Autonomous Quadrotor Project: Anzhelka

ALPHA DRAFT

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And when he [Herod] had apprehended him [Peter], he put him in prison, and delivered him to four quaternions of soldiers to keep him; intending after Easter to bring him forth to the people.
–Acts 12:14, King James Bible, Cambridge Edition

Revions Here is where you will place the revisions of this document.

9:55pm - All of the spelling was checked and fixed for the first 2 secitions writen by Luke.

Table of Contents

1 Introduction

1.1 Executive Summary

This senior design project's goal was to create an autonomous quadrotor that would be used for outdoor sports like mountain biking, snowboarding, etc. The quadrotor would have a video camera mounted onto a gimble that would always point at a subject/object in which the tracking device was placed. The tracking device would have its' own GPS and IMU in order to be able to determine the location and heading of the subject/object.

Our quadrotor has many features including: 3-Axis Gyro, 3-Axis Accelerometer, 3-Axis Compass, Voltage and Current monitoring of each motor, a separate battery for logic operations for emergency recoveries, ability to control up to 8 Servos, able to track the exact speed and position of each motor, monitor 8 additional analog inputs, and mounting holes for all components and future upgrades.

This senior design project was built around being Open. Open Source. Open Hardware. The frame that was used for the quadrotor was designed by Ken Gracey, an employee at Parallax, and is called the "Elev-8". There is a Git repository hosted by Google Code in which you can find all the information used and created during this senior design project. There is also a Blog which goes into some of the extensive detail that was put into this project. The main processing board for this quad rotor features a Parallax Propeller, overclocked to 100Mhz, and a fully custom board that measures in at 4inches by 3inches.

Testing something that is so dynamic in nature is a great challenge in its own. One of the test that has to be done in order to calculate some of the gains for the control algorithms is the motor's torque and thrust. This meant that there had to be a test stand that would test both of these constants. Another test that had to be completed was on the control board that was designed for the quadrotor.

The project was started without any expertise or experiance with autonomous flying or quadrotors, but with will to learn, create and develop a system that could even be understood by people with experience in these fields. Software is one of the groups expertise. Both team members have had years of experience in multiple programming languages. Hardware on the other hand is a bit more difficult. Only Luke had any real experience with designing PCB's and circuits, however nothing to the extent of this project. The team believed that this project was worth aprroximately 16 credits. This was determined by the amount of hours that were being put into the project each week. Approximately 30 hours per person per week were devoted to this project.

NEEDS ACHIEVEMENTS

1.2 Design Objectives and System Overview

This project was designed to be open ended and to be used in an unprecedented amount of ways. After watching countless videos from Go Pro cameras from a single perspectives and partial views of the subject, project Anzhelka was created. Anzhelka would allow users to be able to capture video angles that were once unattainable without costing thousands of dollars. Anzhelka would allow users to capture video with the same ease as using a Go Pro camera, but without the single perspectives and gitter from traditional methods.

The quadrotor will have at least a 15minute run time, with the abilitly to carry a 2 pound payload. It could also be controlled by a human from up to a mile away with line of sight. The control loop to keep the platform stable will run at 300Hz and be asynchronous.

On this project the team members of Anzhelka decided to keep responsibilities as open as possible, however SRLM did most of the coding and wood working while ILUKESTER did most of the embedded hardware and wiring. Everything else was either split evenly or worked on jointly.

1.3 Background and Prior Art

There have been several different renditions of this project but to the best of the teams knowledge there has not been a project that has contained the 3 main parts of this project. Autonomous Quadrotor, Object tracking, and Open.

1.4 Development Environment and Tools

Cody

1.5 Related Documents and Supporting Materials

Cody, Not nessisary though.

1.6 Definitions and Acronyms

Needs lots more of deffinitions
ESC - Electronics Speed Control
IMU - Inertial Messurement Unit
PWM - Pulse Width Modulation

2 Requirements Specifications

This section describes issues that need to be addressed or resolved prior or while completing the desgn as well as issues that may influence the design process.

2.1 Assumptions

Have you ever mounted a camera on to your helmet and rode down a mountainous trail? What about trying to capture yourself while water skiing? Watching the video usually turns out shaky and in one perspective. Would it be nice to be able to see what you did wrong that caused you to fall of your bike? Most of the time you can't see what went wrong. What if you could do all of that while still capturing amazing views? All this can be accomplished while being as simple as powering on a couple of devices.

2.2 Realistic Constraints

Every system has constraints and Anzhelka is no exception. Our quadrotor can only travel so fast, about 10 mph, therefore it wouldn't be able to keep up with anything much faster than that. Large gust of wind could cause problems with keeping the quadrotor platform stable enough to keep the camera from shaking. Wet weather would be large problem and would cause unknown and uncalculated problems.

