University of Idaho

CS Capstone Design

Capstone Portfolio

Drone Mission Planning Software

Team:
Mission Control

Authors:
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Advisors:
Dr. Bruce Bolden
Dr. Robert Rinker

Customer:
Brandon Ortiz

May 5, 2015

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1 Team Member Contact Information

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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 9 in Appendix C
- Discussed, evaluated, and illustrated the communication sequence.
  - Refer to figur 4 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.
- 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
- 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_LCD TUN packet to another Arduino successfully.

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

- 1630 Meeting Ended

4.9 Jan. 22, 2015

Mission Control Team Agenda

Thursday January 22, 2015.
1100 — 1200 in JEB 30

Type of Meeting
Introductory Meeting

Attendees
David Klingenberg
Taylor Trabun
Emeth Thompson
Joe Higley

Topics Assign responsibilities to new members and bring new members "up to speed" on the state of the project.

Additional Information:

4.9.1 Minutes from Thursday January 22 Meeting

- 1100 Meeting Start
- All documents and software is on Github.
- goal: build GUI to mission plan for autonamous drones.
- review: hardware, communications, and GUI.
- goal: missions are expected to operate within visable range.
- goal: flight instruments for the GUI
- discussion: ideal design is modular with ability to add tools easily.
- hardware: need gps module
- goal: Basic Functionality
  - auto take-off
  - maintain position
  - auto-land

  - move from point of orgin to destination point

- 1200 Meeting Ended

4.10 Jan. 27, 2015

Mission Control Team Agenda

Tuesday January 27, 2015.
1100 — 1200 in JEB 30

Type of Meeting
Discussion

Attendees
David Klingenberg
Taylor Trabun
Emeth Thompson
Joe Higley
Brandon Ortiz

Topics Goals for GUI
Communications

Additional Information:

4.10.1 Minutes from Tuesday January, 27 Meeting

- 1100 Meeting Start
- Discussion: Communications
  - What information needs to be passed?
  - Packet design
- Brandon layed out goals and expectations
- 1200 Meeting Ended

4.11 Feb. 3, 2015

Mission Control Team Agenda

Tuesday February, 3 2015.
1100 — 1200 in JEB 30

Type of Meeting
Demonstration and Discussion

Attendees
David Klingenberg
Taylor Trabun
Emeth Thompson
Joe Higley
Brandon Ortiz

Topics Joe's GUI prototype

Additional Information:

4.11.1 Minutes from Tuesday February, 3 Meeting

- 1100 Meeting Start
- Demonstration: GUI prototype
- GUI needs topographical data and potentially the ability to mapp gps
- Real-time Controls
  - emergency land button
  - stop and hover button
- Instrument Panel
  - artificial horizon
  - vertical speed indicator
  - dial compass
  - two-minute turn coordinator
  - speed: number in a box
  - altitude: number in a box

- BRANDON
  - need to make extra propellors
  - flight tests: drone debugging - David is making parts via 3D printing
  - Goal: need to be able to take-off -¿ hover -¿ land via communications of a mission plan and real-time controls
  - self take-off
  - altitude control
  - landing
- Organize: Design review
  - Taylor - communications
  - David - hardware
  - Emeth - Documentation and slides
  - Joe - GUI
- Assignment: Emeth - investigate topographical mapping or google maps
- Assignment: Joe - Serial Communication and Xapi
- 1210 Meeting Ended

4.12 Feb. 17, 2015

Mission Control Team Agenda

Tuesday February 17, 2015.
1100 — 1200 in JEB 30

Type of Meeting
Discussion and Review

Attendees
David Klingenberg
Taylor Trabun
Emeth Thompson
Joe Higley

Topics Discuss design review and update goals

Additional Information:

4.12.1 Minutes from Tuesday January, 27 Meeting

- 1100 Meeting Start
- design review went well
- Taylor and Joe combined the mission control GUI and serial port terminal.
- 1200 Meeting Ended

4.13 March 5, 2015

Mission Control Team Agenda

Thursday March 5, 2015.
1100 — 1200 in JEB 30

Type of Meeting
Working Meeting

Attendees
David Klingenberg
Taylor Trabun
Emeth Thompson
Joe Higley

Topics Discuss and prepare for upcomming snapshot day

Additional Information:

4.13.1 Minutes from March 5, 2015 Meeting

- 1100 Meeting Start
- Taylor and Joe work on the software side
- David and Emeth discussed the poster
- 1200 Meeting Ended

5 Code

5.1 Supplemental quad copter autopilot V1.4

```
1 /*****************************
2 Version 1.4
3
4 Supplemental quad copter Autopilot.
5
6  Contains a prototype controller algorithm
7  to maintain an altitude hold. In this
8  version  only an ultrasonic rangefinder
9  is used to measure altitude.
10
11 Important numbers for the kk2.1
12
13 center satick :1500 micro seconds
14 Full Right/Back: 2100
15 Full Left/Forward: 900
16
17 100% Throttle: 2300
18 0% Throttle: 1000
19 *****************************/
20
21 #include <Servo.h>
22 #include <NewPing.h>
23 #include <PID_v1.h>
24 #include <Adafruit_LSM303_U.h>
25 #include <Adafruit_BMP085_U.h>
26 #include <Adafruit_L3GD20_U.h>
27 #include <Adafruit_Sensor.h>
28 #include <Wire.h>
29
30
31 /*  INPUT RANGE */
32 #define ZERO_THROTTLE   1000
33 #define FULL_THROTTLE   2300
34
35 #define FULL_STICK_LEFT_FORWARD   900
36 #define FULL_STICK_RIGHT_BACK     2100
37 #define ZERO_STICK                1500
38
39 /* Pin assignments. */
```

```
40 #define AILERONS_PIN   2
41 #define ELEVATOR_PIN   3
42 #define THROTTLE_PIN   4
43 #define RUDDER_PIN     5
44 #define AUX            6
45
46
47 /* Sonar Setup */
48 #define GROUND_PING_PIN              12
49 #define GROUND_ECHO_PIN              11
50 #define GROUND_MAX_SONAR_DISTANCE 200
51 #define GROUND_SONAR_ITERATION     5
52
53 /*  PID Setup */
54 #define thr_out_range 1.25
55 #define Kp_add       0
56 #define Ki_add       1
57 #define Kd_add       2
58 #define auxset_add   3
59 #define pidMode_add 4
60
61 void zero_stick();
62 void zero_all_inputs();
63 void set_thr(int);
64 void set_ali(int);
65 void set_elv(int);
66 void set_rud(int);
67 void setup_pins();
68 byte arm();
69 byte disarm();
70
71
72 /* Global Variables */
73 double                    altitude_hold, ground_range_value,
       throttle_position;
74 byte                      RangeTime_1cm;
75 int                       groundRangeTime;
76 Servo                     throttle, rudder, aileron, elevator, aux;
77 byte                      armed;
78 NewPing                   ground_range(GROUND_PING_PIN, GROUND_ECHO_PIN,
       GROUND_MAX_SONAR_DISTANCE);
79
```

```
80 /* Global Sensor Variables */
81 Adafruit_LSM303_Accel_Unified acc =
       Adafruit_LSM303_Accel_Unified(30301);
82 Adafruit_LSM303_Mag_Unified   mag   =
       Adafruit_LSM303_Mag_Unified(30302);
83 Adafruit_BMP085_Unified       bmp   = Adafruit_BMP085_Unified(18001);
84 Adafruit_L3GD20_Unified       gyro  = Adafruit_L3GD20_Unified(20);
85 sensors_event_t event;
86
87 /* Global PID Variables */
88 PID altPID(&ground_range_value, &throttle_position, &altitude_hold, 2,
       5, 1, DIRECT);
89
90 /* Pin secttion. */
91 void setup_pins(){
92   aileron.attach(AILERONS_PIN);
93   elevator.attach(ELEVATOR_PIN);
94   throttle.attach(THROTTLE_PIN);
95   rudder.attach(RUDDER_PIN);
96 }
97
98 /*
99 void displaySensorDetails(void)
100 {
101   sensor_t sensor;
102
103   accel.getSensor(&sensor);
104   Serial.println(F("------------ ACCELEROMETER ------------"));
105   Serial.print  (F("Sensor:       ")); Serial.println(sensor.name);
106   Serial.print  (F("Driver Ver:   ")); Serial.println(sensor.version);
107   Serial.print  (F("Unique ID:    "));
          Serial.println(sensor.sensor_id);
108   Serial.print  (F("Max Value:    ")); Serial.print(sensor.max_value);
          Serial.println(F(" m/s^2"));
109   Serial.print  (F("Min Value:    ")); Serial.print(sensor.min_value);
          Serial.println(F(" m/s^2"));
110   Serial.print  (F("Resolution:   "));
          Serial.print(sensor.resolution); Serial.println(F(" m/s^2"));
111   Serial.println(F("------------------------------------"));
112   Serial.println(F(""));
113
114   gyro.getSensor(&sensor);
```

```
115   Serial.println(F("------------ GYROSCOPE ----------"));
116   Serial.print  (F("Sensor:       ")); Serial.println(sensor.name);
117   Serial.print  (F("Driver Ver:   ")); Serial.println(sensor.version);
118   Serial.print  (F("Unique ID:    "));
          Serial.println(sensor.sensor_id);
119   Serial.print  (F("Max Value:    ")); Serial.print(sensor.max_value);
          Serial.println(F(" rad/s"));
120   Serial.print  (F("Min Value:    ")); Serial.print(sensor.min_value);
          Serial.println(F(" rad/s"));
121   Serial.print  (F("Resolution:   "));
          Serial.print(sensor.resolution); Serial.println(F(" rad/s"));
122   Serial.println(F("------------------------------------"));
123   Serial.println(F(""));
124
125   mag.getSensor(&sensor);
126   Serial.println(F("----------- MAGNETOMETER ----------"));
127   Serial.print  (F("Sensor:       ")); Serial.println(sensor.name);
128   Serial.print  (F("Driver Ver:   ")); Serial.println(sensor.version);
129   Serial.print  (F("Unique ID:    "));
          Serial.println(sensor.sensor_id);
130   Serial.print  (F("Max Value:    ")); Serial.print(sensor.max_value);
          Serial.println(F(" uT"));
131   Serial.print  (F("Min Value:    ")); Serial.print(sensor.min_value);
          Serial.println(F(" uT"));
132   Serial.print  (F("Resolution:   "));
          Serial.print(sensor.resolution); Serial.println(F(" uT"));
133   Serial.println(F("------------------------------------"));
134   Serial.println(F(""));
135
136   bmp.getSensor(&sensor);
137   Serial.println(F("-------- PRESSURE/ALTITUDE ---------"));
138   Serial.print  (F("Sensor:       ")); Serial.println(sensor.name);
139   Serial.print  (F("Driver Ver:   ")); Serial.println(sensor.version);
140   Serial.print  (F("Unique ID:    "));
          Serial.println(sensor.sensor_id);
141   Serial.print  (F("Max Value:    ")); Serial.print(sensor.max_value);
          Serial.println(F(" hPa"));
142   Serial.print  (F("Min Value:    ")); Serial.print(sensor.min_value);
          Serial.println(F(" hPa"));
143   Serial.print  (F("Resolution:   "));
          Serial.print(sensor.resolution); Serial.println(F(" hPa"));
144   Serial.println(F("------------------------------------"));
```

```
145   Serial.println(F(""));
146
147   delay(1500);
148 }
149 */
150
151 /*  Zero out  the control x,y and rotational inputs. */
152 void zero_stick(){
153   aileron.writeMicroseconds(ZERO_STICK);
154   elevator.writeMicroseconds(ZERO_STICK);
155   rudder.writeMicroseconds(ZERO_STICK);
156 }
157
158 void zero_all_inputs(){
159   zero_stick();
160   set_thr(0);
161 }
162
163 /* Sets the throttle. Use a range of 0 to 100. */
164 void set_thr (int val){
165   throttle.writeMicroseconds(map(val, 0, 100, ZERO_THROTTLE,
        FULL_THROTTLE));
166   //Serial.println(map(val, 0, 100, ZERO_THROTTLE, FULL_THROTTLE));
167 }
168
169 /*  Set the ailerons. Use a range of -100 to 100. */
170 void set_ail (int val) {
171   if (val == 0)
172     aileron.writeMicroseconds(ZERO_STICK);
173   else
174     aileron.writeMicroseconds(map(val, -100, 100,
          FULL_STICK_LEFT_FORWARD, FULL_STICK_RIGHT_BACK));
175 }
176
177 /*  Set the  elevator. Use a range of -100 to 100. */
178 void set_elv (int val) {
179   if (val == 0)
180     elevator.writeMicroseconds(ZERO_STICK);
181   else
182      elevator.writeMicroseconds(map(val, -100, 100,
          FULL_STICK_LEFT_FORWARD, FULL_STICK_RIGHT_BACK));
183 }
```

```
184
185 /*  Set the  rudder. Use a range of -100 to 100. */
186 void set_rud (int val) {
187   if (val == 0)
188     rudder.writeMicroseconds(ZERO_STICK);
189   else
190     rudder.writeMicroseconds(map(val, -100, 100,
          FULL_STICK_LEFT_FORWARD, FULL_STICK_RIGHT_BACK));
191 }
192
193 /* Arms the motors */
194 byte arm(){
195   set_thr(0);
196   set_rud(-100);
197   delay(1000);
198   set_rud(0);
199
200   return 1;
201
202 }
203
204 /* Disarms the motors */
205 byte  disarm(){
206   set_thr(0);
207   set_rud(100);
208   delay(1000);
209   set_rud(0);
210
211   return(0);
212 }
213
214 byte time_1cm(){
215   float temperature, time;
216   bmp.getTemperature(&temperature);
217   time = 2/((331.3 * sqrt(1 + temperature / 273.15))/10000);
218
219 //  Serial.print(temperature);
220 //  Serial.print(" C, time: ");
221 //  Serial.println(time,6);
222   return time;
223 }
224
```

```
225
226 void pid_loop(){
227  int thr_min, thr_max;  //
228
229  //thr_min = throttle_position - thr_out_range;
230  //thr_max = throttle_position + thr_out_range;
231  //altPID.SetOutputLimits(thr_min,thr_max);
232  altPID.Compute();
233  Serial.print((int)throttle_position);
234  throttle.writeMicroseconds((int)throttle_position);
235
236 }
237
238 void setup() {
239   Serial.begin(115200);
240
241   if(!acc.begin())
242   {
243     /* There was a problem detecting the ADXL345 ... check your
          connections */
244     Serial.println(F("Ooops, no LSM303 detected ... Check your
          wiring!"));
245     while(1);
246   }
247   if(!mag.begin())
248   {
249     /* There was a problem detecting the LSM303 ... check your
          connections */
250     Serial.println("Ooops, no LSM303 detected ... Check your wiring!");
251     while(1);
252   }
253   if(!bmp.begin())
254   {
255     /* There was a problem detecting the BMP085 ... check your
          connections */
256     Serial.print("Ooops, no BMP085 detected ... Check your wiring or
          I2C ADDR!");
257     while(1);
258   }
259   if(!gyro.begin())
260   {
261     /* There was a problem detecting the L3GD20 ... check your
```

```
        connections */
262     Serial.print("Ooops, no L3GD20 detected ... Check your wiring or
            I2C ADDR!");
263     while(1);
264   }
265
266   altPID.SetMode(AUTOMATIC);
267   altPID.SetOutputLimits(1000, 2300);
268   throttle_position = 1500;
269   altitude_hold = 20;
270   RangeTime_1cm = time_1cm();
271
272   setup_pins();
273   zero_all_inputs();
274   throttle.writeMicroseconds(throttle_position);
275   delay (1500);
276   //displaySensorDetails();
277 }
278
279
280 void loop(){
281
282   ground_range_value =
          ground_range.ping_median(GROUND_SONAR_ITERATION);
283   ground_range_value = (int)ground_range_value / RangeTime_1cm;
284
285   pid_loop();
286
287   acc.getEvent(&event);
288   Serial.print(" Acc Z: ");
289   Serial.print(event.acceleration.z);
290
291   gyro.getEvent(&event);
292   Serial.print(" gyro Z: ");
293   Serial.print(event.gyro.z);
294
295   Serial.print(" Ping: ");
296   Serial.print(ground_range_value);
297   Serial.println(" cm");
298
299
300
```

```
301     //armed = arm();
302
303     //delay (5000);
304
305     //armed = disarm();
306
307     //delay(10);
308 }
```

