University of Idaho

CS Capstone Design

Capstone Portfolio

Drone Mission Planning Software

Team:
Mission Control

Authors:
David Klingenberg
Taylor Trabun

Advisors:
Dr. Bruce Bolden
Dr. Robert Rinker

Customer:
Brandon Ortiz

December 4, 2014

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1 Team Member Contact Information

Name	Phone Number	Email Address
David Klingenberg	(208) 310-9657	bigwookiee@Gmail.com
Taylor Trabun	(509) 995-0904	trab1744@vandals.uidaho.edu

Table 1: Team Member Contact Information

2 Introduction

Software to create and upload a flight plan to a quad copter drone. The flight plan will be uploaded using xBee radio communication.

This project will use off-the-shelf parts. ATMEL© based microcontrollers found on ardunio based open source boards is the current preference.

2.1 Target Priorities

Number	Category	Need	Importance
1	Quadcopter	Center of Gravity Refined	5
2	Quadcopter	Reliable Flight	5
3	Quadcopter	Functioning xBee Hardware	4
4	Quadcopter	Hardware (Microcontroller) with xAPI and services to control flight	5
5	Quadcopter	Controlled with XP communications	4
6	Quadcopter	Autoland	5
7	Software	software package for flight planning	2
8	Software	API for sending commands from computer	2

Table 2: Priorities

3 Initial Client Interview Transcript 9/10/14

Mentor/Client: Brandon Ortiz

3.1 Meetings

We will be having weekly meetings in Brandon's office on Thursdays at 3:30 PM. These meeting will include status updates, further work on designs, troubleshooting, and assignment of tasks

3.2 End Goal

To have a stable and flying quadcopter that can be communicated with remotely. In addition, work done on a flight planning software (including GUI) should be underway. The project will be done in small steps, as this project requires research and development throughout.

3.3 First Steps

- Learn how quadcopter works
- Reconstruct quadcopter to be stable
- Learn how to fly quadcopter
- Understand flight computer documentation
- Design communications
- Be sure to use xAPI

3.4 Requirements

- Functional quadcopter (stable)
- Documentation of quadcopter construction
- Use of xAPI on arduino communication system
- Communication system using xBEE to communicate from computer to quadcopter
- Ability to send commands to quadcopter
- Flight planning software, including GUI

3.5 Other Notes

Other notes from the meeting included aviation terminology, how to pair the remote control and quadcopter receiver, quick tour of controller and motor adjustments, and a quick tour of flight computer.

4 Meeting Agendas

4.1 Sept. 10, 2014

Mission Control Team Agenda

Friday September 10, 2014.
1500 — 1600 in JEB Think Tank.

Type of Meeting
Initial client interview.

Attendees
David Klingenberg
Taylor Trabun
Brandon Ortiz

Topics

Topic	Responsible	Time (in minutes)
Product Overview	Brandon	15
System Requirements	Brandon	15
Tasks Breakdown	Open Discussion	15
Question & Answers	Open Discussion	25

Additional Information: This is our initial client interview.

4.1.1 Minutes from Friday September 10 Meeting

Refer to Section 3 initial client transcript.

4.2 Sept. 18, 2014

Mission Control Team Agenda

Thrusday September 18, 2014.
1500 — 1600 in JEB Think Tank.

Type of Meeting
Initial Planning

Attendees
David Klingenberg
Taylor Trabun
Brandon Ortiz
Bruce Bolden

Topics

Topic	Responsible	Time (in minutes)
Progress Report	David, Taylor	5
System Overview	Brandon	10
Tasks Breakdown	Open Discussion	20
Additional Words of Wisdom	Bruce	5
Question & Answers	Open Discussion	20

Additional Information:
The rerouting and reconfiguring of the drone is proceeding nicely. It progress will be shown at the meeting time.

