Fall 2017 Research Proposal

Research Overview:

The objective of this project is to build a single motor flying robot that is able to remain stable in air and move based on our control. The project give solution for building a stable and controllable aerial system with only one actuator. As a result, robots can be made smaller and more lightweight. Furthermore, if we build several single motor robots, we are able to control them as a robot swarm.

Background/ Related work/ References

The whole single motor flying robot system is based on a open source quadcopter kit called Crazyflie 2.0. Crazyflie 2.0 is a miniature, customizable and programmable system with 10-DOF IMU, MCU and radio module on board. The system can be controlled using Bitcraze Virtual Machine and ROS (Robot Operating System). Using Bitcraze Virtual Machine provided by on the Crazyflie website [1], we are capable of reading robot states on the clients. According to ROS Crazyflie package [2], the ROS driver is able to publish on-board sensor data in ROS standard message formats. In addition, the ROS driver and controller are written in C++ which makes it easier to understand and program.

In the Crazyflie technical report [3], the author uses ROS to do modification on the controller of a Crazyflie system, meaning it is possible to modify the on-board controller to suit our needs.

The controller we are going to implement is based on paper [4], which is designed for stabilize the quadcopter in the case of losing one, two and three propellers. Losing three propellers case can be adapted into building our system.

Goals/ Deliverables/ Tasks

The final goal of this quarter is to design, test and build a single motor flying robot system with sensing and controlling on board. This goal can be broken down into smaller tasks and goals that fits into ten weeks period during Fall 2017.I will be mainly focus on understanding the hardware/software interface of Crazyflie 2.0, modifying controller code inside Crazyflie 2.0 and conducting any necessary hardware related experiment and testing.

Project Goals in terms of

- October
  - Install ROS Crazyflie package and interface
  - Figure out how to program
  - Finish hardware experiment
- November
  - Study Paper "Stability and control of a quadrocopter despite the complete loss of one, two, or three propellers by Mueller, M. W., & Dandrea, R. (2014)."
  - Understand the control algorithm for quadcopter losing one, two and three motors
  - Translate algorithm to code that can be flashed onto Crazyflie (Start with case of losing one or two motors)
- December
  - Testing and debugging under-actuated system and compare result with simulation

Weekly Milestones(tentative):
Week 2: Read documentation of ROS Crazyflie package and configure the package with Crazyflie 2.0. Gather readings from Crazyflie on board sensor and start to explore how are we able to modify controller using ROS.
Deliverable: text file containing a series of reading from Crazyflie on board sensor.

Week 3: Read and modify controller code in ROS Crazyflie package based on Crazyflie technical report [3] and resources from internet. Change the PID parameters of current controller and observe the difference of robot behavior to verify the modifications are valid.
Deliverable: Blog post on Lemur website about a brief walkthrough(tutorial) of how to change controller code on Crazyflie using ROS.

Week 4/5: Read and discuss paper [4] with Shuang to understand how to implement the controller for the cases of losing one, two and three motors. Determine whether we can obtain all necessary variables from the on-board sensors.
Deliverable:

Week 6/Week 7: Start to implement controller algorithm from paper [4] to code that can be uploaded and flashed to Crazyflie 2.0 for the case of losing on motor. Test the modified controller on Crazyflie with one motor removed.

Week 8: TBD
Week 9: TBD
Week 10: TBD