./Supplementary_autopilot.c

5.2 Home Arduino Firmware

```
 1 #include <Serial_service.h>
 2 #include <LiquidCrystal.h>
 3 #include <LCD_service.h>
 4 #include <Xapi.h>
 5 #include <Subscriptions.h>
 6 #include <Universal.h>
 7 #include <Util.h>
 8 #include <Single_buff.h>
 9
10 //#include <Arm_service.h>
11 //#include <Heartbeat_service.h>
12 //#include <AltHold_service.h>
13 //#include <Heading_service.h>
14
15 //0013a200
16 //40a1446d
17
18 //*********************************************
19 //*********************************************
20 Xapi xapi = Xapi(Serial);
21 //Serial_service serial_service = Serial_service(Serial1, xapi);
22 LCD_service lcd_service (xapi);
23 Serial_service serial_service = Serial_service(Serial1, xapi,
       lcd_service);
24 //Arm_service arm_service(xapi, lcd_service);
25 //Heartbeat_service heartbeat_service(xapi, lcd_service);
26 uint8_t msg1[] =   "I FEEL GREAT";
27 uint8_t msg2[] =   "COMMODORE 64";
28 uint8_t _clear[] = "                ";
29
30
```

```
31 //*************************************************
32 //*************************************************
33 void setup()
34 {
35  Serial.begin(MISC_PC_SPEED);
36  Serial1.begin(MISC_PC_SPEED);
37
38
39
40 }
41
42 //*************************************************
43 //*************************************************
44 void loop()
45 {
46   system_active();
47   process_buttons();
48   xapi.xapi_latch();
49   lcd_service.lcd_service_latch();
50   serial_service.serial_service_latch();
51   //arm_service.arm_service_latch();
52   //heartbeat_service.heartbeat_service_latch();
53   //delay(4000);
54 }
55
56 //*************************************************
57 //*************************************************
58
59 void process_buttons()
60 {
61   // storage for the button
62   int button;
63
64   button = lcd_service.get_lcd_key();
65
66   // process packet
67   if(button == LCD_btnSELECT)
68   {
69
70     lcd_service.lcd_snd_local_serial_debug((const uint8_t*)"SELECT");
71     //lcd_service.lcd_snd_LOCAL_message(0,0,(const
         uint8_t*)"VICTORY(C)       ");
```

```
72      lcd_service.lcd_snd_EXTERNAL_message(ADDR_MSB, 0x40a1446d,
            ADDR16_BROADCAST,
73                                                  0,0,(const
                                                        uint8_t*)"VICTORY(EN)      ");
74
75
76      /*
77      lcd_service.lcd_snd_EXTERNAL_message(   DEBUG_MSB_ADDR,
78              DEBUG_LSB_ADDR,
79                      DEBUG_ADDR16,
80              0,
81              0,
82              _clear);
83
84
85
86     lcd_service.lcd_snd_EXTERNAL_message(   DEBUG_MSB_ADDR,
87              DEBUG_LSB_ADDR,
88                      DEBUG_ADDR16,
89              0,
90              0,
91              msg1);
92
93    lcd_service.lcd_print(0, 0, (const char*)"first message");
94    lcd_service.lcd_print(0,1, (const char*)"                ");
95
96 */
97    }
98
99    if(button == LCD_btnLEFT )
100   {
101
102     lcd_service.lcd_snd_LOCAL_message(0,0,(const uint8_t*)"GOOD
            JERB!!!!!!");
103
104     /*
105     lcd_service.lcd_snd_EXTERNAL_message(   DEBUG_MSB_ADDR,
106             DEBUG_LSB_ADDR,
107                     DEBUG_ADDR16,
108             0,
109             1,
110             _clear);
```

```
111
112
113       lcd_service.lcd_snd_EXTERNAL_message(   DEBUG_MSB_ADDR,
114                 DEBUG_LSB_ADDR,
115                       DEBUG_ADDR16,
116                 0,
117                 1,
118                 msg2);
119
120     lcd_service.lcd_print(0, 1, (const char*)"second message");
121     lcd_service.lcd_print(0,0, (const char*)"                ");
122
123     */
124     }
125 }
126
127 //*********************************************
128 //*********************************************
129 void system_active()
130 {
131       static uint16_t cnt = 0;
132       static uint8_t row = 0;
133
134       cnt++;
135
136       if ( (cnt%2500) == 0)
137      {
138         // turn off both stars
139         lcd_service.lcd_print(15, 0, (const char*)" ");
140         lcd_service.lcd_print(15, 1, (const char*)" ");
141
142         row++;
143         // turn on new row
144         lcd_service.lcd_print(15, row%2, (const char*)"*");
145
146      }
147
148 }
```

./commCode/XAPI_HOME_ARDUINO.ino

5.3 xAPI Services

5.3.1 Do Move Service

```
1 #ifndef DOMOVE_SERVICE_h
2 #define DOMOVE_SERVICE_h
3 #include <arduino.h>
4 #include <Xapi.h>
5 #include <Util.h>
6 #include <LCD_service.h>
7
8
9 //*********************************************
10 //*********************************************
11
12 class DoMove_service
13 {
14   // objects used
15   private:
16     Xapi& m_xapi;
17     Util m_util;
18     LCD_service& m_lcd;
19   private:
20
21
22   // functions for do_move service
23   private:
24     void reset_TUN_storage();
25     void process_local_TUN_packet();
26     void process_external_TUN_packet();
27
28   // general functions for do_move
29   public:
30     void DoMove_service_latch();
31
32   // Constructor
33   public:
34     DoMove_service(Xapi& _xapi, LCD_service& _lcd);
35 };
36
37 #endif
```

./commCode/DoMove_service.h

```
1
2 #ifndef DOMOVE_SERVICE_cpp
3 #define DOMOVE_SERVICE_cpp
4 #include <DoMove_service.h>
```

```
5
6 //************************************************
7 // This latch is what is called in the microcontroller's
8 // main loop. Put any required processing here
9 //************************************************
10 void DoMove_service::DoMove_service_latch()
11 {
12
13   // process any local LCD message packets
14   process_local_TUN_packet();
15
16   // process any external LCD message packets
17   process_external_TUN_packet();
18 }
19
20
21
22 //************************************************
23 //************************************************
24 // This routine will query the XAPI to see
25 // if there is a local message waiting for
26 // the Land service. If so, we need to grab it and react.
27 void DoMove_service::process_external_TUN_packet()
28 {
29   // see if there is a packet waiting
30   if(m_xapi.CONNECT_external_TUN_get_type() ==
       TUN_TYPE_EXTERNAL_DO_MOVE)
31   {
32     // allocate the space
33     uint8_t TUN_packet[MED_BUFF_SZ];
34
35     // extract the packet
36     m_xapi.CONNECT_external_TUN_get_packet(TUN_packet, MED_BUFF_SZ);
37
38     // do something
39     //lcd prints are for debugging, should be removed
40     m_lcd.lcd_print(0,0,"do move");
41
42
43
44   }
45 }
```

```
46
47 //*************************************************
48 //*************************************************
49 // This routine will query the XAPI to see
50 // if there is a local message waiting for
51 // the Land service. If so, we need to grab it and do something.
52 void DoMove_service::process_local_TUN_packet()
53 {
54   // see if there is a packet waiting
55   if(m_xapi.CONNECT_local_TUN_get_type() == TUN_TYPE_LOCAL_DO_MOVE)
56   {
57     // allocate the space
58     uint8_t TUN_packet[MED_BUFF_SZ];
59
60     // extract the packet
61     m_xapi.CONNECT_local_TUN_get_packet(TUN_packet, MED_BUFF_SZ);
62
63     // do something
64
65   }
66 }
67
68 //*************************************************
69 //*************************************************
70 // Resets the TUN packet storage
71 void DoMove_service::reset_TUN_storage()
72 {
73   // obsolete
74 }
75
76 //*************************************************
77 //*************************************************
78 DoMove_service::DoMove_service(Xapi& _xapi, LCD_service& _lcd):
79 m_xapi(_xapi), m_lcd(_lcd)
80 {
81   reset_TUN_storage();
82
83 }
84
85
86 #endif
```

./commCode/DoMove_service.cpp

5.3.2 Heading Service

```
1 #ifndef HEADING_SERVICE_h
2 #define HEADING_SERVICE_h
3 #include <arduino.h>
4 #include <Xapi.h>
5 #include <Util.h>
6 #include <LCD_service.h>
7
8
9 //*********************************************
10 //*********************************************
11
12 class Heading_service
13 {
14   // objects used
15   private:
16     Xapi& m_xapi;
17     Util m_util;
18     LCD_service& m_lcd;
19   private:
20
21
22   // functions for heading service
23   private:
24     void reset_TUN_storage();
25     void process_local_TUN_packet();
26     void process_external_TUN_packet();
27
28   // general functions for heading
29   public:
30     void heading_service_latch();
31
32   // Constructor
33   public:
34     Heading_service(Xapi& _xapi, LCD_service& _lcd);
35 };
36
37 #endif
```

./commCode/Heading_service.h

```
1 #ifndef HEADING_SERVICE_cpp
2 #define HEADING_SERVICE_cpp
```

```
3 #include <AutoPilot.h>
4 #include <Heading_service.h>
5
6 extern uint8_t bit_autopilot_flags;
7 extern drone_state *P_state;
8 //************************************************
9 // This latch is what is called in the microcontroller's
10 // main loop. Put any required processing here
11 //************************************************
12 void Heading_service::heading_service_latch()
13 {
14
15   // process any local LCD message packets
16   process_local_TUN_packet();
17
18   // process any external LCD message packets
19   process_external_TUN_packet();
20 }
21
22
23
24 //************************************************
25 //************************************************
26 // This routine will query the XAPI to see
27 // if there is a local message waiting for
28 // the Land service. If so, we need to grab it and react.
29 void Heading_service::process_external_TUN_packet()
30 {
31   // see if there is a packet waiting
32   if(m_xapi.CONNECT_external_TUN_get_type() ==
       TUN_TYPE_EXTERNAL_SET_HEADING)
33   {
34     // allocate the space
35     uint8_t TUN_packet[MED_BUFF_SZ];
36     uint8_t payload_buff[SMALL_BUFF_SZ];
37     uint8_t payload_buff_sz = 0;
38     int heading = 0;
39     // extract the packet
40     m_xapi.CONNECT_external_TUN_get_packet(TUN_packet, MED_BUFF_SZ);
41
42     //extract payload
43     payload_buff_sz = m_util.get_TUN_payload(TUN_packet, payload_buff,
```

```
        SMALL_BUFF_SZ);
44
45      //grab height from payload (2s bytes)
46      heading = m_util.hex_to_int(0, 2, payload_buff_sz, payload_buff);
47
48      P_state->hold_head = heading;
49      // do something
50      //lcd prints are for debugging, should be removed
51      //m_lcd.lcd_print(0,0,"*************");
52      //m_lcd.lcd_print(0,0,"Got Takeoff");
53      //m_lcd.lcd_print(0,0,"ttest1");
54      //m_lcd.lcd_print(0,0,"takeoff");
55      //m_lcd.lcd_print(0,0,"ttest2");
56      //if(height = 10){
57      //  m_lcd.lcd_print(0,0,"Height 10");
58      //}
59      //P_state->hold_alt = P_state->ground_alt + height;
60      //bit_autopilot_flags |= ALTHOLD_FLAG;
61    }
62 }
63
64 //*************************************************
65 //*************************************************
66 // This routine will query the XAPI to see
67 // if there is a local message waiting for
68 // the Land service. If so, we need to grab it and do something.
69 void Heading_service::process_local_TUN_packet()
70 {
71   // see if there is a packet waiting
72   if(m_xapi.CONNECT_local_TUN_get_type() ==
        TUN_TYPE_LOCAL_SET_HEADINGs)
73   {
74     // allocate the space
75     uint8_t TUN_packet[MED_BUFF_SZ];
76
77     // extract the packet
78     m_xapi.CONNECT_local_TUN_get_packet(TUN_packet, MED_BUFF_SZ);
79
80     // do something
81
82   }
83 }
```

```
84
85 //************************************************
86 //************************************************
87 // Resets the TUN packet storage
88 void Heading_service::reset_TUN_storage()
89 {
90   // obsolete
91 }
92
93 //************************************************
94 //************************************************
95 Heading_service::Heading_service(Xapi& _xapi, LCD_service& _lcd):
96 m_xapi(_xapi), m_lcd(_lcd)
97 {
98   reset_TUN_storage();
99
100 }
101
102
103 #endif
```

./commCode/Heading_service.cpp

5.3.3 Heading Hold Service

```
1 #ifndef HEADINGHOLD_SERVICE_h
2 #define HEADINGHOLD_SERVICE_h
3 #include <arduino.h>
4 #include <Xapi.h>
5 #include <Util.h>
6 #include <LCD_service.h>
7
8
9 //************************************************
10 //************************************************
11
12 class HeadingHold_service
13 {
14   // objects used
15   private:
16     Xapi& m_xapi;
17     Util m_util;
18     LCD_service& m_lcd;
19   private:
```

```
20
21
22    // functions for headinghold service
23    private:
24      void reset_TUN_storage();
25      void process_local_TUN_packet();
26      void process_external_TUN_packet();
27
28    // general functions for althold
29    public:
30      void headingHold_service_latch();
31
32    // Constructor
33    public:
34      HeadingHold_service(Xapi& _xapi, LCD_service& _lcd);
35 };
36
37 #endif
```

