EE CprE 491 – May 1718
MicroCART Senior Design Team
Week 1 Report

October 10 – 16
Faculty Advisors: Phillip Jones, Nicola Elia

Team Members:

Brendan Bartels — *Controls Software Key Concept Holder*
Kris Burney — *Ground Station Key Concept Holder*
Joe Bush — *Quadcopter Software Key Concept Holder*
Jake Drahos — *Team Webmaster*
Eric Middleton — *Hardware Maintainer*
Tara Mina — *Team Communications Leader*
Andy Snawerdt — *Control Systems Key Concept Holder*
David Wehr — *Team Leader*

Summary for Progress this Week

Our most important task this week was to complete the first version of our Project Plan, which had to be done from scratch. In addition, this week we continued searching for different ways of measuring the moments of inertia and reached out to the physics department to use their equipment. In addition, we continued doing measurements for characterizing and identifying the quadcopter, by following Matt's thesis and finding the important quadcopter parameters that he lists, which we still have not determined. We also compiled the quadcopter software and got it running on the quadcopter, which though it may seem very straight-forward, took a lot of problem solving and trial-and-error to figure out what was not working

Past Week Accomplishments

- Complete Project Plan 1 - Everyone
  - Started and finished writing our Project Plan Version 1.
  - Followed the template given in EE 491
  - Included some of the structure of dividing the project into multiple sub-sections, as was done by previous senior design teams
- Moment of Inertia Measuring Method - Brendan, Tara, and Andy
  - Discussed our different options of measuring the moment of inertia:
    - Method of set up
    - Flaws and uncertainties
  - Came up with a new idea: contacting the Physics department
    - Contacting the Lab Coordinator: Paula Herrera-Siklody
    - Scheduled a time to meet to see the equipment we can use
- Compiling Quad Software - Joe, Eric, and David
  - We found a workaround for the maximum baud rate limit in the UART driver by re-implementing the driver's setBaudRate function without the baud rate check
- Quad echoing packet for latency timing - Joe, Eric, and David

- Added simple functionality for the quad to send back the message ID of any VRPN data received, so we can test the latency.

- Identification of Quad - Brendan, Tara, and Andy
  - We continued our task of identifying all of the quadcopter parameters. This included creating a document on our drive consisting of all of the found parameters. This document can be found here - Modeling Parameters.
    - This week we found the following modeling parameters:
- Website -Jake, Brendan
  - Set up template, toolchain, uploaded skeleton site
    - Using Jekyll static site generator with HackCSS theme
  - Setup navigation
  - Created some test pages
    - Will be very easy to create content
- Ground station - Jake, Kris
  - Adapting old code - Jake
    - Fixed major problems with logging module
    - Added thread safety to logging and quad socket
    - microcart_cli.c (old) will eventually become the backend daemon of the new software
  - Communication with quad/VRPN - Kris
  - Socket work - Kris
  - Initial thought and design of new Back End + Front End(CLI or GUI) - Jake, Kris

Symbol	Nominal Value	Units	Brief Description
m_q	0.986	*kg*	Quadrotor mass
m_b	0.204	*kg*	Battery mass
m	1.19	*kg*	Quadrotor + battery mass
K_T	8.1558×10^{-6}	$\frac{kgm}{rad^2}$	Rotor thrust constant
K_d	1.7473×10^{-7}	$\frac{kgm^2}{rad^2}$	Rotor drag constant
$\lvert r_{h_x} \rvert$	0.016	*m*	x-axis distance from center of mass to a rotor hub
$\lvert r_{h_y} \rvert$	0.016	*m*	y-axis distance from center of mass to a rotor hub
$\lvert r_{h_z} \rvert$	0.003	*m*	z-axis distance from center of mass to a rotor hub
R_m	0.2308	Ω	Motor resistance

K_Q	96.3422	$\frac{A}{Nm}$	Motor torque constant
K_V	96.3422	$\frac{rad}{Vs}$	Motor back-emf constant
i_f	0.511	A	Motor internal friction current

Pending Issues

- No main issues or obstacles currently… this will most probably soon change

Individual Contributions

Team Member	Contribution	Weekly Hours	Total Hours
Brendan Bartels	Project Plan, compiling quad software, identification of quad	10	37
Kris Burney	Project Plan, Switched from threading to select() started receiving responses from quad, Back End + Front End design	10	64
Joe Bush	Project plan, quad tools/software	11	46.5
Jake Drahos	Website, ground station, git repo, Back End + Front End design	6	31
Eric Middleton	Compiling quad software, echo functionality, project plan	11	65
Tara Mina	Project Plan, Measuring quadcopter parameters	8	43
Andy Snawerdt	Identification of Quad, Project Plan	9	64
David Wehr	Compiling quad software, Echo functionality, Project plan	16	52