4.2.1 Minutes from Thursday September 18 Meeting

- 1505Meeting Started
- Discussed drone rebuild progress.
- Evaluated ESC bin for the drone.
  - Refer to figur 4 in Appendix C
- Discussed, evaluated, and illustrated the communication sequence.
  - Refer to figur 1 in Appendix A
- 1610 Meeting

4.3 Sept. 25, 2014

Mission Control Team Agenda

Thrusday September 25, 2014. 1530 — 1630 in JEB 37

Type of Meeting
Status Report and Next Week Planning

Attendees
David Klingenberg
Taylor Trabun
Brandon Ortiz

Topics

Topic	Responsible	Time (in minutes)
Progress Report	David & Taylor	10
Demonstrations	David & Taylor	10
New Tasks	Open Discussion	20
Question & Answers	Open Discussion	20

Additional Information:

4.3.1 Minutes from Thursday September 25 Meeting

- 1530 Meeting Start
- Discussed LCD use on Arduinos.
- Reviewed TUN packets.
- Status updates
  - Things moving along.
  - Getting closer to flying possibly next Thursday.
- xBee discussion on how to connect.
- Evaluated future problems.
  - Gyros and accelerometers need to be implemented separately from the flight computer.
- 1630 Meeting Ended

4.4 Oct. 2, 2014

Mission Control Team Agenda

Thrusday October 2, 2014. 1530 — 1630 in JEB 37

Type of Meeting
Status Report and Next Week Planning

Attendees
David Klingenberg
Taylor Trabun
Brandon Ortiz

Topics

Topic	Responsible	Time (in minutes)
Progress Report	David & Taylor	10
Demonstrations	David & Taylor	10
New Tasks	Open Discussion	20
Question & Answers	Open Discussion	20

Additional Information:

4.4.1 Minutes from Thursday October 2 Meeting

- 1530 Meeting Start
- Status updates.
  - Taylor has one-way communications working.
  - David finished a prototype for the ECS bin.
    - Bin needs its weight reduced.
    - ECS cables need to be lengthened.
- To
  - Taylor will attempt to get XP comm working.
  - David will finish quadcopter.
  - Get a new adrenal for running a second xBee radio.
  - Solder new LCD board.

- xBee Configuration notes.
  - Use XCTU tool for configuration.
  - Need FID drivers installed for XCTU tool.
- 1630 Meeting Ended

4.5 Oct. 9, 2014

Mission Control Team Agenda

Thrusday October 9, 2014. 1530 — 1630 in JEB 37

Type of Meeting
Status Report and Next Week Planning

Attendees
David Klingenberg
Taylor Trabun
Brandon Ortiz

Topics

Topic	Responsible	Time (in minutes)
Progress Report	David & Taylor	10
Demonstrations	David & Taylor	10
New Tasks	Open Discussion	20
Question & Answers	Open Discussion	20

Additional Information:

4.5.1 Minutes from Thursday October 9 Meeting

- 1530 Meeting Start
- Update
  - Taylor is preparing for snapshot day.
  - David
    - Quadcopter rebuilt.
    - Simple xBee terminals working between two computers.

- New Resources
  - UAV control paper with GUI design example.
  - Survey of UAV papers.
- Action Items
  - David will experiment with PWM and the quadcopter and portfolio.
  - Taylor will work on poster for snapshot day and continue working on communications.
- Test Flight
  - Quadcopter has severe drift forward. David will work on solution.
- 1630 Meeting Ended

4.6 Oct. 16, 2014

Mission Control Team Agenda

Thrusday October 16, 2014. 1530 — 1630 in JEB 37

Type of Meeting
Status Report and Next Three Week Planning

Attendees
David Klingenberg
Taylor Trabun
Brandon Ortiz

Topics

Topic	Responsible	Time (in minutes)
Progress Report	David & Taylor	10
Demonstrations	David & Taylor	10
New Tasks	Open Discussion	20
Question & Answers	Open Discussion	20

Additional Information:
Our next meeting will be in 3 weeks Nov 6, 2014.

4.6.1 Minutes from Thursday October 16 Meeting

- 1530 Meeting Start
- Update
  - Tatlor reported on snapshot day and his progress with the zigBee radios.
  - David
    - Begin fine-tuning the drone for stabilization and self level flight. Drifting stability have been greatly improved.
- New Resources
- Action Items
  - David will continue to experiment with PWM and the quadcopter. He will explore control algorithms.
  - Taylor will continue his work on communications.
- Test Flight
  - Quadcopter severe forward drift has been improved. David needs to develop a battery frame to stop the batteries from shifting which is causing some of the uncontrolled drift.
- 1630 Meeting Ended

4.7 Nov. 6, 2014

Mission Control Team Agenda

Thrusday November 6, 2014. 1530 — 1630 in JEB 37

Type of Meeting
Status Report and additional Short-term Planning.