./commCode/HeadingHold_service.h

```
 1 #ifndef HEADINGHOLD_SERVICE_cpp
 2 #define HEADINGHOLD_SERVICE_cpp
 3 #include <AutoPilot.h>
 4 #include <HeadingHold_service.h>
 5
 6 extern uint8_t bit_autopilot_flags;
 7 extern drone_state *P_state;
 8 //************************************************
 9 // This latch is what is called in the microcontroller's
10 // main loop. Put any required processing here
11 //************************************************
12 void HeadingHold_service::headingHold_service_latch()
13 {
14
15   // process any local LCD message packets
16   process_local_TUN_packet();
17
18   // process any external LCD message packets
19   process_external_TUN_packet();
20 }
21
22
23
```

```
24 //************************************************
25 //************************************************
26 // This routine will query the XAPI to see
27 // if there is a local message waiting for
28 // the Land service. If so, we need to grab it and react.
29 void HeadingHold_service::process_external_TUN_packet()
30 {
31   // see if there is a packet waiting
32   if(m_xapi.CONNECT_external_TUN_get_type() ==
       TUN_TYPE_EXTERNAL_HEADING_HOLD)
33   {
34     // allocate the space
35     uint8_t TUN_packet[MED_BUFF_SZ];
36     uint8_t payload_buff[SMALL_BUFF_SZ];
37     uint8_t payload_buff_sz = 0;
38     int hold = 0;
39     // extract the packet
40     m_xapi.CONNECT_external_TUN_get_packet(TUN_packet, MED_BUFF_SZ);
41
42     //extract payload
43     payload_buff_sz = m_util.get_TUN_payload(TUN_packet, payload_buff,
         SMALL_BUFF_SZ);
44
45     //grab height from payload (4 bytes)
46     hold = m_util.hex_to_int(0, 1, payload_buff_sz, payload_buff);
47     switch(hold){
48       case 0:
49         //activate longitude hold
50         bit_autopilot_flags |= LONGHOLD_FLAG;
51         break;
52       case 1:
53         //disable longitude hold
54         bit_autopilot_flags &= ~LONGHOLD_FLAG;
55         break;
56
57       case 2:
58         //activate lat hold
59         bit_autopilot_flags |= LATHOLD_FLAG;
60         break;
61
62       case 3:
63         //disable lat hold
```

```
64          bit_autopilot_flags &= ~LATHOLD_FLAG;
65          break;
66      }
67
68      // do something
69      //lcd prints are for debugging, should be removed
70      //m_lcd.lcd_print(0,0,"************");
71      //m_lcd.lcd_print(0,0,"Got Takeoff");
72      //m_lcd.lcd_print(0,0,"ttest1");
73      //m_lcd.lcd_print(0,0,"takeoff");
74      //m_lcd.lcd_print(0,0,"ttest2");
75      //if(height = 10){
76      //  m_lcd.lcd_print(0,0,"Height 10");
77      //}
78      //P_state->hold_alt = P_state->ground_alt + height;
79      //bit_autopilot_flags |= ALTHOLD_FLAG;
80    }
81 }
82
83 //*************************************************
84 //*************************************************
85 // This routine will query the XAPI to see
86 // if there is a local message waiting for
87 // the Land service. If so, we need to grab it and do something.
88 void HeadingHold_service::process_local_TUN_packet()
89 {
90   // see if there is a packet waiting
91   if(m_xapi.CONNECT_local_TUN_get_type() ==
        TUN_TYPE_LOCAL_HEADING_HOLD)
92   {
93     // allocate the space
94     uint8_t TUN_packet[MED_BUFF_SZ];
95
96     // extract the packet
97     m_xapi.CONNECT_local_TUN_get_packet(TUN_packet, MED_BUFF_SZ);
98
99     // do something
100
101  }
102 }
103
104 //*************************************************
```

```
105 //************************************************
106 // Resets the TUN packet storage
107 void HeadingHold_service::reset_TUN_storage()
108 {
109   // obsolete
110 }
111
112 //************************************************
113 //************************************************
114 HeadingHold_service::HeadingHold_service(Xapi& _xapi, LCD_service&
      _lcd):
115 m_xapi(_xapi), m_lcd(_lcd)
116 {
117   reset_TUN_storage();
118
119 }
120
121
122 #endif
```

./commCode/HeadingHold_service.cpp

5.3.4 Heartbeat Service

```
 1 #ifndef HEARTBEAT_SERVICE_h
 2 #define HEARTBEAT_SERVICE_h
 3 #include <arduino.h>
 4 #include <Xapi.h>
 5 #include <Util.h>
 6 #include <LCD_service.h>
 7
 8
 9 //************************************************
10 //************************************************
11
12 class Heartbeat_service
13 {
14   // objects used
15   private:
16     Xapi& m_xapi;
17     Util m_util;
18     LCD_service& m_lcd;
19     unsigned long lastSent;
20
```

```
21    private:
22
23
24    // functions for land service
25    private:
26      void reset_TUN_storage();
27      void process_local_TUN_packet();
28      void process_external_TUN_packet();
29      void send_heartbeat();
30
31    // general functions for landing
32    public:
33      void heartbeat_service_latch();
34
35    // Constructor
36    public:
37      Heartbeat_service(Xapi& _xapi, LCD_service& _lcd);
38 };
39
40 #endif
```

./commCode/Heartbeat_service.h

```
 1 #ifndef HEARTBEAT_SERVICE_cpp
 2 #define HEARBEAT_SERVICE_cpp
 3 #include <Heartbeat_service.h>
 4
 5 //************************************************
 6 // This latch is what is called in the microcontroller's
 7 // main loop. Put any required processing here
 8 //************************************************
 9 void Heartbeat_service::heartbeat_service_latch()
10 {
11   unsigned long currTime = millis();
12   // process any local LCD message packets
13   process_local_TUN_packet();
14
15   // process any external LCD message packets
16   process_external_TUN_packet();
17   //millis() will rollover to 0 after 50 days, extra provisioning
18   if(currTime < lastSent){
19     lastSent = currTime;
20   }
21   //if 1 second has passed send heartbeat
```

```
22    if((currTime-lastSent) > 1000){
23      send_heartbeat();
24      lastSent = millis();
25    }
26 }
27
28
29
30 //*************************************************
31 //*************************************************
32 // This routine will query the XAPI to see
33 // if there is a local message waiting for
34 // the Land service. If so, we need to grab it and react.
35 void Heartbeat_service::process_external_TUN_packet()
36 {
37   // see if there is a packet waiting
38   if(m_xapi.CONNECT_external_TUN_get_type() ==
       TUN_TYPE_EXTERNAL_HEARTBEAT)
39   {
40     // allocate the space
41     uint8_t TUN_packet[MED_BUFF_SZ];
42
43     // extract the packet
44     m_xapi.CONNECT_external_TUN_get_packet(TUN_packet, MED_BUFF_SZ);
45
46     // do something
47     //lcd prints are for debugging, should be removed
48     //m_lcd.lcd_print("*********");
49     //m_lcd.lcd_print(0,0,"ltest1");
50     m_lcd.lcd_print(0,0,"heartbeat packet");
51     //m_lcd.lcd_print(0,0,"ltest2");
52   }
53 }
54
55 //*************************************************
56 //*************************************************
57 // This routine will query the XAPI to see
58 // if there is a local message waiting for
59 // the Land service. If so, we need to grab it and do something.
60 void Heartbeat_service::process_local_TUN_packet()
61 {
62   // see if there is a packet waiting
```

```
63    if(m_xapi.CONNECT_local_TUN_get_type() == TUN_TYPE_LOCAL_HEARTBEAT)
64    {
65      // allocate the space
66      uint8_t TUN_packet[MED_BUFF_SZ];
67
68      // extract the packet
69      m_xapi.CONNECT_local_TUN_get_packet(TUN_packet, MED_BUFF_SZ);
70
71      // do something
72    }
73 }
74 //************************************************
75 //************************************************
76 // This function is used to send a external heartbeat
77 // packet, which contains drone information
78 void Heartbeat_service::send_heartbeat()
79 {
80    uint32_t msb = 0x0;
81    uint16_t lsb = 0xffff;
82
83
84    uint8_t x = 0;
85    uint8_t y = 0;
86    uint8_t LCD_payload_sz = 0;
87    uint8_t packet_size = 0;
88    // storage for payload
89    //uint8_t payload[] = {0x00};
90    //uint8_t message[MED_BUFF_SZ];
91    // storage for new packet
92    //uint8_t new_TUN_packet[LARGE_BUFF_SZ];
93    //uint8_t new_TUN_packet_sz = 0;
94
95    uint8_t payload_buff_sz = 0;
96
97    uint8_t payload_buff[MED_BUFF_SZ];
98    uint8_t packet_buff[LARGE_BUFF_SZ];
99
100   uint8_t TUN_buff[LARGE_BUFF_SZ];
101   uint8_t TUN_buff_sz = 0;
102
103
104   //m_lcd.lcd_print(0,0,"first");
```

```
105   //payload_buff_sz = m_util.get_TUN_payload(buff, payload_buff,
          MED_BUFF_SZ);
106   payload_buff[0] = 0x00; //temp code
107   payload_buff_sz = 2;
108   //m_lcd.lcd_print(0,0,"second");
109
110   TUN_buff_sz = m_util.create_TUN_packet( TUN_TYPE_EXTERNAL_HEARTBEAT,
111                payload_buff,
112                payload_buff_sz,
113                TUN_buff,
114                LARGE_BUFF_SZ);
115   //construct and send packet
116           //m_lcd.lcd_print(0,0,"third");
117
118
119   //TUN_buff[0] = 'X';
120   //TUN_buff[1] = 'X';
121   //TUN_buff[2] = 'X';
122   //TUN_buff_sz = 3;
123
124   packet_size = m_xapi.construct_transmit_req(msb,
125                            lsb,
126                            ADDR16_BROADCAST,
127                            TUN_buff,
128                            TUN_buff_sz,
129                            packet_buff,
130                            LARGE_BUFF_SZ);
131   //m_lcd.lcd_print(0,0,"fourth");
132
133
134   m_xapi.snd_packet(packet_buff, packet_size);
135
136 }
137
138 //************************************************
139 //************************************************
140 // Resets the TUN packet storage
141 void Heartbeat_service::reset_TUN_storage()
142 {
143   // obsolete
144 }
145
```

```
146 //************************************************
147 //************************************************
148 Heartbeat_service::Heartbeat_service(Xapi& _xapi, LCD_service& _lcd):
149 m_xapi(_xapi), m_lcd(_lcd)
150 {
151   reset_TUN_storage();
152   //send first heartbeat
153   send_heartbeat();
154   //initialize lastSend
155   lastSent = millis();
156
157 }
158
159
160 #endif
```

./commCode/Heartbeat_service.cpp

5.3.5 Land Service

```
 1 #ifndef LAND_SERVICE_h
 2 #define LAND_SERVICE_h
 3 #include <arduino.h>
 4 #include <Xapi.h>
 5 #include <Util.h>
 6 #include <LCD_service.h>
 7
 8
 9 //************************************************
10 //************************************************
11
12 class Land_service
13 {
14   // objects used
15   private:
16     Xapi& m_xapi;
17     Util m_util;
18     LCD_service& m_lcd;
19
20   private:
21
22
23   // functions for land service
24   private:
```

```
25      void reset_TUN_storage();
26      void process_local_TUN_packet();
27      void process_external_TUN_packet();
28
29    // general functions for landing
30    public:
31      void land_service_latch();
32
33    // Constructor
34    public:
35      Land_service(Xapi& _xapi, LCD_service& _lcd);
36  };
37
38  #endif
```

./commCode/Land_service.h

```
 1  #ifndef LAND_SERVICE_cpp
 2  #define LAND_SERVICE_cpp
 3  #include <Land_service.h>
 4
 5  //*************************************************
 6  // This latch is what is called in the microcontroller's
 7  // main loop. Put any required processing here
 8  //*************************************************
 9  void Land_service::land_service_latch()
10  {
11
12    // process any local LCD message packets
13    process_local_TUN_packet();
14
15    // process any external LCD message packets
16    process_external_TUN_packet();
17  }
18
19
20
21  //*************************************************
22  //*************************************************
23  // This routine will query the XAPI to see
24  // if there is a local message waiting for
25  // the Land service. If so, we need to grab it and react.
26  void Land_service::process_external_TUN_packet()
27  {
```

```
28   // see if there is a packet waiting
29   if(m_xapi.CONNECT_external_TUN_get_type() == TUN_TYPE_EXTERNAL_LAND)
30   {
31     // allocate the space
32     uint8_t TUN_packet[MED_BUFF_SZ];
33
34     // extract the packet
35     m_xapi.CONNECT_external_TUN_get_packet(TUN_packet, MED_BUFF_SZ);
36
37     // do something
38     //lcd prints are for debugging, should be removed
39     //m_lcd.lcd_print("*********");
40     m_lcd.lcd_print(0,0,"ltest1");
41     m_lcd.lcd_print(0,0,"land");
42     m_lcd.lcd_print(0,0,"ltest2");
43   }
44 }
45
46 //*************************************************
47 //*************************************************
48 // This routine will query the XAPI to see
49 // if there is a local message waiting for
50 // the Land service. If so, we need to grab it and do something.
51 void Land_service::process_local_TUN_packet()
52 {
53   // see if there is a packet waiting
54   if(m_xapi.CONNECT_local_TUN_get_type() == TUN_TYPE_LOCAL_LAND)
55   {
56     // allocate the space
57     uint8_t TUN_packet[MED_BUFF_SZ];
58
59     // extract the packet
60     m_xapi.CONNECT_local_TUN_get_packet(TUN_packet, MED_BUFF_SZ);
61
62     // do something
63   }
64 }
65
66 //*************************************************
67 //*************************************************
68 // Resets the TUN packet storage
69 void Land_service::reset_TUN_storage()
```

```
70 {
71   // obsolete
72 }
73
74 //************************************************
75 //************************************************
76 Land_service::Land_service(Xapi& _xapi, LCD_service& _lcd):
77 m_xapi(_xapi), m_lcd(_lcd)
78 {
79   reset_TUN_storage();
80
81 }
82
83
84 #endif
```

./commCode/Land_service.cpp

5.3.6 Takeoff Service

```
1 #ifndef TAKEOFF_SERVICE_h
2 #define TAKEOFF_SERVICE_h
3 #include <arduino.h>
4 #include <Xapi.h>
5 #include <Util.h>
6 #include <LCD_service.h>
7
8
9 //************************************************
10 //************************************************
11
12 class Takeoff_service
13 {
14   // objects used
15   private:
16     Xapi& m_xapi;
17     Util m_util;
18     LCD_service& m_lcd;
19   private:
20
21
22   // functions for takeoff service
23   private:
24     void reset_TUN_storage();
```

```
25      void process_local_TUN_packet();
26      void process_external_TUN_packet();
27
28    // general functions for takeoff
29    public:
30      void takeoff_service_latch();
31
32    // Constructor
33    public:
34      Takeoff_service(Xapi& _xapi, LCD_service& _lcd);
35  };
36
37  #endif
```

./commCode/Takeoff_service.h

```
 1
 2  #ifndef TAKEOFF_SERVICE_cpp
 3  #define TAKEOFF_SERVICE_cpp
 4  #include <AutoPilot.h>
 5  #include <Takeoff_service.h>
 6
 7  extern uint8_t bit_autopilot_flags;
 8  extern drone_state *P_state;
 9  //************************************************
10  // This latch is what is called in the microcontroller's
11  // main loop. Put any required processing here
12  //************************************************
13  void Takeoff_service::takeoff_service_latch()
14  {
15
16    // process any local LCD message packets
17    process_local_TUN_packet();
18
19    // process any external LCD message packets
20    process_external_TUN_packet();
21  }
22
23
24
25  //************************************************
26  //************************************************
27  // This routine will query the XAPI to see
28  // if there is a local message waiting for
```

```
29 // the Land service. If so, we need to grab it and react.
30 void Takeoff_service::process_external_TUN_packet()
31 {
32   // see if there is a packet waiting
33   if(m_xapi.CONNECT_external_TUN_get_type() ==
       TUN_TYPE_EXTERNAL_TAKEOFF)
34   {
35     // allocate the space
36     uint8_t TUN_packet[MED_BUFF_SZ];
37     uint8_t payload_buff[SMALL_BUFF_SZ];
38     uint8_t payload_buff_sz = 0;
39     int height = 0;
40     // extract the packet
41     m_xapi.CONNECT_external_TUN_get_packet(TUN_packet, MED_BUFF_SZ);
42
43     //extract payload
44     payload_buff_sz = m_util.get_TUN_payload(TUN_packet, payload_buff,
         SMALL_BUFF_SZ);
45
46     //grab height from payload (4 bytes)
47     height = m_util.hex_to_int(0, 4, payload_buff_sz, payload_buff);
48
49     // do something
50     //lcd prints are for debugging, should be removed
51     //m_lcd.lcd_print(0,0,"*************");
52     //m_lcd.lcd_print(0,0,"Got Takeoff");
53     //m_lcd.lcd_print(0,0,"ttest1");
54     //m_lcd.lcd_print(0,0,"takeoff");
55     //m_lcd.lcd_print(0,0,"ttest2");
56     //if(height = 10){
57     //  m_lcd.lcd_print(0,0,"Height 10");
58     //}
59     P_state->hold_alt = P_state->ground_alt + height;
60     bit_autopilot_flags |= ALTHOLD_FLAG;
61   }
62 }
63
64 //*************************************************
65 //*************************************************
66 // This routine will query the XAPI to see
67 // if there is a local message waiting for
68 // the Land service. If so, we need to grab it and do something.
```

```
69 void Takeoff_service::process_local_TUN_packet()
70 {
71   // see if there is a packet waiting
72   if(m_xapi.CONNECT_local_TUN_get_type() == TUN_TYPE_LOCAL_TAKEOFF)
73   {
74     // allocate the space
75     uint8_t TUN_packet[MED_BUFF_SZ];
76
77     // extract the packet
78     m_xapi.CONNECT_local_TUN_get_packet(TUN_packet, MED_BUFF_SZ);
79
80     // do something
81
82   }
83 }
84
85 //*************************************************
86 //*************************************************
87 // Resets the TUN packet storage
88 void Takeoff_service::reset_TUN_storage()
89 {
90   // obsolete
91 }
92
93 //*************************************************
94 //*************************************************
95 Takeoff_service::Takeoff_service(Xapi& _xapi, LCD_service& _lcd):
96 m_xapi(_xapi), m_lcd(_lcd)
97 {
98   reset_TUN_storage();
99
100 }
101
102
103 #endif
```

