Autonomous GPS Navigation Controller For a Radiosonde Recovery Glider

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Abstract

A radiosonde is a small telemetry package that measures temperature, pressure, wind speed and humidity at various altitudes using a weather balloon. Over 200 radiosondes are launched daily by the NOAA, however less than 20% of are recovered. This project implements a Microchip PIC as a flight navigation computer to guide a radiosonde payload to a predetermined destination using GPS. The PIC microcontroller calculates current and desired heading towards the location and sends a PWM signal to the rudder servo to minimize the difference in heading. The success of the design is measured using a flight simulator app that reads the rudder position and adjusts the change in output GPS coordinates proportionally to the PWM duty cycle and a simulated wind function.

Introduction

- Embedded systems are found everywhere, including cars, appliances, satellites, etc.
- Characterized by a system that requires a processor but for which processing is not the task
- This research implements a XC8 C-programmed PIC18F4550 microprocessor along with a GPS module, an Xbee communication module, and two servos to control a high altitude glider (Figure 1)
- The GPS module and Xbee module communicate with the PIC using a TTL USART channel

Simulation

- This C# app takes in the PWM signal from the PIC and outputs USART GPS coordinates at 1 Hz
- The output coordinates are a function of rudder deflection, wind velocity, vehicle speed, previous heading and previous position

Control Algorithm

- Upon launching, the navigation controller monitors altitude to see if the ceiling reached
- After balloon release at ceiling, the navigation controller begins to calculate actual and desired heading (Figure 2)
- The heading calculation is based on an adjusted longitude calculation
- The navigation controller sends a PWM signal to the rudder servo to minimize the difference between the headings with a preset gain
- This loop continues until the vehicle reaches within 25 m of the landing zone
- Within 25 to 50 m of the landing zone, the desired heading is increased 90º, causing the craft to fly in a tangent circle around the position until it reaches ground or escapes from the circle

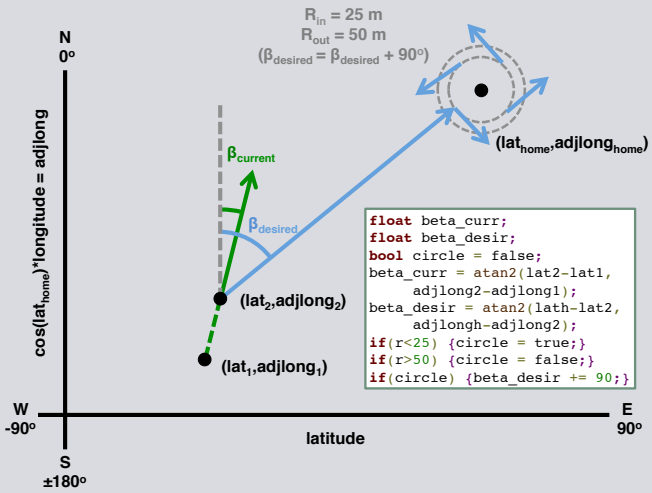

Figure 2. Heading calculation conceptual drawing and pseudo-code snippet

Results

- The simulation has shown that the navigation controller can guide the glider through a Gaussian wind distribution to its landing position

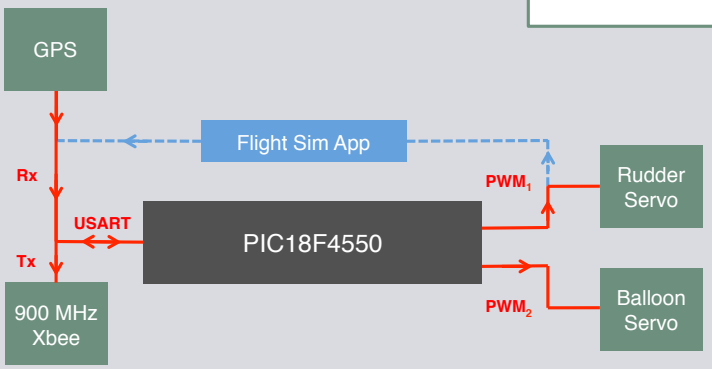

Figure 1. Communication and setup block diagram

Further Research

- Testing the navigation system in a glider is the next stage in the process
- An Air Hogs Titan will be used, a simple foam glider with good flight characteristics
- An FAA Notice to Airmen will be issued and the results of the navigation will be shared with NOAA

Acknowledgements

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