Attendees
David Klingenberg
Taylor Trabun
Brandon Ortiz

Topics

Topic	Responsible	Time (in minutes)
Progress Report	David & Taylor	10
Demonstrations	David & Taylor	10
New Tasks	Open Discussion	20
Question & Answers	Open Discussion	20

Additional Information:
Our next meeting will be Nov 20, 2014.

4.7.1 Minutes from Thursday October 16 Meeting

- 1530 Meeting Start
- Update
  - Taylor
    - Gui mock-up finished, class documentation work (design review presentation, wiki).
  - David
    - Having a great deal of problem with PWM as an input to flight computer. Will have to try different firmware's for the flight computer and explore possible alternatives to PWM.
- New Resources
- Action Items

  - David will continue to experiment with PWM and the quadcopter. Will explore control algorithms used by existing quad copters.
  - Taylor will continue his work on communications.

- Test Flight
  - Quadcopter severe forward drift has been improved. David needs to develop a battery frame to stop the batteries from shifting.

- 1630 Meeting Ended

4.8 Nov. 20, 2014

Mission Control Team Agenda

Thrusday November 20, 2014. 1530 — 1630 in JEB 37

Type of Meeting
Status Report and additional Short-term Planning.

Attendees
David Klingenberg
Taylor Trabun
Brandon Ortiz

Topics

Topic	Responsible	Time (in minutes)
Progress Report	David & Taylor	10
Demonstrations	David & Taylor	10
New Tasks	Open Discussion	20
Question & Answers	Open Discussion	20

Additional Information:
Our next meeting will be Dec 4, 2014.

4.8.1 Minutes from Thursday October 16 Meeting

- 1530 Meeting Start
- Update
  - Taylor
    - Worked with Brandon to debug XBee comms, still under-way Action Items 15min
  - David
    - Focusing more on senior design and plans on continuing to work on project next semester, code written for PWM flight control
- New Resources
- Action Items
  - David is working on PWM, PWM flight service, team citizenship form

– Taylor is working on design document, wiki update, team citizenship form, continue working out XBee comm bugs and send EXTERNAL$_L CDTUN packet to another Arduino successfully.$

- Test Flight
  - Broken bones and foul weather will place any future flight testing on hold.
- 1630 Meeting Ended

