Autonomous Quadcopter with Human Tracking and Gesture Recognition

Functional Requirements List and Performance Specifications

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Introduction

A "quadcopter" is a type of aircraft similar to a helicopter, but has four powered propellers which provide lift. By varying the speed of each propeller, the aircraft can alter its orientation and direction of motion.

Earlier senior projects used the XAircraft X650CF quadcopter platform. However, no successful autonomous flight resulted, therefore, the current project will be a new endeavour. Using the existing platform, a carbon fiber frame with four motors and speed controllers connected to an input/output module, we will design, interface, write software, and run diagnostics for the inertial measurement unit, camera, ultrasonic sensors, and gps on the quadcopter.

The goal of this project is to create a quadcopter that can autonomously track and follow a particular human as well as respond to gesture-based commands. The human tracking will rely on sensor data such as video images and GPS coordinates. The quadcopter will also have a wifi connection, allowing live video feeds and data to be streamed over the internet. Autonomous flight will include auto-stabilization, and obstacle avoidance. As an added safety measure, there will be a radio control (R/C)-based manual override.

System Block Diagram

Figure 1 shows the block diagram of the quadcopter system.

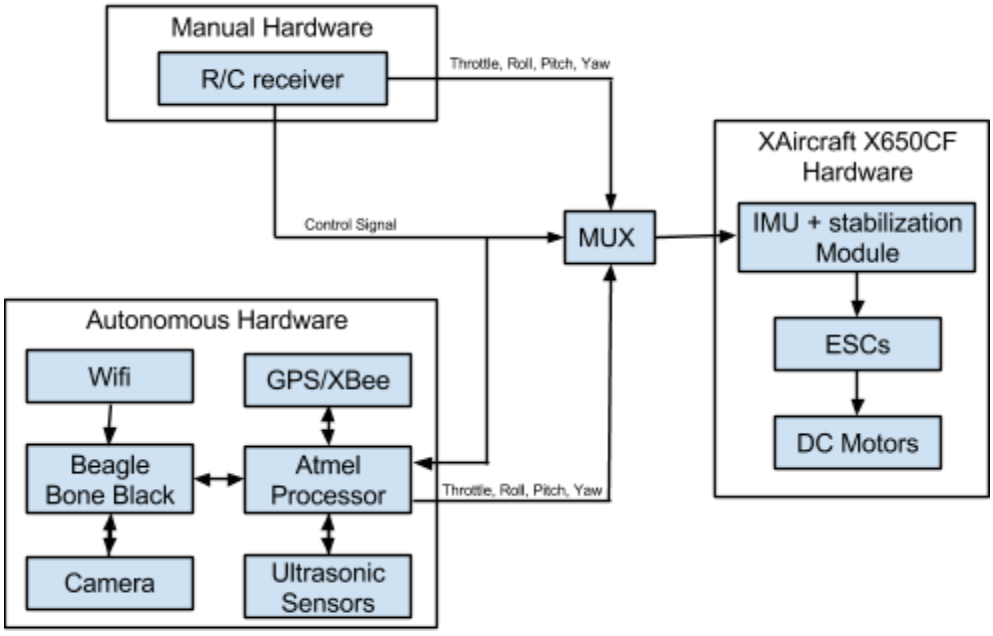

Figure 1: Block Diagram of Quadcopter System

Functional Requirements

Manual override

- There shall be a manual override, in the form of a standard R/C system, to switch from autonomous control to manual R/C control. The Turnigy Power System 9X 2.4G 9 Channel controller will be the initial platform and will be upgraded as needed.

Wifi connectivity

- A WiFi connection shall be established for the purpose of live video streaming or sending other data to a website. (Assuming constant connection on Bradley's campus)
- If WiFi is not available data shall be stored on a SD card until WiFi is available

GPS

- GPS data shall be retrieved at a minimum rate of 1 Hz
- GPS data (latitude, longitude, altitude, etc.) for the quadcopter shall be gathered from a GPS unit on the quadcopter
- GPS data (latitude, longitude, altitude, etc.) for the human shall be gathered, from a GPS unit held by the human, and transmitted to the quadcopter via RF link
- GPS latitude and longitude coordinates received by the quadcopter shall be used to set waypoints for human tracking

Gesture recognition

- Using image processing, a camera shall recognize three different gestures given by the user for the following tasks:
    - Increase distance, by 1 meter unless the quadcopter is 10 meters away from the user, between the user and the quadcopter
    - Decrease distance, by 1 meter unless the quadcopter is 5 meters away from the user, between the user and the quadcopter
    - Land safely on the ground
- The gestures for these maneuvers shall be the right turn, left turn, and stop signals used by bike riders
- A camera image shall be processed by the beaglebone black at a minimum rate of 1 Hz
- Gesture recognition shall be done using OpenCV

Flight Specifications

- The aircraft shall maintain a minimum height of 3 meters from the ground unless landing
- The aircraft shall maintain a minimum distance of 5 meters from the user
- The aircraft shall carry no more than 850 grams
- The aircraft shall fly no faster than 2 meters per second in autonomous mode unless needed to avoid an obstacle

Object Avoidance

- Using ultrasonic sensors and image processing from the camera, the quadcopter shall avoid trees, buildings, people, and all other obstacles
- The ultrasonic sensors shall relay distance reading at a rate of 1 Hz at minimum
- Images from the camera shall be used to avoid obstacles using an optical flow algorithm

Other Requirements

- A BeagleBone Black (BBB) or a similar Linux-based single-board computer (SBC) shall be used
- Programs running on the BBB shall be written in C/C++ and Python
- An ATmega328P shall be used for sensor interfacing if deemed necessary by timing requirements or pin shortages on the BBB.
- Programs for the ATmega328P shall be written in C

References

[1] "Home-XAircraft." *Home-XAircraft*. N.p., n.d. Web. 26 Sept. 2013. <http://xaircraft.com/en/portal.php>.

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[3] Karim, Achour, and Kahlouche Souhila. "Optical Flow based robot obstacle avoidance." *Advanced Robotic Systems International*. n. page. Web. 26 Sep. 2013. <http://cdn.intechopen.com/pdfs/4206/InTech-Optical_flow_based_robot_obstacle_avoidance.pdf>.