based on our system's performance requirement. Then I compared and selected several hardware components, such as power connectors and a motor shield for microcontroller board based on the calculated specifications.

Below shows the catalog and connection diagram of the major onboard electronic components, and their power consumption specifications. Note that either Intel NUC i7 or NVIDIA Jetson TX2 will be adopted as the onboard computer, but not both.

Component	Input Voltage	Max Current (each)	Quantity
OpenCR1.0 Microcontroller Board	12V	~2.0A	1
Dynamixel AX-12A	12V	900mA	2
Dynamixel XM430-W210-T	12V	2.3A	2
Dynamixel MX-106T	12V	5.2A	2
Intel NUC i7	12-19V	~2.5A at 12V	1
NVIDIA Jetson TX2	12-24V	~1.2A at 12V	1
Intel RealSense Depth Camera	5V	360mA	1
Hokuyo URG-04LX-UG01 LiDAR	5V	500mA	1

Table 1. Catalog of Electronics Components

After calculating the power consumption need, we decided to use two 11.1V 3-cell LiPo batteries in parallel, with 5200mAh capacity each, in order to satisfy the performance requirement of our system, which is being able to operate continuously for at least two hours once fully charged. I also designed a power distributing system PCB for splitting power supplies and providing extra protections, such as short-circuit, over-voltage and reverse-voltage protection for each component and subsystem.

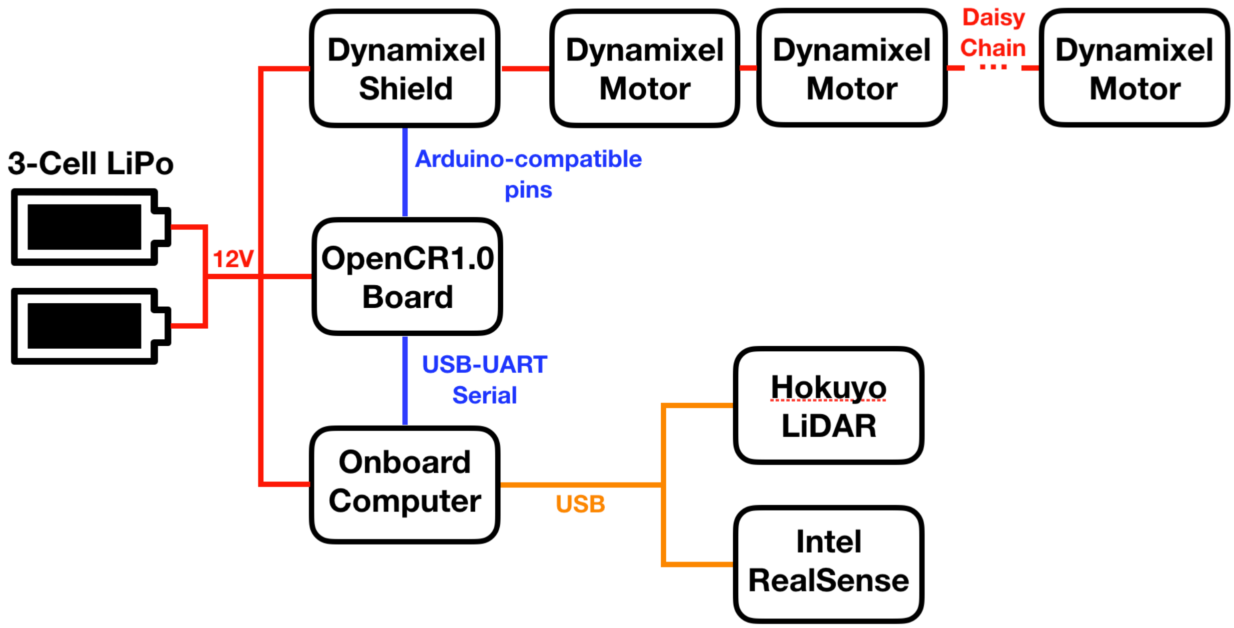

Figure 1. Connection Diagram of the Electronic System

Challenges:

The major challenge that we encountered was configuring and setting up the Dynamixel servo motors. Dynamixel servo motor is a large family with many different series. The ones we used in the project are AX, MX and X series, which had different types of connectors and communication protocols. Previously we though that we were able to daisy-chain all the motors together and control them through a single port on the OpenCR1.0 microcontroller board that came with the TurtleBot 3. The incompatibility of different series made it more difficult. We had to cut several cables, made different connectors, and added another motor shield board to control the extra motors. Another difficulty we faced was that the motors required specific configurations, such as motor ID and baud rate, in order to work together as a chain on the same data bus. However, we were not able to talk to any of the motors after flashing the parameters into their memory. We searched for almost every possible solution regarding this issue online and tried talking to the motors through several different OS, computers and microcontroller boards, but still could not resolve it. We will try contacting the manufacturer for support soon.

Teamwork:

As mentioned above, we worked closely together during the past two weeks trying to finish the design and prototyping of the grasping subsystem. I worked together with Jorge and Nithin on the configuration of the Dynamixel motors and some practical hands-on work to set up the electronics system. We also worked with Paulo and Laavanye to discuss about the manipulator design and wiring, as well as the placement of the cameras to achieve a wide field-of-view for efficient object segmentation and grasping.

Future Plans:

Our first priority for the next phase will be to resolve the issues related to Dynamixel motors, either by contacting technical support to find a solution if possible, or to buy new motors to replace them. Another milestone will be to integrate the manipulator and the sensors together with the mobile base platform. With the manipulator mounted and integrated, we can start validate the design of the grasping mechanism on the real robot, and to iterate the design of we find any problem with the current prototype. With the camera and lidar mounted, we can start collecting data to improve our vision algorithm for object segmentation and identification, as well as the SLAM and planning algorithms in the environment.