Comments and Extended Discussion

This week we sketched out a basic plan for how we would go about compartmentalizing our senior design project as well as what in-between milestones we want to achieve on the way to obtaining our final product at the end of the spring semester. This gave us a better, more concrete idea about how we can accomplish our final goal, and helped lay out a rough, overall schedule for us to follow and aim for smaller goals every month or so, which will help guide us meet our ultimate goals for the project.

Plans for Coming Week

- Measure Moment of Inertia – Brendan, Tara, and Andy
    - Go to Physics department and get familiar with moment of inertia equipment
    - Learn the method that Physics department uses to measure moment of inertia
    - Perform measurements on moment of inertia on all three axes of rotation (pitch, roll, and yaw)
- Learn how to Measure other Quadcopter Parameters – Brendan, Tara, and Andy
    - Email to schedule a time to meet with Matt Rich
    - Will discuss how to measure some of the more difficult quadcopter parameters
        - Rotor velocity thrust adjustment factor

        - Rotor in-plane drag constant
        - Approximate constant battery discharge rate
        - Latencies:
            - Camera system total latency
            - Throttle channel latency
            - Aileron channel latency
            - Elevator channel latency
            - Communication rudder channel latency
    - Gain a good understanding of what some of the parameters mean in a physical sense, since some of them are a bit obscure.
- Begin creating a Simulink template - Brendan, Tara, and Andy
    - Begin implementing our mathematical model into Simulink
    - Will include some of the parameters that we already determined
    - Starts out with PID constants that will not be completely determined yet
- More work on ground-station backend
    - Finish implementing event-driven model
    - Test ASCII protocol w/ console
    - Implement
- Measure latency of Bluetooth and WiFi - David, Eric, Joe, Kris
- Start implementing real-time streaming of flight data in quad software - Eric, Joe, David
    - Remove bulk transfer of flight log after flight has ended
    - Add logging of non-autonomous flights
    - Implement logging as binary data (versus current ascii protocol)
- Get WiFi communication in ground station - David, Kris

Summary of Weekly Advisor Meeting

This week we discussed as a team how we need to create a good structure for our Project Plan, which was due this week. We also discussed our progress over the course of this week in terms of compiling code to the quadcopter and getting it to fly, as well as with system identification and determining the thrust and drag constant parameters.

- Advice for how to go about the Project Plan 1 structure:
    - Go back to previous year's final write up
        - Make template comparable to ours
        - Includes a lot of connections and information that will be helpful
    - Using previous year's project plans is also a good template to follow
- Updates for WiFi from David
    - Did testing with TCP
        - Dropped from 2.2 to 1.5 milliseconds in latency
        - Optimized the communication process by re-using an already made connection, instead of creating a new one each time
        - Tests were from laptop to module only
    - Specs with UDP were also received: about 1.3 milliseconds
- Quadcopter Software Updates
    - Can compile and do configuration using SDK

    - Tried to compile the existing program, but it hangs when we initialize the UART
    - Comments from Eric:
        - In the file, max rate is defined
        - Users in Xilinx forum claim that you can increase it
        - But build script re-writes the header file, so cannot change it
    - Important note: Did not overwrite the existing, working SD card
- Ground State Advice from Dr. Jones:
    - Before using new threads, evaluate your alternatives first
    - Try using the "Select" functionality, which is a powerful systems-level function
    - Previous year's code uses "Select" bits
    - For controllers, want things to stay sequential, not parallel
- Controls Team Updates:
    - Considering different methods of measuring the moment of inertia of the quadcopter
    - Notes on the different methods:
        - Using thrust to determine the torque will accumulate error
        - Mass and pulley method at least gives us a very well-known torque
        - Friction can be a possible problem with mass and pulley method
        - Will not be able to get a large sample size with dropping a mass
            - May not be an issue, should test this to be sure
        - Data collection becomes annoying with either method, a working ECP machine would clearly be the most ideal method
    - Have talked to Lee about possibly fixing the ECP machine
    - Dr. Jones and other team members believe we should go with the mass and pulley method
    - Dr. Elia and Ian believe we should go with the thrust method
- Ground station computer issue
    - Working again!
    - But RFcomm is not being recognized...