ESE 519 Project Proposal - Group Firestorm

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1. Project Title: Autonomous Air Traffic Controller for Drones/Quadrotors

2. Team:

A. Karan Modi (Lead: Quad-rotor -control and flight)
B. Nitesh Singh (Lead: ATC Base station -networking and operation)
C. Prateek Singhal (Lead: Mission Planning)

3. Motivation:

The idea is to come up with a demonstration which will assist in an already going research focussing on segregated airspace for future high density autonomous traffic like UAV and drone deliveries. Civilian and military air space has so far been very efficiently controlled by existing Air Traffic Control with the primary motive of completion of flight safely. All this is done manually with visual and navigation instrument assistance. Additionally ATC is highly centralized and has many static and hierarchical points of reference. Autonomous ATC for drones is designed to have a decentralized and a singular point of reference looking ahead in the future.

4. Goal:

Design and implement autonomous ATC for Quadrotors.
Coordination between several quadrotors in simulated TRACON environment.
Follow a preset series of waypoints for several quadrotors.
Establish communication protocols to give real-time ATC directives like holding, new routing etc
Simulate 3 real-time situations:

- Sequential take-off and landing.
- Parallel take-off and landing.
- Emergency landing

5. Methodology:

Quadrotor should be able to follow a pre-programmed fly-in sequence followed by a land-in sequence
Simulate an ATC directed land-in sequence
Simulate a mayday or an airfield event

6. Project Components:

Hardware has two broad sections - Base station/ATC and the quadrotor(s).
Each base station will be comprised of following :

a. Odroid-XU4 - Base station board
b. Picostation M2HP - Wireless Access point for broadcasting
c. USB GPS module - optional, for getting reference location of base station

Each Quadrotor will be comprised of following :

a. QAV250 - Quadrotor chasis

b. Pixracer - flight computer
c. 3DR uBlox GPS with compass kit - For positioning information of the drone
d. Lumenier LiPo battery
e. DXe Transmitter - for manually controlling the quadrotors during initial testing.

Software has following sections :

a. Ubuntu on Odroid-XU4
b. ROS with Ardupilot flight stacks
c. Communication protocols based on actual ATC, between the basestation and the quadrotor

Additional requirement is proper implementation of trajectories to be followed by quadrotors.

7. Testing and Evaluation:

Testing will be done at the GRASP PERCH center. Initially, we shall try to control the quadrotors with a hand-held controller. Then, they will be controlled through a laptop. Finally, communication will be established between quadrotors and a base station, which will be created from scratch. During the testing phase the team will work with 2 quadrotors. However, the final demo will be done with 4 quadrotors.

8. Deliverables:

Baseline Goals –
Baseline 1: Fly and follow a preprogrammed path - showing mission planning implementation
Baseline 2: Externally preprogrammed takeoff and landing of a quadrotor
Baseline 3: ATC directed takeoff and landing of quadrotor- showing autonomous functioning of ATC

Reach Goals –
Reach 1: Sequential takeoff and landing for atleast a pair of quadrotors following a specified path
Reach 2: Parallel takeoff and landing for atleast a pair of quadrotors following a specified path
Reach 3: Emergency landing of a quadrotor showing implementation of dynamic mission planning

9. Overall Timeline:

7 Oct-14 Oct : Project proposal,setup picostation and raspberry pi, understand ATC communication, learn splines, BOM approval
15 Oct-21 Oct : Final proposal, Mission planning setup, Ardupilot simulation, setup flight aware system
22 Oct-28 Oct : Hands-on quadrotor,Test with Odroid, communicate between pixracer and odroid
29 Oct-4 Nov : Integration and testing of ATC hardware, quadrotor; testing of ROS code and protocols
5 Nov-11 Nov : Initial demo, ATC controlling predefined paths for two quadrotors

12 Nov-18 Nov : Demo rehearsal,Demo of Baseline Goals
19 Nov-25 Nov : Fixing things to achieve maximum goals, making video of the testing/demos
26 Nov-2 Dec : Final Demo of Reach Goals
3 Dec-8Dec : Reports, blog completion, code and video submission