./commCode/Takeoff_service.cpp

5.3.7 Serial Service (Modified from Brandon's Version)

```
1
2 #ifndef SERIAL_SERVICE_h
3 #define SERIAL_SERVICE_h
4
```

```
 5 #include <arduino.h>
 6 #include <single_buff.h>
 7 #include <util.h>
 8 #include <xapi.h>
 9 #include <LCD_service.h>
10
11 //*******************************************
12 //*******************************************
13 // The Serial Service allows for the XAPI to
14 // communicate over a standard serial connection
15 // to the outside world. This service only
16 // communicates via the standard TUN packet.
17 // TUN packet format:
18 // Format of the TUNNELED (TUN) packet in ASCII-HEX:
19 // $[TYPE:2][PAYLOAD_SZ:2][CHECKSUM:4][PAYLOAD:?]%
20
21
22 class Serial_service
23 {
24   // The objects this service requires
25   private:
26     Util m_util;
27     HardwareSerial& m_serial;
28     Xapi& m_xapi;
29     LCD_service& m_lcd;
30
31   // This buffer and variables keep track of
32   // incoming RX bytes.
33   private:
34     uint8_t m_rx_buff[LARGE_BUFF_SZ];
35     boolean m_rx_start_found;
36     boolean m_rx_end_found;
37     boolean m_rx_buff_ready;
38     uint8_t m_rx_buff_index;
39
40   // routines to maintain state
41   private:
42     uint8_t assemble_TUN_packet(uint8_t c);
43     void reset_rx_state();
44     boolean process_TUN_packet( uint8_t* buff, uint8_t buff_sz);
45     void simple_local_LCD_msg( uint8_t* buff, uint8_t buff_sz);
46     void snd_serial_add_frame(const uint8_t* buff, uint8_t buff_sz);
```

```
47      void snd_local_TUN_packet_via_serial();
48      void create_and_pass_external(uint8_t packet_type, uint8_t* buff,
49                      uint8_t buff_sz);
50
51    // constructor and latch
52    public:
53      Serial_service(HardwareSerial& _serial, Xapi& _xapi, LCD_service&
            _lcd);
54      void serial_service_latch();
55  };
56
57  #endif
```

./commCode/Serial_service.h

```
 1
 2  #ifndef SERIAL_SERVICE_cpp
 3  #define SERIAL_SERVICE_cpp
 4
 5  #include <serial_service.h>
 6
 7  //*********************************************************************
 8  //*********************************************************************
 9  // Simply sends a buffer over serial.
10  // Will add a frame to the buffer
11  void Serial_service::snd_serial_add_frame(const uint8_t* buff, uint8_t
        buff_sz)
12  {
13    m_serial.print(SENT_START_BYTE);
14
15    m_serial.write(buff, buff_sz);
16
17    m_serial.print(SENT_END_BYTE);
18
19    m_serial.flush();
20  }
21
22  //*********************************************************************
23  //*********************************************************************
24  // Process any local serial messages
25  void Serial_service::snd_local_TUN_packet_via_serial()
26  {
27    uint8_t packet_sz = 0;
28
```

```
29   // storage for the debug packet
30   uint8_t serial_packet[LARGE_BUFF_SZ];
31
32   // clean packet
33   m_util.clean_packet(serial_packet, LARGE_BUFF_SZ);
34
35   // extract the packet
36   m_xapi.CONNECT_local_TUN_get_packet(serial_packet, LARGE_BUFF_SZ);
37
38   // get the size of the packet
39   packet_sz = m_util.get_TUN_packet_sz(serial_packet);
40
41   // ship out the packet through serial
42   snd_serial_add_frame(serial_packet, packet_sz);
43 }
44
45 //*********************************************************************
46 //*********************************************************************
47 // Latch to sample the serial hardware
48 void Serial_service::serial_service_latch()
49 {
50   uint8_t packet_type = 0;
51
52   // see if there is a new byte
53   if (m_serial.available() > 0)
54   {
55     assemble_TUN_packet(m_serial.read());
56   }
57
58   // process any local serial packets that need to
59   // be shipped out over serial.
60   // NOTE: the point of this code is to allow other
61   // services to ship out packets via serial instead
62   // of radio.
63   packet_type = m_xapi.CONNECT_local_TUN_get_type();
64   switch(packet_type)
65   {
66     case TUN_TYPE_LOCAL_SERIAL_DEBUG_MSG:
67     case TUN_TYPE_LOCAL_CHAT:
68       snd_local_TUN_packet_via_serial();
69     break;
70   }
```

```
71 }
72
73 //*********************************************************************
74 //*********************************************************************
75 // This routine allows for the serial service to display
76 // a simple local LCD message.
77 // The payload is used to create an entirely new LCD packet.
78 // The new derived packet is of type TUN_TYPE_LOCAL_LCD_MSG
79 // packet format:
80 // [TYPE:2][PAYLOAD_SZ:2][CHECKSUM:4][PAYLOAD:?]
81 void Serial_service::simple_local_LCD_msg( uint8_t* buff,
82                         uint8_t buff_sz)
83 {
84   // storage for payload
85   uint8_t payload[MED_BUFF_SZ];
86
87   // storage for new packet
88   uint8_t new_TUN_packet[LARGE_BUFF_SZ];
89   uint8_t new_TUN_packet_sz = 0;
90
91   // extract payload
92   m_util.get_TUN_payload(buff, payload, MED_BUFF_SZ);
93
94   // create the TUN packet
95   new_TUN_packet_sz = m_util.create_TUN_lcd_packet( true, 0, 0,
       payload,
96                               strlen((char*)payload),
97                               new_TUN_packet,
98                               LARGE_BUFF_SZ);
99
100  // send the new TUN packet out locally
101  m_xapi.CONNECT_local_TUN_set_packet(new_TUN_packet,
       new_TUN_packet_sz);
102 }
103
104 //*********************************************************************
105 //*********************************************************************
106 // This routine processes a completely assembled RX TUN packet.
107 // Returns:
108 // true: packet was processed
109 // false: packet was not processed due to CHECKSUM error
110 boolean Serial_service::process_TUN_packet( uint8_t* buff,
```

```
111                         uint8_t buff_sz)
112 {
113   boolean success = false;
114   uint8_t TUN_type = ILLEGAL_TUN_TYPE;
115
116   // only process the buffer if passes CHECKSUM
117   if(m_util.verify_checksum(buff))
118   {
119     TUN_type = m_util.get_TUN_type(buff);
120
121     switch(TUN_type)
122     {
123       // an incoming request to use the local
124       // LCD screen to display a message.
125       case TUN_TYPE_LOCAL_LCD_MSG:
126         m_xapi.CONNECT_local_TUN_set_packet(buff, buff_sz);
127       break;
128
129       // for doing a simple local LCD debug message
130       case TUN_TYPE_LOCAL_SIMPLE_LCD_MSG:
131         simple_local_LCD_msg(buff, buff_sz);
132       break;
133
134       case TUN_TYPE_EXTERNAL_LCD_MSG:
135         create_and_pass_external(TUN_TYPE_EXTERNAL_LCD_MSG, buff,
                buff_sz);
136         //m_lcd.lcd_print("**************");
137         m_lcd.lcd_print(0,0,"Got LCD");
138       break;
139       case TUN_TYPE_EXTERNAL_LAND:
140         create_and_pass_external(TUN_TYPE_EXTERNAL_LAND,buff, buff_sz);
141         //m_lcd.lcd_print("**************");
142         m_lcd.lcd_print(0,0,"Got Land");
143       break;
144       case TUN_TYPE_EXTERNAL_TAKEOFF:
145         create_and_pass_external(TUN_TYPE_EXTERNAL_TAKEOFF, buff,
                buff_sz);
146         //m_lcd.lcd_print("**************");
147         m_lcd.lcd_print(0,0,"Got Takeoff");
148       break;
149       case TUN_TYPE_EXTERNAL_DO_MOVE:
150         create_and_pass_external(TUN_TYPE_EXTERNAL_DO_MOVE, buff,
```

```
            buff_sz);
151         //m_lcd.lcd_print("**************");
152         m_lcd.lcd_print(0,0,"Got Do Move");
153       break;
154       case TUN_TYPE_EXTERNAL_SET_HEADING:
155         create_and_pass_external(TUN_TYPE_EXTERNAL_SET_HEADING, buff,
            buff_sz);
156         //m_lcd.lcd_print("**************");
157         m_lcd.lcd_print(0,0,"Got Set HEading");
158       break;
159       case TUN_TYPE_EXTERNAL_ALT_HOLD:
160         create_and_pass_external(TUN_TYPE_EXTERNAL_ALT_HOLD, buff,
            buff_sz);
161         //m_lcd.lcd_print("**************");
162         m_lcd.lcd_print(0,0,"Got Alt Hold");
163       break;
164       case TUN_TYPE_EXTERNAL_HEADING_HOLD:
165         create_and_pass_external(TUN_TYPE_EXTERNAL_HEADING_HOLD, buff,
            buff_sz);
166         //m_lcd.lcd_print("**************");
167         m_lcd.lcd_print(0,0,"Got head Hold");
168       break;
169       case TUN_TYPE_EXTERNAL_ARM:
170         create_and_pass_external(TUN_TYPE_EXTERNAL_ARM, buff, buff_sz);
171         //m_lcd.lcd_print("**************");
172         m_lcd.lcd_print(0,0,"Got Arm");
173       break;
174     }
175
176     success = true;
177   }
178   return success;
179 }
180
181 void Serial_service::create_and_pass_external(uint8_t packet_type,
182                         uint8_t* buff,
183                         uint8_t buff_sz)
184 {
185 /*  Router info
186           MSB: 13A200
187           LSB: 40A8BC2C
188         */
```

```
189         //uint32_t msb = 0x13A200;
190         //uint16_t lsb = 0x40A8BC2C;
191         uint32_t msb = 0x0;
192         uint16_t lsb = 0xffff;
193
194
195         uint8_t x = 0;
196         uint8_t y = 0;
197         uint8_t LCD_payload_sz = 0;
198         uint8_t packet_size = 0;
199         // storage for payload
200         uint8_t payload[MED_BUFF_SZ];
201         uint8_t message[MED_BUFF_SZ];
202         // storage for new packet
203         //uint8_t new_TUN_packet[LARGE_BUFF_SZ];
204         //uint8_t new_TUN_packet_sz = 0;
205
206         uint8_t payload_buff_sz = 0;
207
208         uint8_t payload_buff[LARGE_BUFF_SZ];
209         uint8_t packet_buff[LARGE_BUFF_SZ];
210
211         uint8_t TUN_buff[LARGE_BUFF_SZ];
212         uint8_t TUN_buff_sz = 0;
213         /*
214         // extract payload, should contain x,y,message
215         LCD_payload_sz = m_util.get_TUN_payload(buff, payload,
               MED_BUFF_SZ);
216
217         // get the X and Y coordinates
218         x = m_util.hex_to_int(LCD_X_START, LCD_X_END, LCD_X_SZ,
               LCD_payload);
219         y = m_util.hex_to_int(LCD_Y_START, LCD_Y_END, LCD_Y_SZ,
               LCD_payload);
220
221         // figure out the msg size
222         LCD_payload_sz -= (LCD_X_SZ + LCD_Y_SZ);
223
224         // display the string
225         for(uint8_t i = 0; i < LCD_payload_sz; i++)
226           message[i] = LCD_payload[i+LCD_MSG_START];
227         */
```

```
228         //m_lcd.lcd_print(0,0,"first");
229         payload_buff_sz = m_util.get_TUN_payload(buff, payload_buff,
                MED_BUFF_SZ);
230         //m_lcd.lcd_print(0,0,"second");
231
232         TUN_buff_sz = m_util.create_TUN_packet( packet_type,
233                     payload_buff,
234                     payload_buff_sz,
235                     TUN_buff,
236                     LARGE_BUFF_SZ);
237         //construct and send packet
238                 //m_lcd.lcd_print(0,0,"third");
239
240
241         //TUN_buff[0] = 'X';
242         //TUN_buff[1] = 'X';
243         //TUN_buff[2] = 'X';
244         //TUN_buff_sz = 3;
245
246         packet_size = m_xapi.construct_transmit_req(msb,
247                                 lsb,
248                                 ADDR16_BROADCAST,
249                                 TUN_buff,
250                                 TUN_buff_sz,
251                                 packet_buff,
252                                 LARGE_BUFF_SZ);
253         //m_lcd.lcd_print(0,0,"fourth");
254
255
256         m_xapi.snd_packet(packet_buff, packet_size);
257
258         //uint8_t* TUN_buff[3];
259         //TUN_buff[0] = 'X';
260         //TUN_buff[1] = 'X';
261         //TUN_buff[2] = 'X';
262         //lcd.lcd_snd_EXTERNAL_message( msb,
263           //            lsb,
264             //          ADDR16_BROADCAST,
265               //        0,
266                 //      0,
267                   //    (uint8_t*)"XXXX");
268
```

```
269         //m_lcd.lcd_print(0,0,"final");
270         //m_xapi.display_TUN_packet(TUN_buff, TUN_buff_sz);
271
272 }
273
274 //*************************************************************************
275 //*************************************************************************
276 // This routine resets the entire RX state and
277 // makes the service ready to RX a new TUN packet.
278 void Serial_service::reset_rx_state()
279 {
280   m_util.clean_packet(m_rx_buff, LARGE_BUFF_SZ);
281   m_rx_start_found = false;
282   m_rx_end_found = false;
283   m_rx_buff_ready = false;
284   m_rx_buff_index = 0;
285 }
286
287 //*************************************************************************
288 //*************************************************************************
289 // This routine takes in RX bytes and assembles a TUN packet.
290 // Format of the TUNNELED (TUN) packet in ASCII-HEX:
291 // $[TYPE:2][PAYLOAD_SZ:2][CHECKSUM:4][PAYLOAD:?]%
292 uint8_t Serial_service::assemble_TUN_packet(uint8_t c)
293 {
294   uint8_t rx_byte = c;
295
296   // first see if a byte is waiting
297
298     // only add to buffer is byte is read
299     if(c != '\0')
300     {
301       // see if byte is start byte
302       if(rx_byte == SENT_START_BYTE)
303       {
304         // record that it's the start of a new packet
305         reset_rx_state();
306         m_rx_start_found = true;
307       }
308       else if( rx_byte == SENT_END_BYTE)
309       {
310         // ensure we have read start byte
```

```
311         // and there is more than 0 characters in buffer
312         if( (m_rx_start_found == true) && (m_rx_buff_index > 0))
313         {
314           // we have a complete packet
315           m_rx_end_found = true;
316           m_rx_buff_ready = true;
317
318           // process the packet
319           process_TUN_packet(m_rx_buff, m_rx_buff_index);
320
321           // reset the buffer
322           reset_rx_state();
323         }
324       }
325       else if(  (m_rx_start_found == true) &&
326             (m_rx_end_found == false) &&
327             (m_rx_buff_index < (LARGE_BUFF_SZ - 1)) )
328             {
329               // we have a single character that is
330               // not a stop or a start
331               // So just store it
332               m_rx_buff[m_rx_buff_index++] = rx_byte;
333             }
334     }
335
336   // return the byte we read
337   return rx_byte;
338 }
339
340 //*********************************************
341 //*********************************************
342 Serial_service::Serial_service(HardwareSerial& _serial, Xapi& _xapi,
      LCD_service& _lcd):
343 m_serial(_serial), m_xapi(_xapi), m_lcd(_lcd)
344 {
345   m_util = Util();
346   reset_rx_state();
347 }
348
349 #endif
```

./commCode/Serial_service.cpp

6 Design Presentation

6.1 Nov 13, 2014

See Next Page

Drone Mission Planning Software

David Klingenberg
Taylor Trabun

- Problem Definition
- Specific Component Design
  - Communications Design
  - Drone Design
  - Graphical User Interface Design
- Timeline
- Questions/Concerns

Overview

Problem Definition

The goal of this project is to design and develop a graphical user interface (GUI) for drone mission planning.

