AVC

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Abstract:

For my IMDL project I made the AVC. This device is capable of controlling a variety of fixed and rotary wing aircraft. It takes advantage on an onboard IMU along with a GPS and barometric pressure sensor to accomplish this job.

Executive Summary:

The AVC is capable of controlling fixed and rotary wing aircraft. It uses a GPS for position. It reads its altitude form an onboard pressure sensor. There is also an onboard IMU. This IMU consists of a 3 axis accelerometer and 3 one axis gyros. This board has on onboard Atmel processing for flight planning and control and uses a XBee for ground downlink. During test the inner loop was shown to have the ability to level the aircraft. Also in ground testing the GPS path planning software worked. There was not a full plight test due to weather and plane limitations.

Introduction:

For my project I built the AVC, Air Vehicle Controller. The goal of the AVC was to build a IMU based controller that can be adapted to a variety of aircraft. Originally I started off with a quad copter. This plan fell through due to cheap propulsion hardware. Next I switched to a fixed wing aircraft. This show success on individual tests but was not able to complete a full run due to aircraft limitations with the weather.

Integrated System:

This system is a autonomous controller for a fixed wing aircraft. It will hopefully have applications for rotary aircraft. The system has an onboard Atmel processor for control of the aircraft. It will sense it's orientation using an onboard IMU. For position it has an onboard GPS and it senses it's altitude using a barometric pressure sensor.

Mobile Platform:

The platform is a GWS slow stick. I am using HS-55 servos for the control surfaces. I have also modified the airplane to have ailerons and added a brushless motor. To mount the electronics I use custom plywood mounting brackets on the main spar of the aircraft. I found this platform did not work because it's payload was at it's max. Also the design made it susceptible to wind gust causing it to be hard to fly and control.

Ground Station:

For ground control I use a hacked RC transmitter. This device has an XBee for communication with the aircraft. It also has a 4x20 LCD for displaying live data from the aircraft. This controller is also used to set the aircraft trims and manually fly the aircraft. This ground station runs on a Atmel 324p processor. Future advancements to this ground station will include a GPS and pressure sensor. Also I would like to upgrade the LCD to a GLCD.

Actuation:

On the robot I have 3 moving control surfaces. To move these surfaces I use HS-55 servos. I use these because they are light weight and strong.

Sensors:

I have an onboard GPS for determining the position of the aircraft. I am using a standard GPS with a small footprint. I am reading the standard NMEA GPS strings. To determine altitude I am using a SCP1000 pressure sensor. This gives me a high precision altitude measurement.

My special sensor is a IMU. This IMU is integrated into the board and all the sensors are read over a SPI bus. This IMU consist of a 3 axis ST accelerometer and 3 Melexis gyros. I can sense up to 6g's of acceleration. The gyros can sense up to 300deg/s of roll.

Behaviors:

The main behavior of my airplane is the ability to control its roll and pitch. These behaviors are maintained through the use of a PID control loop. The secondary behaviors are done by taking control of the primary behaviors. The secondary behaviors are the altitude control and heading control. On top of these behaviors is the waypoint navigation behavior. This uses GPS to calculate the bearing required to get to the waypoint and passes it off to the secondary behavior.

Experimental Layout and Results:

The results of the AVC are inconclusive. This is because the winds were to high to adequately test the AVC. I was able to test the inner loop of the program and have the controller bring the plane to a level orientation. I also have tested the GPS software in a ground vehicle to confirm that it works. I will need to wait for a calmer day or need to upgrade the plane before I can fully test the altitude hold and heading hold functions.

Conclusion:

The AVC behaved properly in all ground tests. I feel that is the aircraft had the ability to penetrate the wind I could have completed all air goals. For next time I would like to have more onboard processing. I am contemplating having a co-processor for handling communications or using an FPGA. I would also definitely go with a different aircraft. I would pick one capable of long flight time with more maneuverability.