Appendices

A Miscellaneous UML Charts

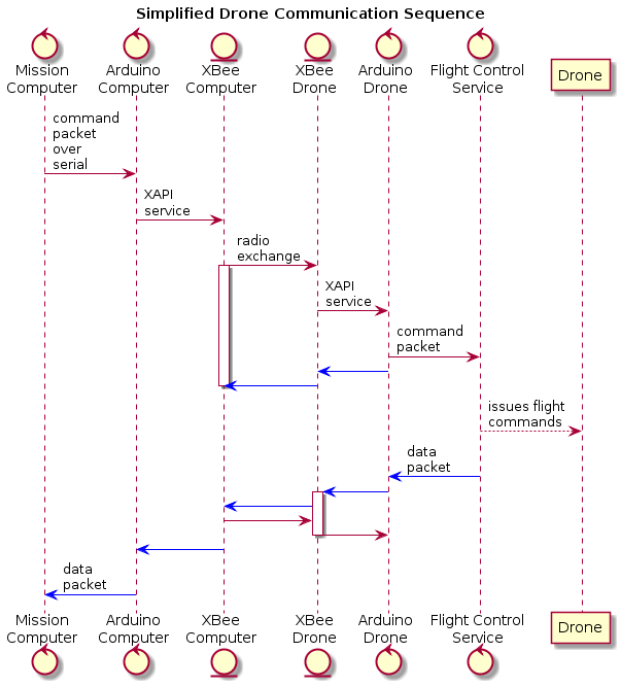

Figure 1: Communication Sequence

B ATMEL© Microcontrollers

Features

- High-performance, Low-power Atmel® AVR® 8-bit Microcontroller
- Advanced RISC Architecture
  - 131 Powerful Instructions – Most Single-clock Cycle Execution
  - 32 x 8 General Purpose Working Registers
  - Fully Static Operation
  - Up to 20 MIPS Throughput at 20MHz
- High Endurance Non-volatile Memory segments
  - 64 Kbytes of In-System Self-programmable Flash program memory
  - 2 Kbytes EEPROM
  - 4 Kbytes Internal SRAM
  - Write/Erase cyles: 10,000 Flash/100,000 EEPROM(1)(3)
  - Data retention: 20 years at 85°C/100 years at 25°C(2)(3)
  - Optional Boot Code Section with Independent Lock Bits
    - In-System Programming by On-chip Boot Program
    - True Read-While-Write Operation
  - Programming Lock for Software Security
- JTAG (IEEE std. 1149.1 Compliant) Interface
  - Boundary-scan Capabilities According to the JTAG Standard
  - Extensive On-chip Debug Support
  - Programming of Flash, EEPROM, Fuses, and Lock Bits through the JTAG Interface
- Peripheral Features
  - Two 8-bit Timer/Counters with Separate Prescalers and Compare Modes
  - One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode
  - Real Time Counter with Separate Oscillator
  - Six PWM Channels
  - 8-channel, 10-bit ADC
    - Differential mode with selectable gain at 1x, 10x or 200x
  - Byte-oriented Two-wire Serial Interface
  - One Programmable Serial USART
  - Master/Slave SPI Serial Interface
  - Programmable Watchdog Timer with Separate On-chip Oscillator
  - On-chip Analog Comparator
  - Interrupt and Wake-up on Pin Change
- Special Microcontroller Features
  - Power-on Reset and Programmable Brown-out Detection
  - Internal Calibrated RC Oscillator
  - External and Internal Interrupt Sources
  - Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby and Extended Standby
- I/O and Packages
  - 32 Programmable I/O Lines
  - 40-pin PDIP, 44-lead TQFP, and 44-pad QFN/MLF
- Speed Grades
  - ATmega644V: 0 - 4MHz @ 1.8V - 5.5V, 0 - 10MHz @ 2.7V - 5.5V
  - ATmega644: 0 - 10MHz @ 2.7V - 5.5V, 0 - 20MHz @ 4.5V - 5.5V
- Power Consumption at 1MHz, 3V, 25°C
  - Active: 240µA @ 1.8V, 1MHz
  - Power-down Mode: 0.1µA @ 1.8V

Notes: 1. Worst case temperature. Guaranteed after last write cycle.
2. Failure rate less than 1 ppm.
3. Characterized through accelerated tests.