Requirements:

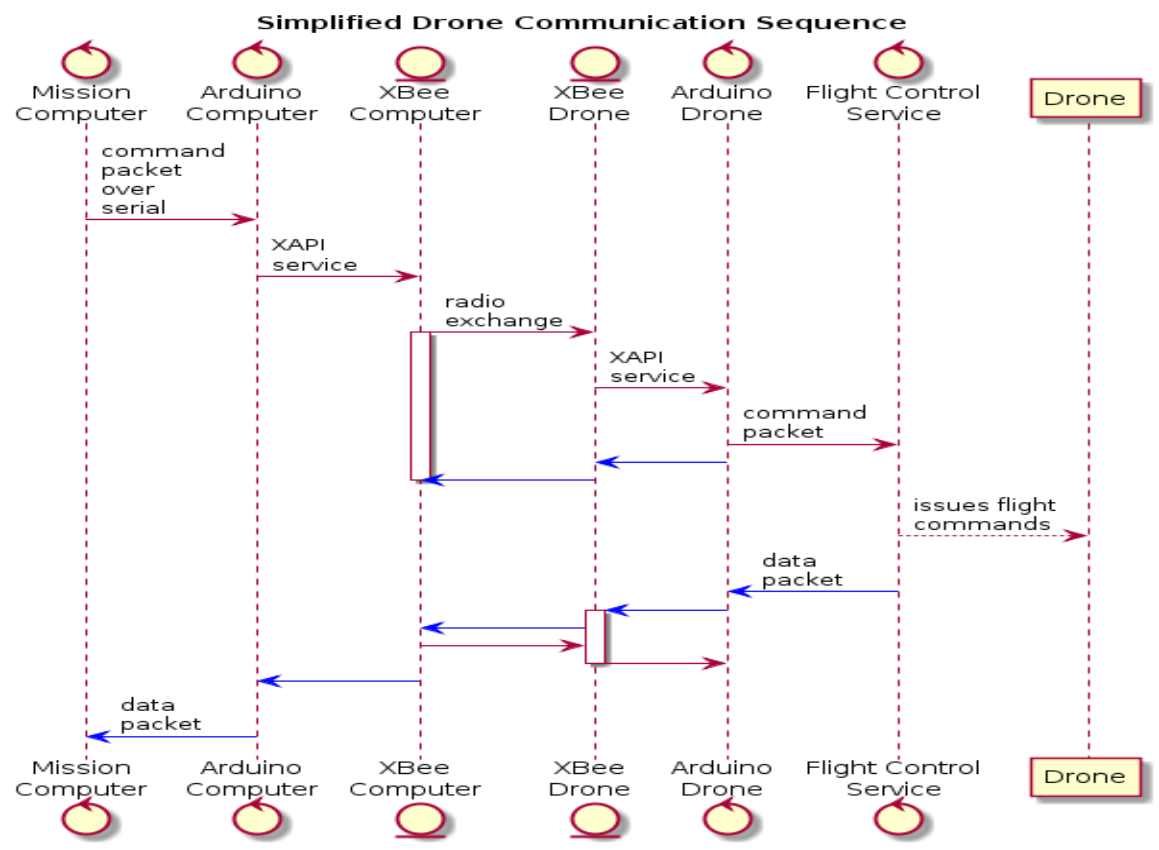
- A user-friendly interface
- Allow 3-dimensional mission planning
- Upload the flight plan using XAPI and XBee
- Allow manual override
- Implement drone hardware for flight control

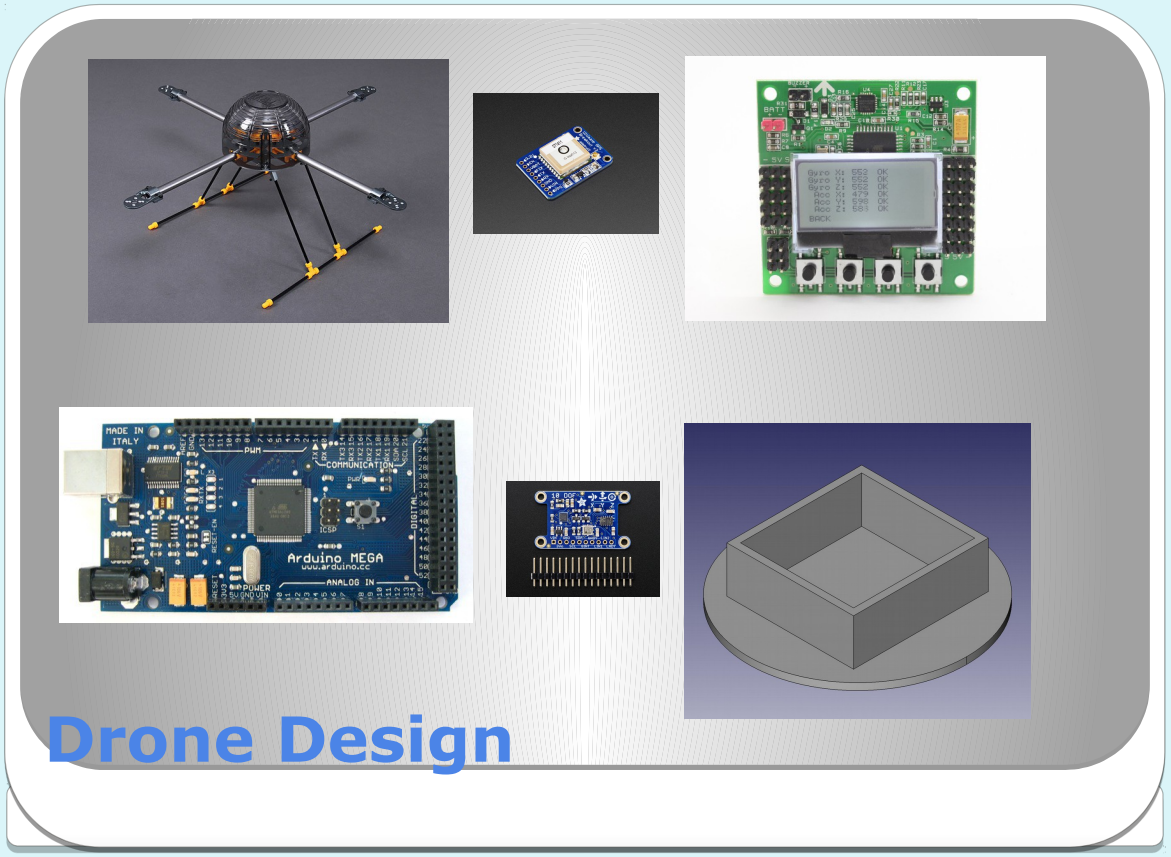
Communication Design

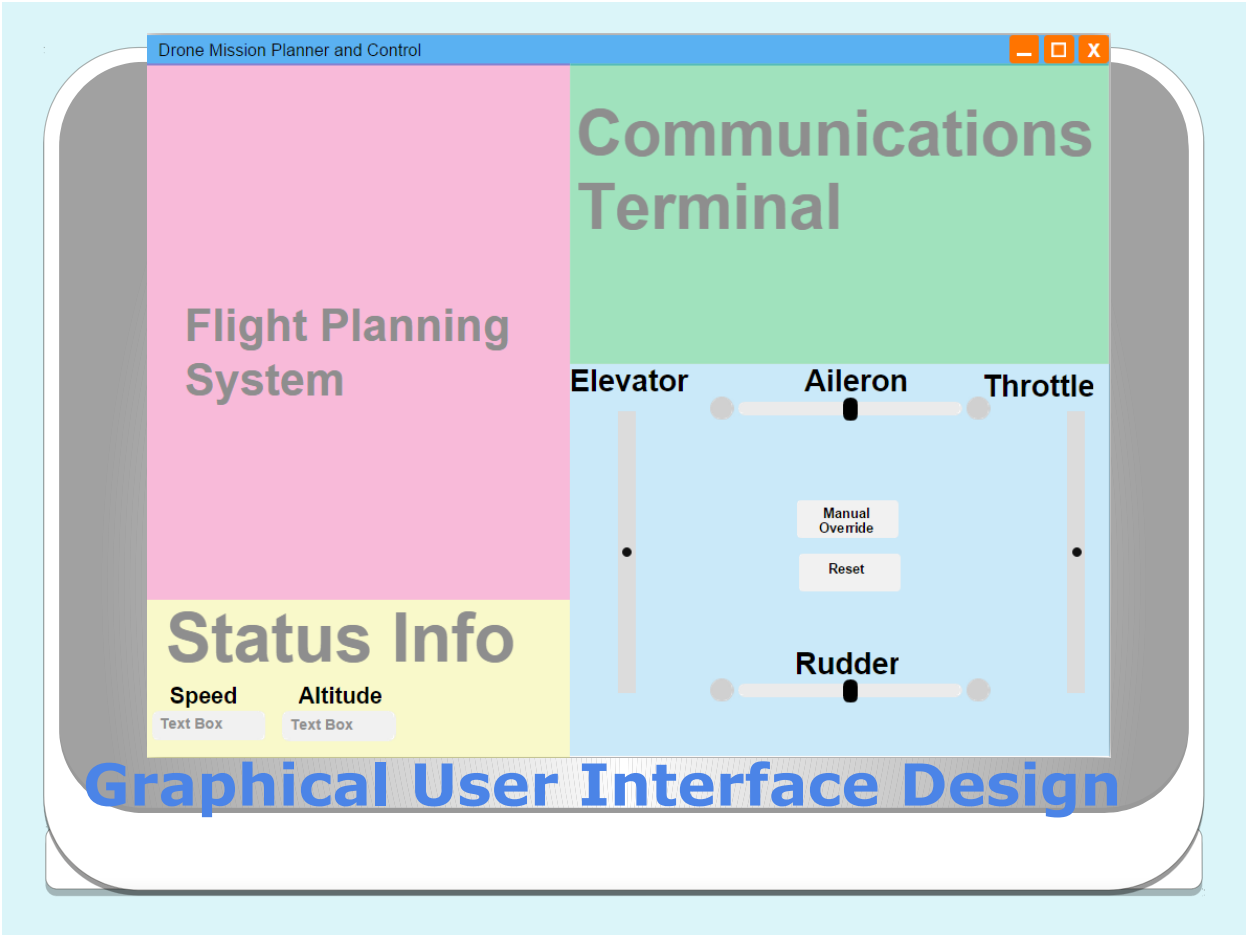
The communication system for this project must allow for commands to be sent from a computer to a drone.

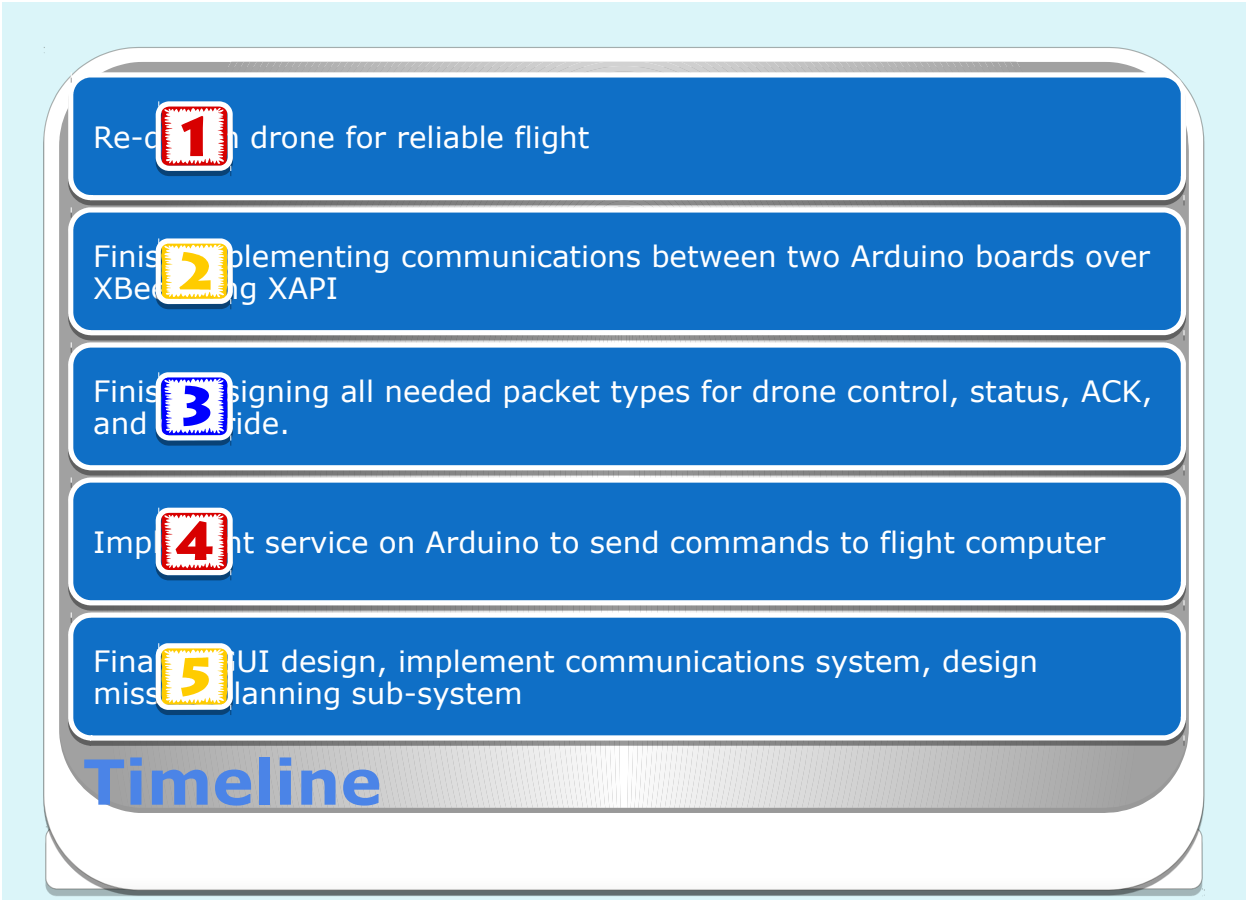
Requirements:

- XAPI and XBee hardware
- Specific TUN packets:
  - Manual drone instructions (altitude, direction, takeoff, etc..)
  - Settings
  - Acknowledgement of packet received
  - Heartbeat/status updates
  - Override (manual, land)
  - Flight plan protocol
    - Initialize for upload
    - Get instructions
    - Echo instructions
    - Terminate upload


Simplified Drone Communication Sequence
Mission Computer
Arduino Computer
XBee Computer
XBee Drone
Arduino Drone
Flight Control Service
Drone
command packet over serial
XAPI service
radio exchange
XAPI service
command packet
issues flight commands
data packet
data packet
Mission Computer
Arduino Computer
XBee Computer
XBee Drone
Arduino Drone
Flight Control Service
Drone


Drone Design


Drone Mission Planner and Control
Communications Terminal
Flight Planning System
Elevator
Aileron
Throttle
Manual Override
Reset
Rudder
Status Info
Speed
Altitude
Text Box
Text Box
Graphical User Interface Design


1
Re-d n drone for reliable flight
2
Finis lementing communications between two Arduino boards over XBe g XAPI
3
Finis signing all needed packet types for drone control, status, ACK, and ide.
4
Imp t service on Arduino to send commands to flight computer
5
Fina UI design, implement communications system, design miss lanning sub-system
Timeline

Questions or concerns?