2.3 System Environment and External Interfaces

To be able to accomplish all of these tasks there is a lot of interfacing between many different devices. Our main control board must control all 4 ESC's, communicate with the IMU via I2C, servos must be controlled via PWM signals, voltage and current of each motor is monitored via a specially designed circuit.

2.4 Budget and Cost Analysis

Unfortunately there was no money that was given to the team in order to support the project. All of the funding had come from the team members own personal accounts. Below is an exert from our spreadsheet with the cost analysis and money spent on this project.

INSERT COST TABLE HERE

Update table before adding

2.5 Safety

When dealing with any autonomous system one must take extreme cautions in order to insure the safety of everyone. Autonomous systems are dangerous because there is no one behind the controls of the system and can become unpredictable in the event of a system failure.

During the design process of the frame the team made sure to use proper spec fasteners, washers, and nuts. Also, all threaded components were secured using blue lock tight to ensure that nothing would loosen on its own.

Whenever flying an aerial vehicle be sure to wear safety glasses to protect your eyes in the event that the propeller has a failure and is detached/released from the motor(s).

2.6 Risks and Volatile Areas

Should we keep this section?

2.7 Importance of Team Work

Being able to work in a team is both a skill and a challenge. Working on a project in a group helps you split up the work load and possibly get more work done in less time, however being able to work together with others on the project could present a greater challenge than the project itself. This was a foreseen challenge and the team set up a Git repository for all code, data, images, and presentations. There was also an official blog set up where we could go in great detail on what we were working on and we had yet to complete. With these two resources set up and with the help of keeping an open schedule the team has come to realize how important team work really is.

3 System Design

System Designthis level of design includes the entire system, including the people and processes involved, and not just the software architecture.

3.1 Experiment Design

3.2 Experiment Results and Feasibility

4 Program Design

Program Designeach component of the selected solution approach should be carefully designed

4.1 System Architecture

4.2 Rationale and Alternatives

5 Construction of a Prototype

Given the relatively short duration of the class, completion of the project may not be possible; however, you must do your best to produce a working prototype that implements the most important core

functionality of the system you have envisions. If graphical output is not possible, create some screen mock-ups on your own.

5.1 Intermediate Project Reports

Intermediate Project ReportsDocument your progress. Both intermediate ! ! ! project reports should describe your progress toward the construction of the overall prototype. This section should include two brief summaries that document your project at the time of the intermediate demonstrations.

Not required because these were admitted.

5.2 Hardware

Luke

5.3 Software

Cody

6 Implementation

Implementation Here, provide an overview of the high-level code structure of your application. What are the key data structures, modules, etc. Do not provide source code here; it should be an Appendix instead.

6.1 High Level Hardware Design

Luke

6.2 High Level Software Design

Cody

7 Testing

TestingYou are expected to have a detailed test plan, including Unit testing Integration testing Acceptance testing If you are unfamiliar with these terms, look them up. Search engines are marvelous inventions.

7.1 Unit Testing

7.2 Integration Testing

7.3 Acceptance Testing

8 Maintence Plan

You are expected to produce a maintenance plan, which states how you plan to keep the software solution current with future environment changes. Here, we assume that you will maintain your project following the 10 week course period, even though we know that this is not really the case.

8.1 For the next 10 weeks

8.2 For the next year

9 Engineering Effort and Societal Impacts

Engineering Effort and Societal ImpactsEach project must consider realistic constraints on time and money, and should consider safety, reliability, aesthetics, ethics, and other possible social impacts. Produce a short (1-2 page) statement that describes how your group has addressed these key issue.

Essay time!!!

9.1 Project Managementl

9.2 Requirements Traceability Matrix

9.3 Packaging and Installation Issues

9.4 Design Metrics to be used

9.5 Restrictions, Limitations, and Constraints

10 Conclusions

ConclusionsAssume that you write this just before handing in your document. Summarize briey what you did for you project. Address the following; what most surprised you about the process of creating the project. What would you do differently if you had to do it again?

11 References

ReferencesEvery, book, paper, webpage you used must be cited in a standard format. You could use the American Psychological format [1, 2], or the IEEE standard [3], or any other format so long as you are consistent and complete. You should also reference any standard template libraries used in your code. [1] Burgess, P., S. (1995). A Guide for Writing Research Papers based on Styles Recommended ! ! by The American Psychological Association. [2] Coppola, L. (2000). The APA Citation Format. Rochester Institute of Technology, Wallace [3] Institute of Electrical and Electronics Engineers (2000). Computer science style guide.

12 Appendices

AppendicesInclude the following: Source code printed in the 2 pages per page format. A printed copy of the slides used for your nal presentation. If you use ! ! animation in your slides, then you need to sanitize the slides so that they are readable when printed.. A professional quality one-page resume for each member of the group. Use the ! ! ! same template for each resume.

13 Acknowledgements

AcknowledgementsThank anyone who helped your group with the project.