8-bit Atmel Microcontroller with 64K Bytes In-System Programmable Flash

ATmega644/V

2593O–AVR–02/12

Figure 2: ATmega644

Atmel

Atmel ATmega640/V-1280/V-1281/V-2560/V-2561/V

8-bit Atmel Microcontroller with 16/32/64KB In-System Programmable Flash

DATASHEET

Features

- High Performance, Low Power Atmel® AVR® 8-Bit Microcontroller
- Advanced RISC Architecture
  - 135 Powerful Instructions – Most Single Clock Cycle Execution
  - 32 × 8 General Purpose Working Registers
  - Fully Static Operation
  - Up to 16 MIPS Throughput at 16MHz
  - On-Chip 2-cycle Multiplier
- High Endurance Non-volatile Memory Segments
  - 64K/128K/256KBytes of In-System Self-Programmable Flash
  - 4Kbytes EEPROM
  - 8Kbytes Internal SRAM
  - Write/Erase Cycles:10,000 Flash/100,000 EEPROM
  - Data retention: 20 years at 85°C/ 100 years at 25°C
  - Optional Boot Code Section with Independent Lock Bits
    - In-System Programming by On-chip Boot Program
    - True Read-While-Write Operation
  - Programming Lock for Software Security
    - Endurance: Up to 64Kbytes Optional External Memory Space
- Atmel® QTouch® library support
  - Capacitive touch buttons, sliders and wheels
  - QTouch and QMatrix acquisition
  - Up to 64 sense channels
- JTAG (IEEE® std. 1149.1 compliant) Interface
  - Boundary-scan Capabilities According to the JTAG Standard
  - Extensive On-chip Debug Support
  - Programming of Flash, EEPROM, Fuses, and Lock Bits through the JTAG Interface
- Peripheral Features
  - Two 8-bit Timer/Counters with Separate Prescaler and Compare Mode
  - Four 16-bit Timer/Counter with Separate Prescaler, Compare- and Capture Mode
  - Real Time Counter with Separate Oscillator
  - Four 8-bit PWM Channels
  - Six/Twelve PWM Channels with Programmable Resolution from 2 to 16 Bits (ATmega1281/2561, ATmega640/1280/2560)
  - Output Compare Modulator
  - 8/16-channel, 10-bit ADC (ATmega1281/2561, ATmega640/1280/2560)
  - Two/Four Programmable Serial USART (ATmega1281/2561, ATmega640/1280/2560)
  - Master/Slave SPI Serial Interface
  - Byte Oriented 2-wire Serial Interface
  - Programmable Watchdog Timer with Separate On-chip Oscillator
  - On-chip Analog Comparator
  - Interrupt and Wake-up on Pin Change
- Special Microcontroller Features
  - Power-on Reset and Programmable Brown-out Detection
  - Internal Calibrated Oscillator
  - External and Internal Interrupt Sources
  - Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby, and Extended Standby
- I/O and Packages
  - 54/86 Programmable I/O Lines (ATmega1281/2561, ATmega640/1280/2560)
  - 64-pad QFN/MLF, 64-lead TQFP (ATmega1281/2561)
  - 100-lead TQFP, 100-ball CBGA (ATmega640/1280/2560)
  - RoHS/Fully Green
- Temperature Range:
  - -40°C to 85°C Industrial
- Ultra-Low Power Consumption
  - Active Mode: 1MHz, 1.8V: 500µA
  - Power-down Mode: 0.1µA at 1.8V
- Speed Grade:
  - ATmega640V/ATmega1280V/ATmega1281V:
    - 0 - 4MHz @ 1.8V - 5.5V, 0 - 8MHz @ 2.7V - 5.5V
  - ATmega2560V/ATmega2561V:
    - 0 - 2MHz @ 1.8V - 5.5V, 0 - 8MHz @ 2.7V - 5.5V
  - ATmega640/ATmega1280/ATmega1281:
    - 0 - 8MHz @ 2.7V - 5.5V, 0 - 16MHz @ 4.5V - 5.5V
  - ATmega2560/ATmega2561:
    - 0 - 16MHz @ 4.5V - 5.5V

2549Q–AVR–02/2014

Figure 3: ATmega2560

C Technical Drawings

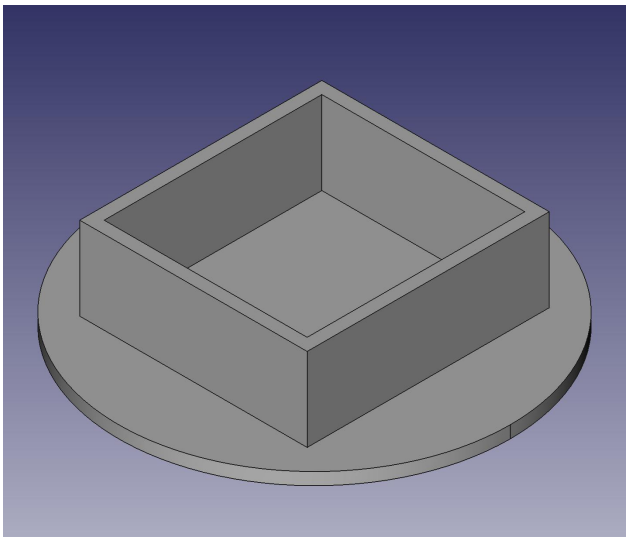

Figure 4: Electronic speed controller part bin