Thank You

Drone Mission Planning Software: Design Document

Taylor Trabun

May 5, 2015

7 Design Document

7.1 Introduction

This document provides the general design of the Drone Mission Planning Software by breaking the entire project down into several components. The current components are the physical drone, the communication system, and the graphical user interface for mission planning.

7.2 Drone Design

The drone design's major requirement that needed to be met was to achieve stable and reliable flight.

By analyzing the drone, it was determined that its center of gravity was not directly centered on the drone, which resulted in drifting during flight. To remedy this issue, a "part holder" was designed to be mounted on the underside of the drone to hold all the motor controls, which moved the center of gravity to the center of the drone.

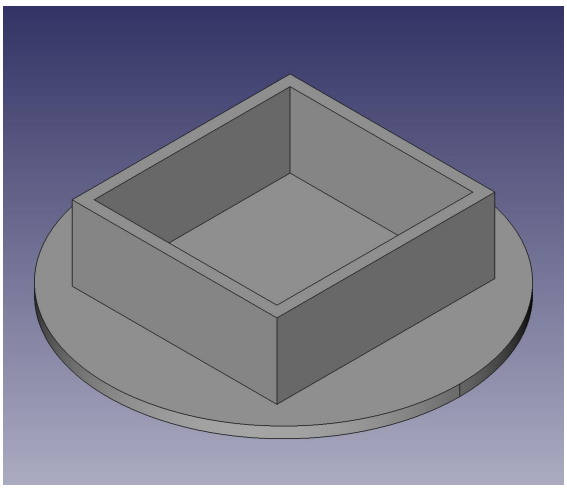


Figure 1: 3D sketch of partbin

7.3 Communication Design

The communications system needs to follow the following requirements:

- Use of XAPI and XBee hardware
- Define required TUN packets for communication system
  - Manual drone instructions
  - Settings and status
  - ACK
  - Heartbeat
  - Override
  - Flight plan protocol types

The following sections will break the communication system down into its several components and detail their design.

7.3.1 Communication Overview

Our communications system, as depicted in the graphic below, requires two-way communication between the computer (including the attached Arduino) and the Arduino located on the drone. This system will take an instruction created on the computer, send it over serial to the connected Arduino, pass it to XAPI, XAPI will ship it over XBee to the Arduino on the drone, and a flight control service will execute the instruction.

7.3.2 Hardware Components

Our current communications requires the following hardware components:

- Arduino Mega 2560
- XBee modules
- LCD Shields (for development and debugging)
- Serial add-on for Arduino
- A computer running Windows to communicate with base Arduino (Workstation needs to be able to run C# programs)

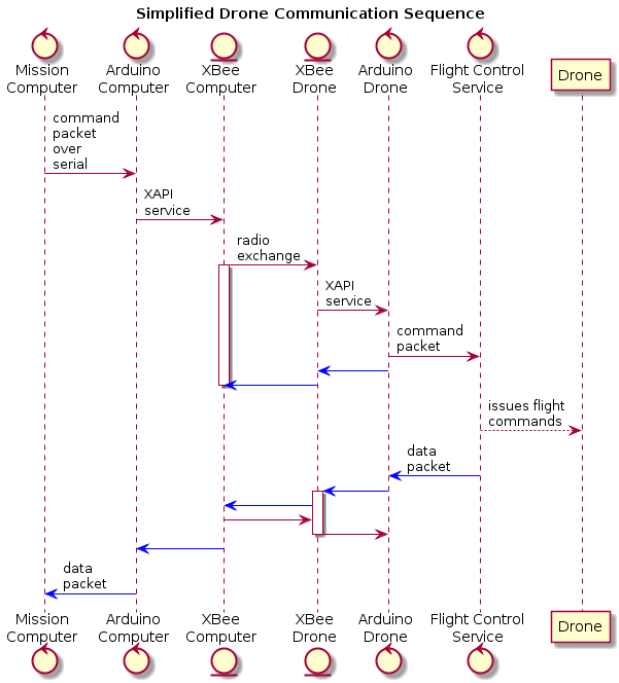


Figure 2: Overview of communications system

7.3.3 XAPI

To satisfy one of our major requirements, we run the XAPI on each Arduino in the communications system.

XAPI is, put simply, a micro-controller service manager that communicates, both internally and externally, using TUN packets. When communicating externally, the XAPI ships the TUN packet using the XBee hardware by embedding the TUN packet in a XBee packet.

Each service available with the API use XAPI to communicate, using XAPI as the core that each service "latches" to. For instance, if a chat service wanted to display a message on a attached LCD screen, the following steps would be carried out:

1. Chat service creates a LOCAL_ LCD TUN packet
2. Chat service passes the newly created packet to the XAPI core
3. XAPI places the packet in its internal packet buffer
4. The LCD service latch queries XAPI for any packets designated for the LCD service
5. LCD service grabs LOCAL_ LCD TUN packet
6. LCD service processes and displays the packet

To satisfy our project's requirements, we need to design a Flight Control service that will be able to handle any instruction packets and translate them to instructions that can be given to the drone's flight computer. In addition to this, there is a requirement for a Mission Plan service that will store and execute flight plan's designed by the user and sent to the drone.

7.4 Graphical User Interface Design

The graphical user interface must satisfy several requirements:

1. Must be user-friendly
2. Allow 3-dimensional mission planning
3. Allow upload of flight plan to drone
4. Allow manual override

Given these requirements we were able to design a general design for the graphical user interface (GUI), as shown below. This GUI is split into several sections that convey different information, that in some cases can be adjusted.

We have a flight control section (light-blue) that shows the status of the drone components and allows the user to "zero out" each component or take manual control. The status information section (yellow) shows different readings from the drone's on-board instruments. The flight planning system (light-red) will be where the user can develop a flight plan to be uploaded to the drone (note that this functionality is still under design and may end up being a separate window that needs to be opened up). The final section is the communications terminal (light-green) that displays all packets sent and received on the Arduino attached to the source computer. This communications terminal will allow the user to see that the drone is still connected and will allow for easy communications debugging.

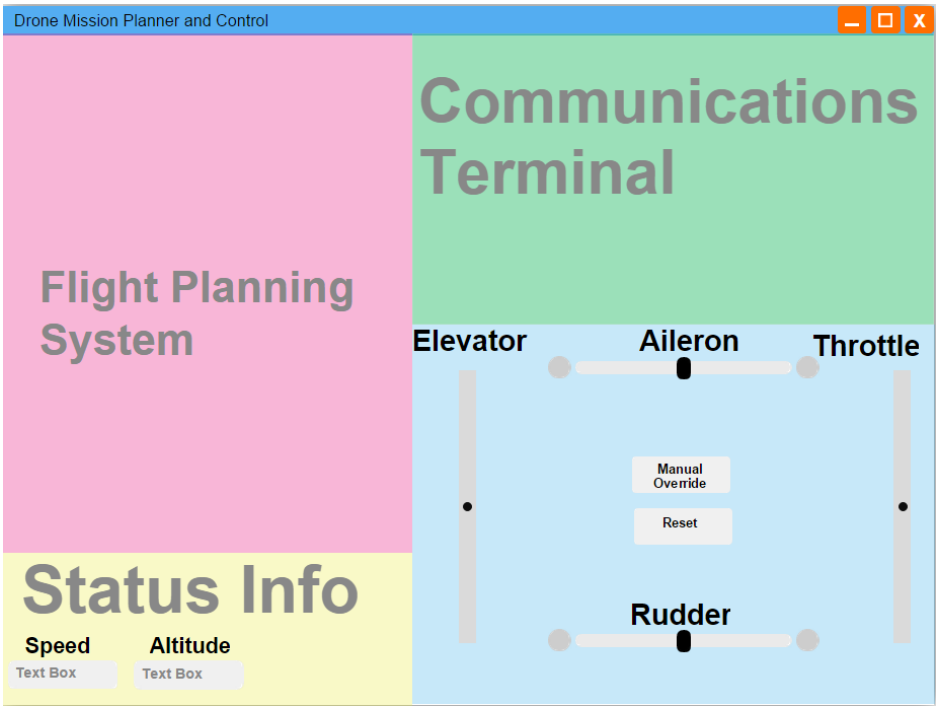


Figure 3: Graphical user interface mock-up design

Appendices

A Miscellaneous UML Charts

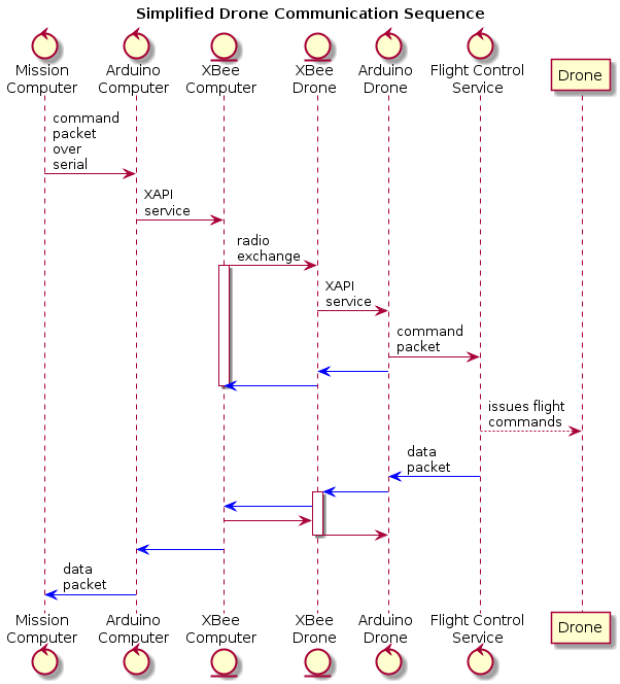


Figure 4: Communication Sequence

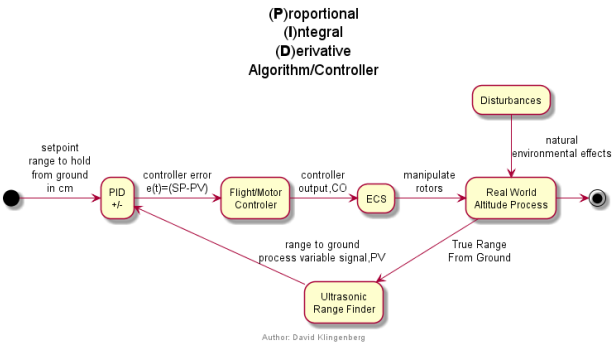


Figure 5: PID Controller

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 6: 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 7: ATmega2560

C Technical Drawings

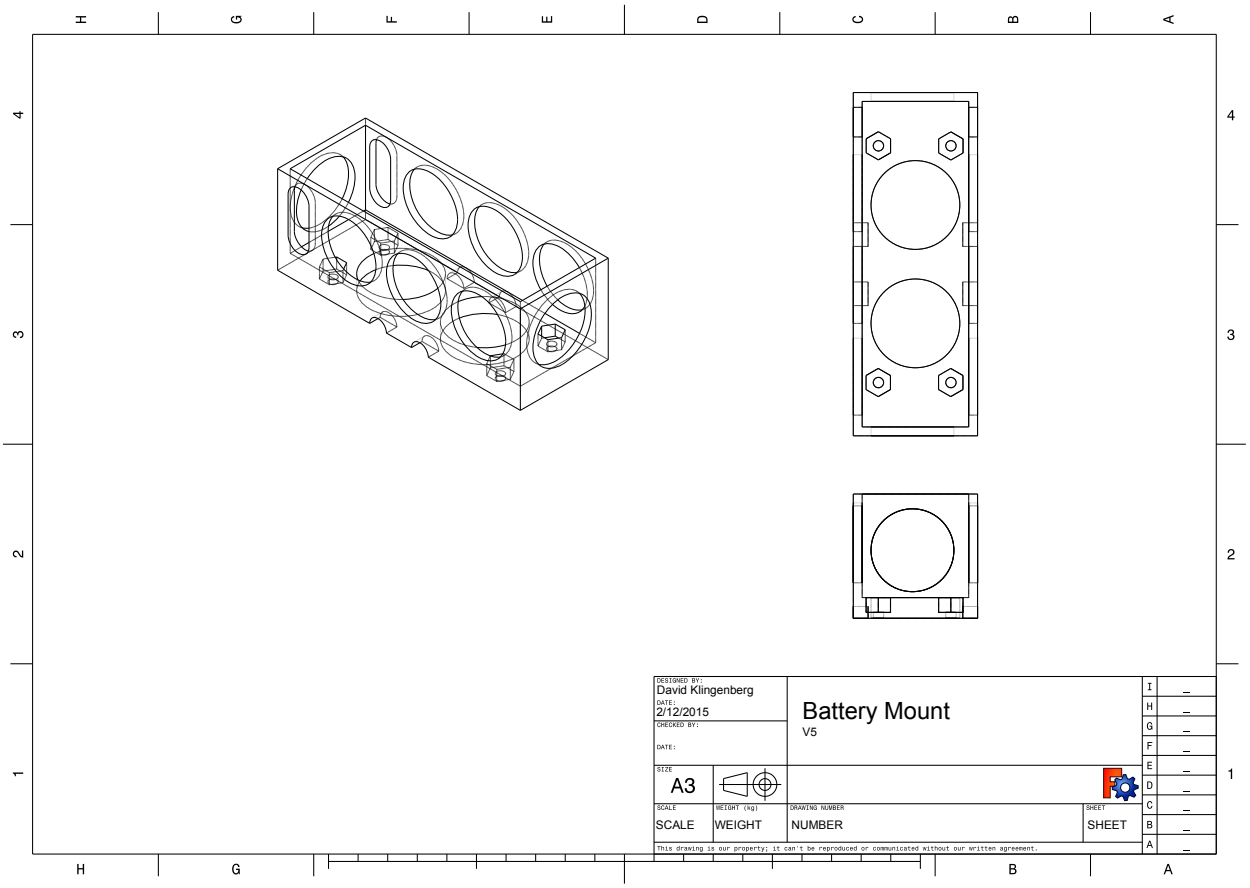


Figure 8: Battery Bracket

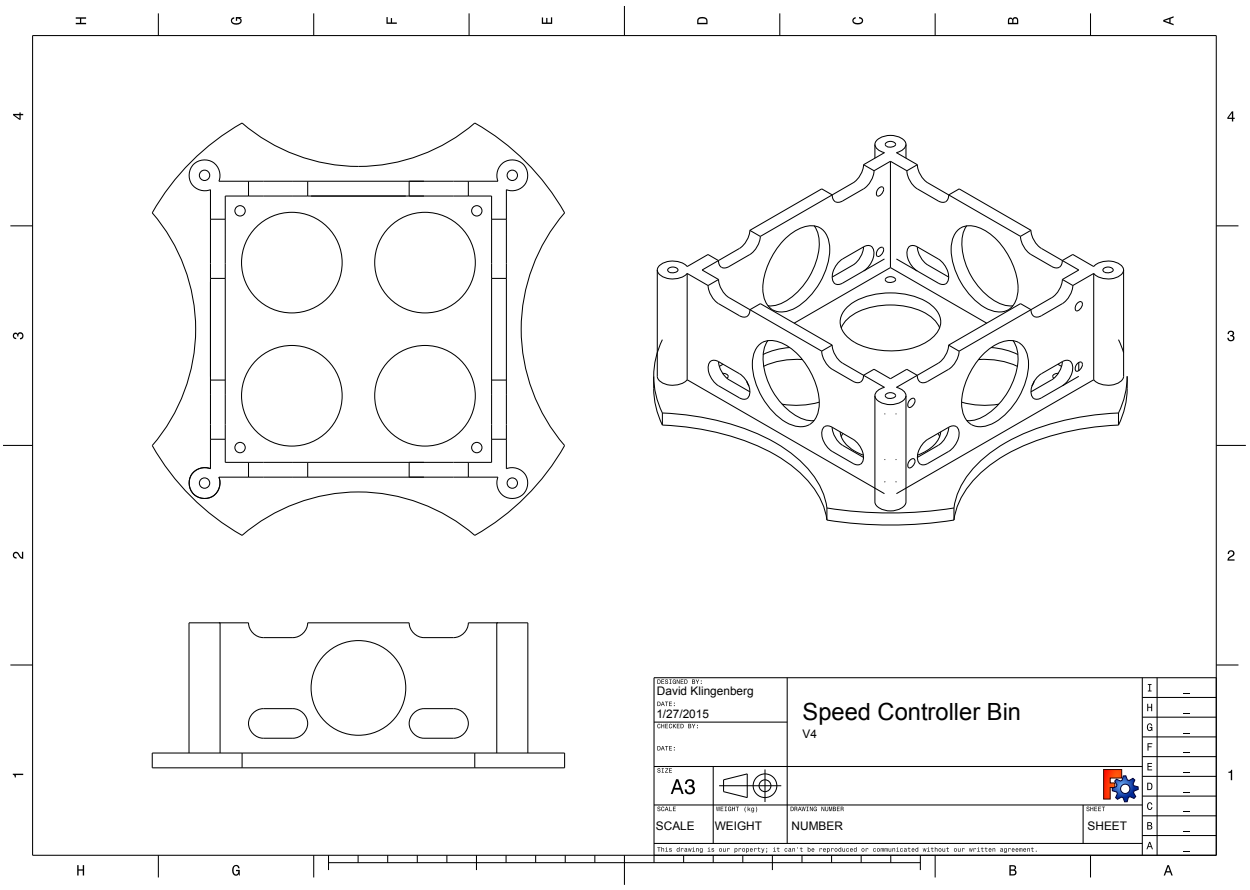


Figure 9: Electronic Speed Controller Bracket

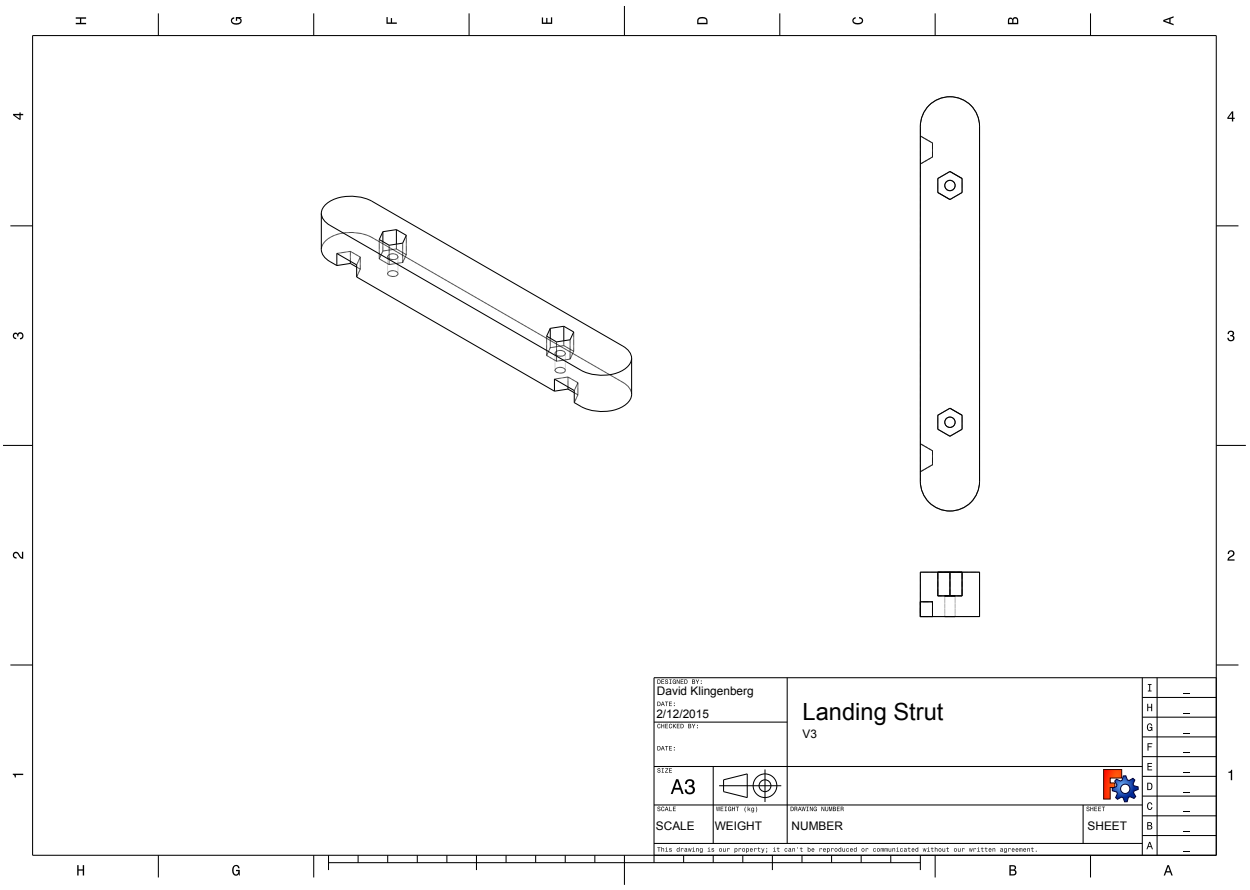


Figure 10: Landing Strut

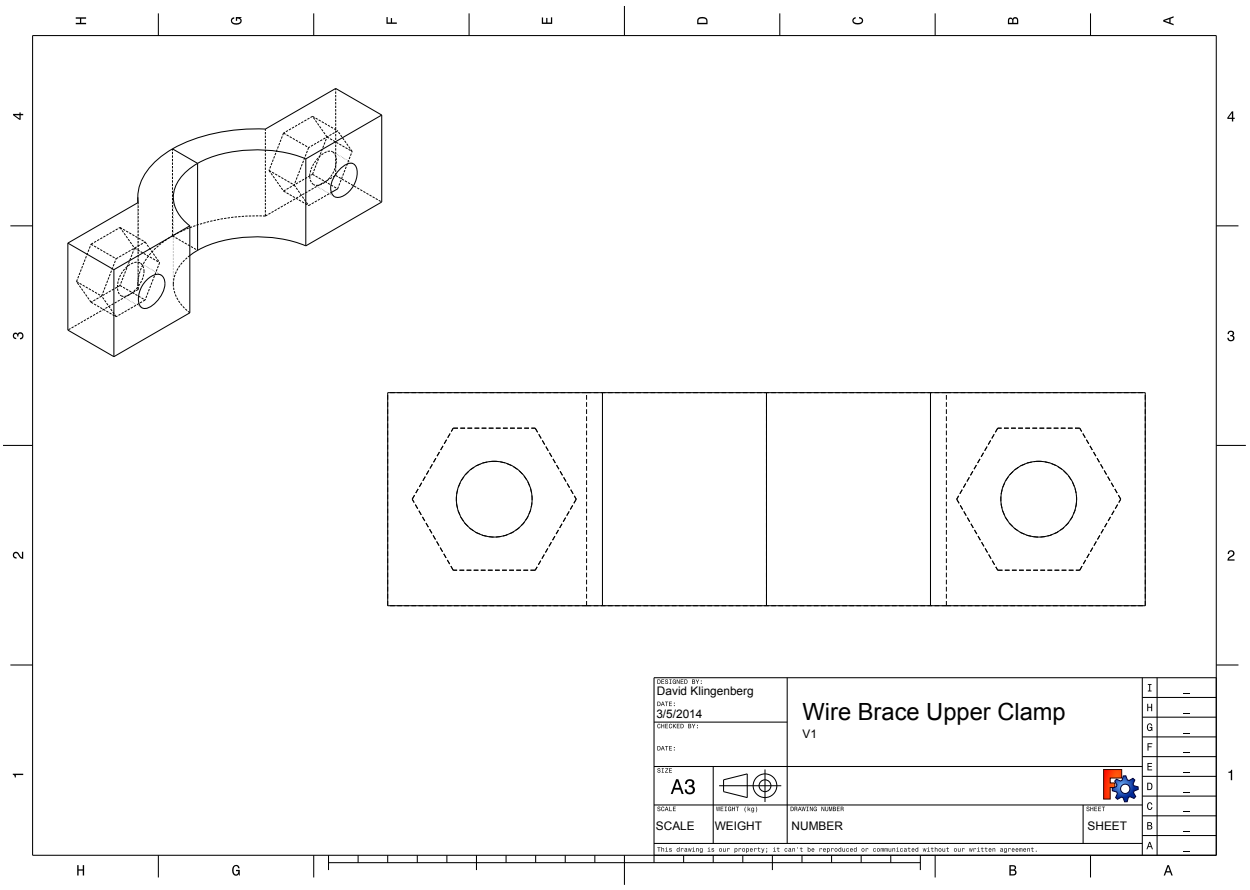


Figure 11: Wire Brace Upper Clamp

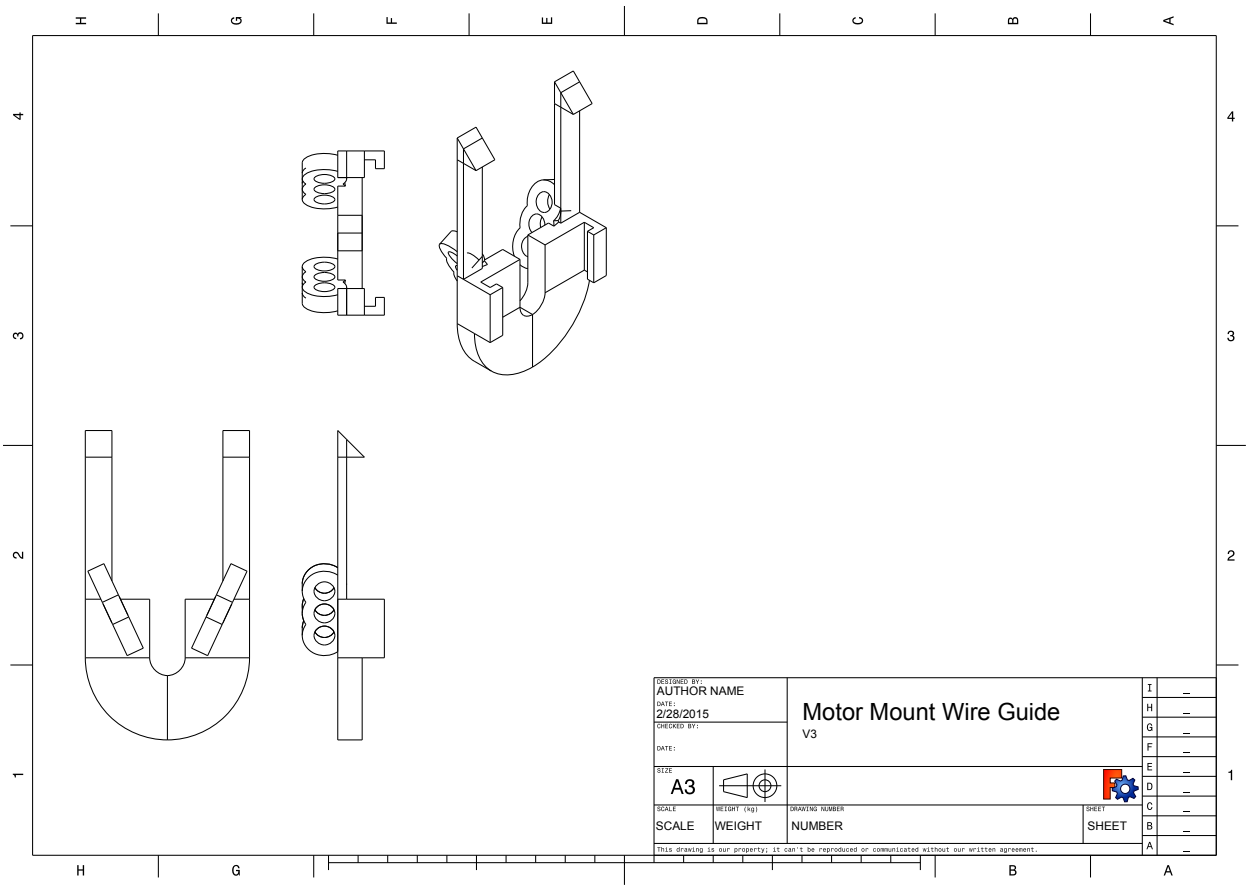


Figure 12: Motor Mount Wire Brace

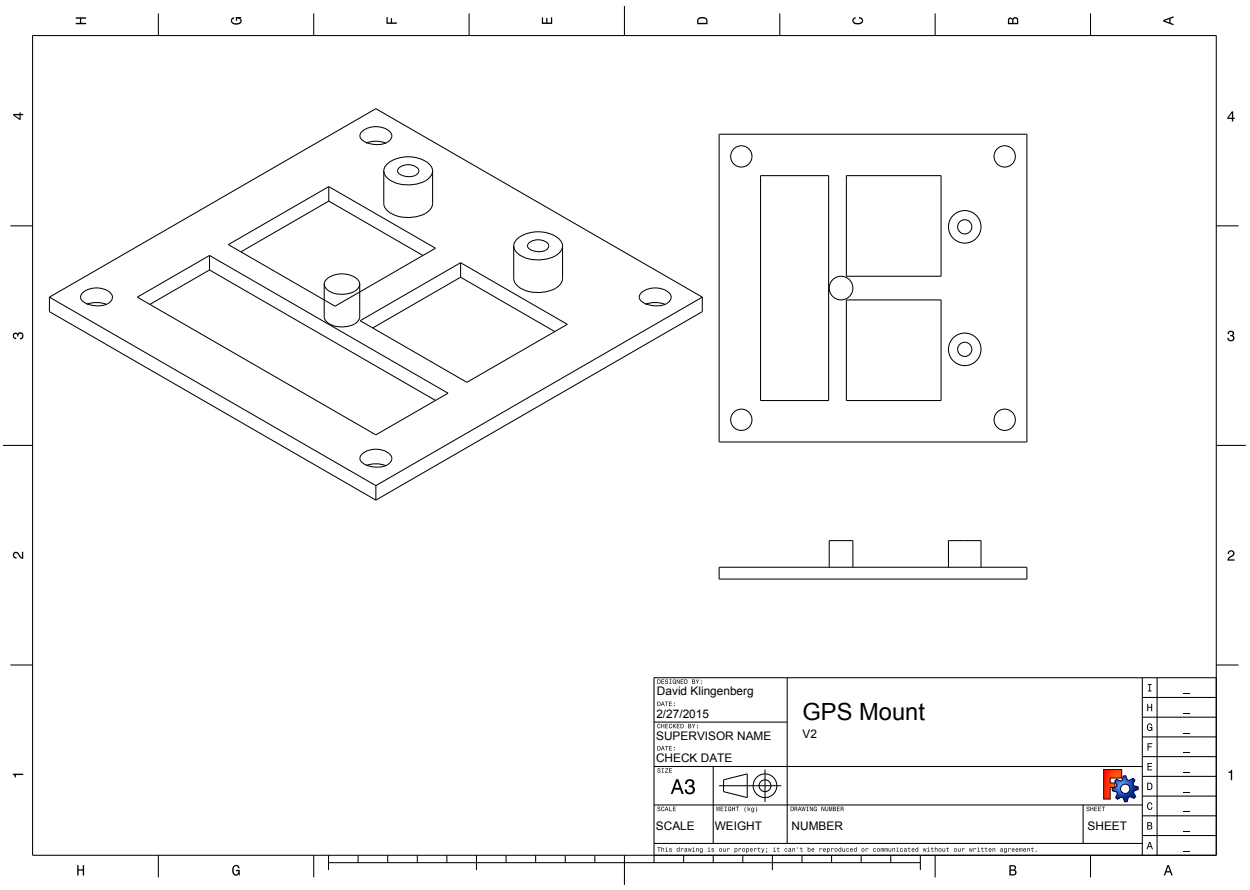


Figure 13: Gps Mount

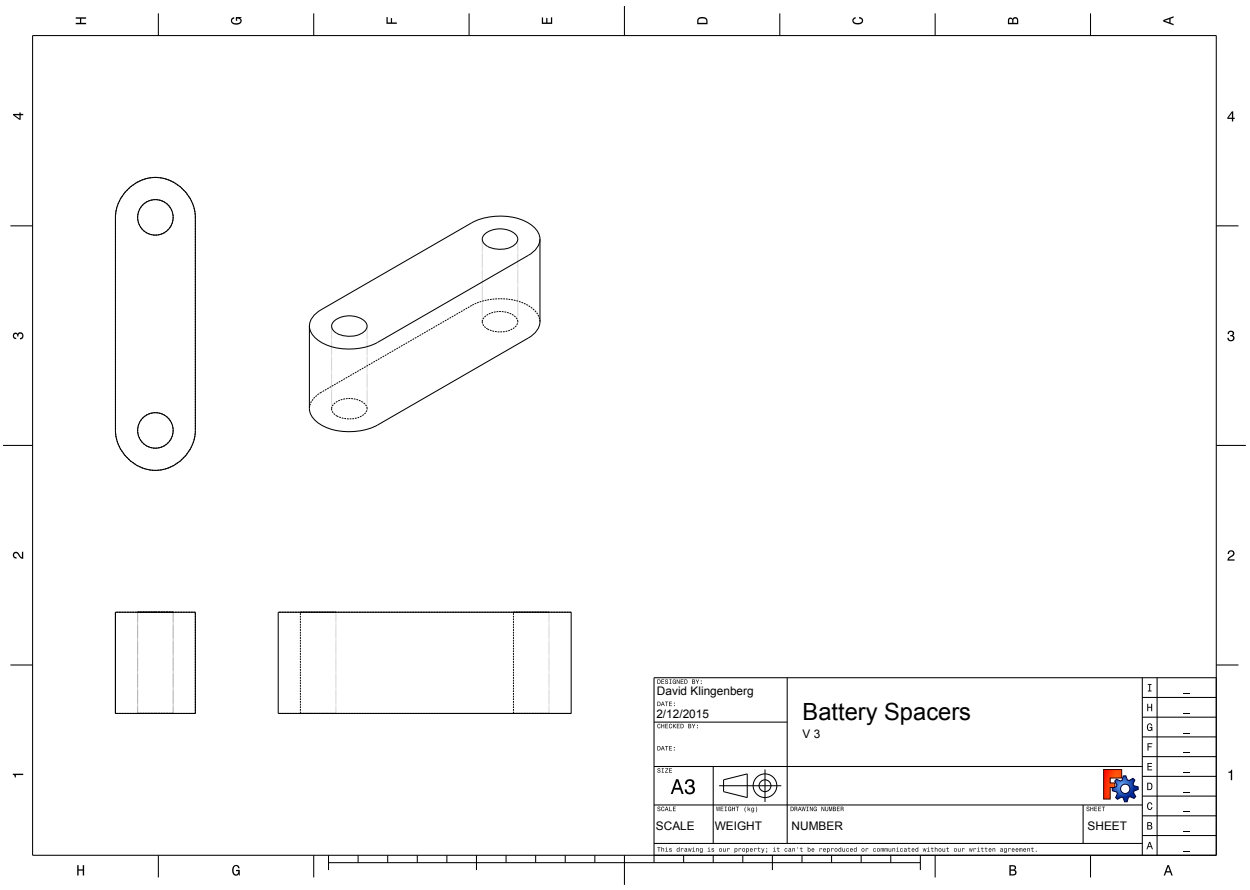


Figure 14: Battery Box Spacers

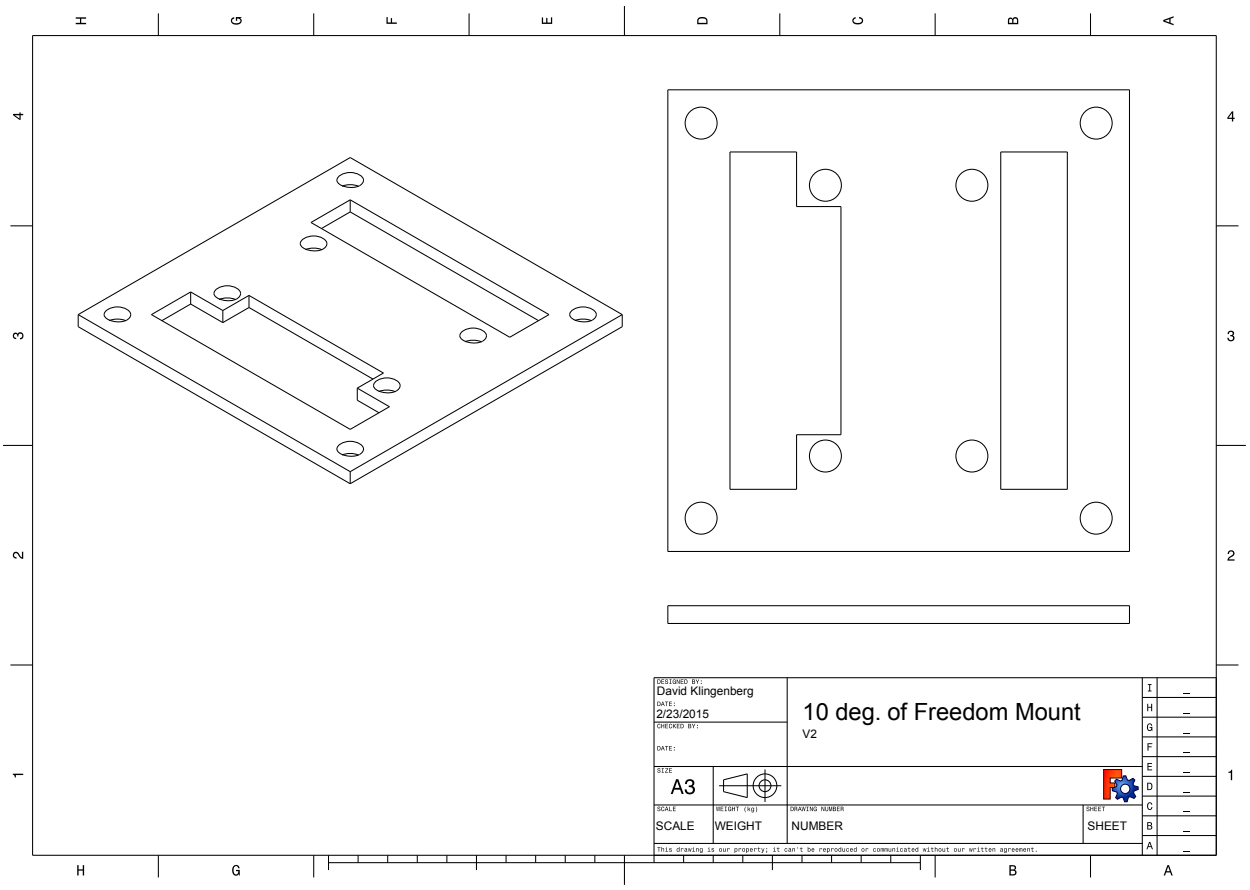


Figure 15: 10 Deg. of Freedom Sensor Platform

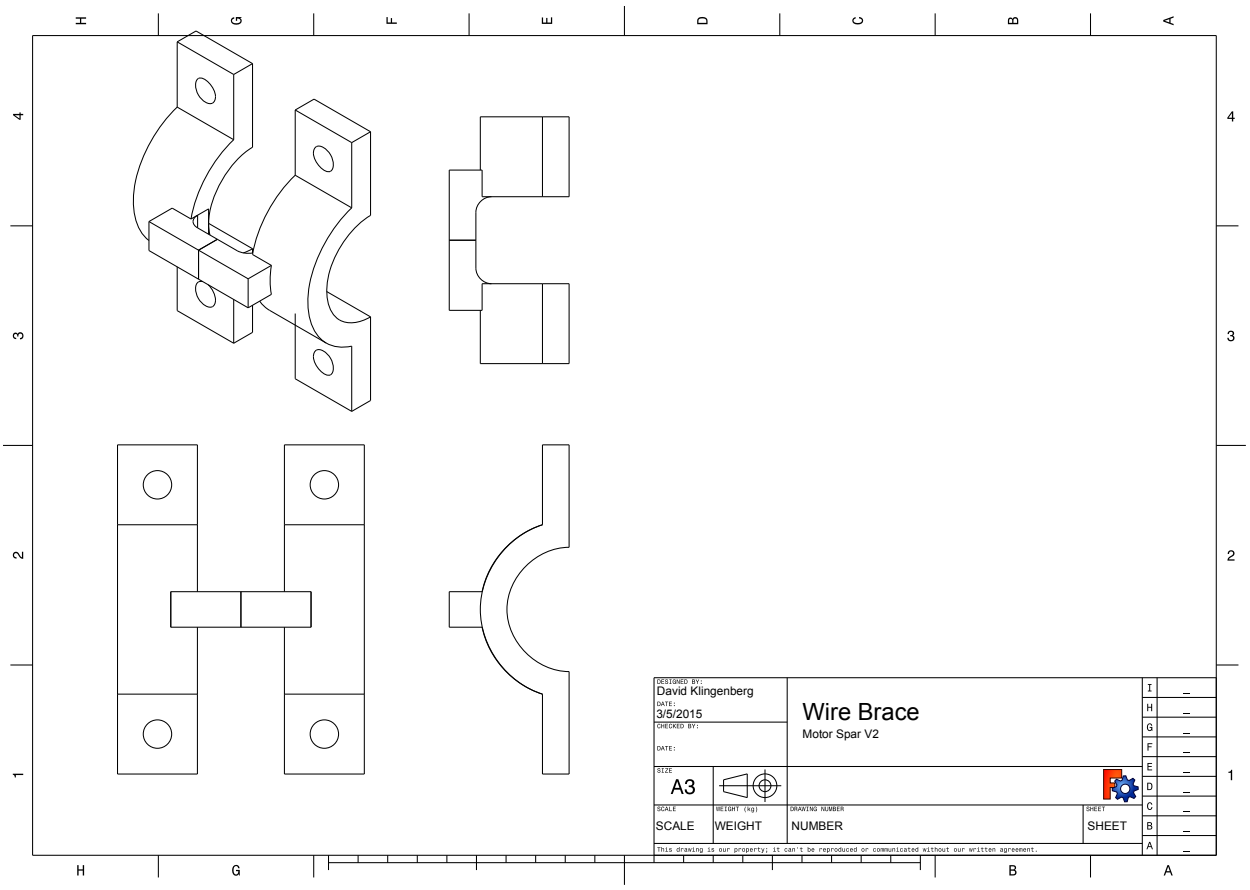


Figure 16: Wire Brace

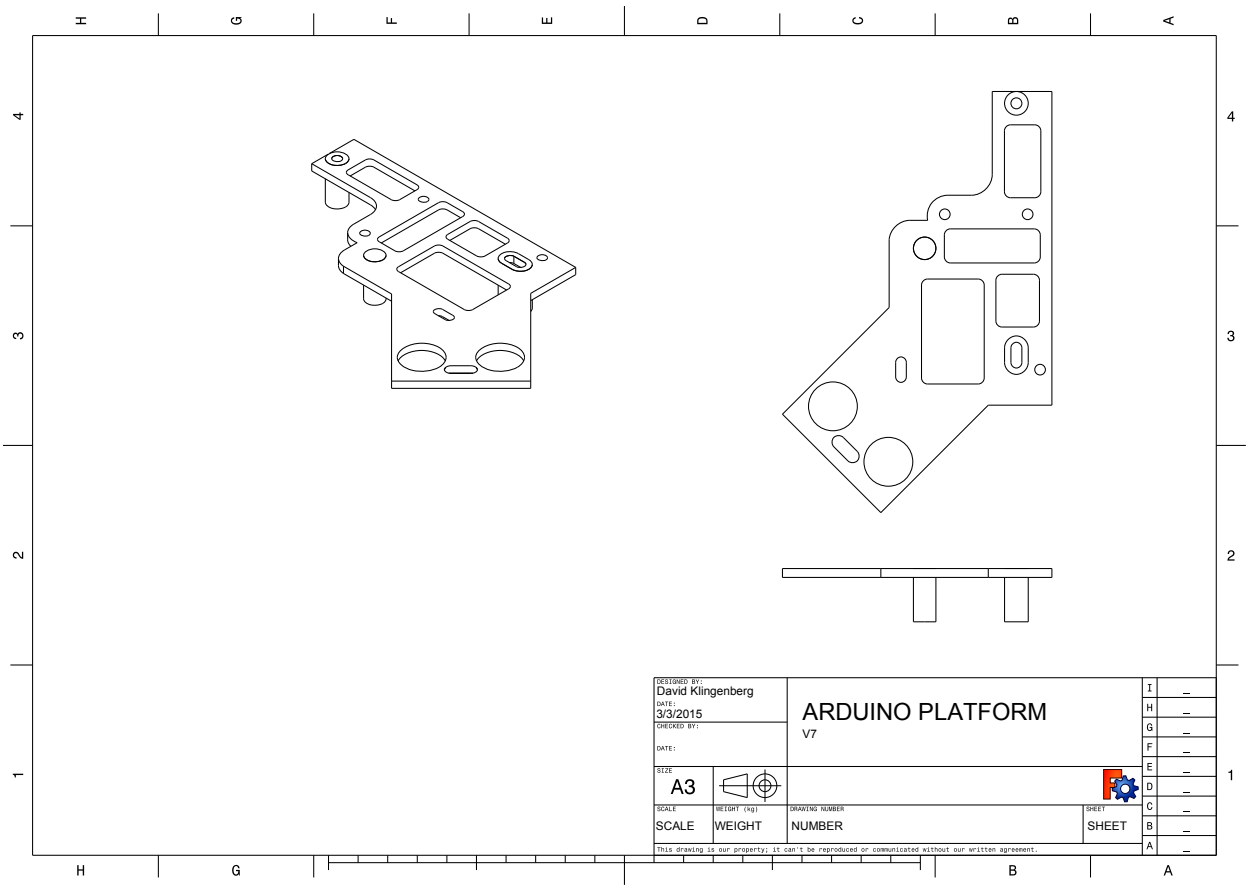


Figure 17: Arduino Platform

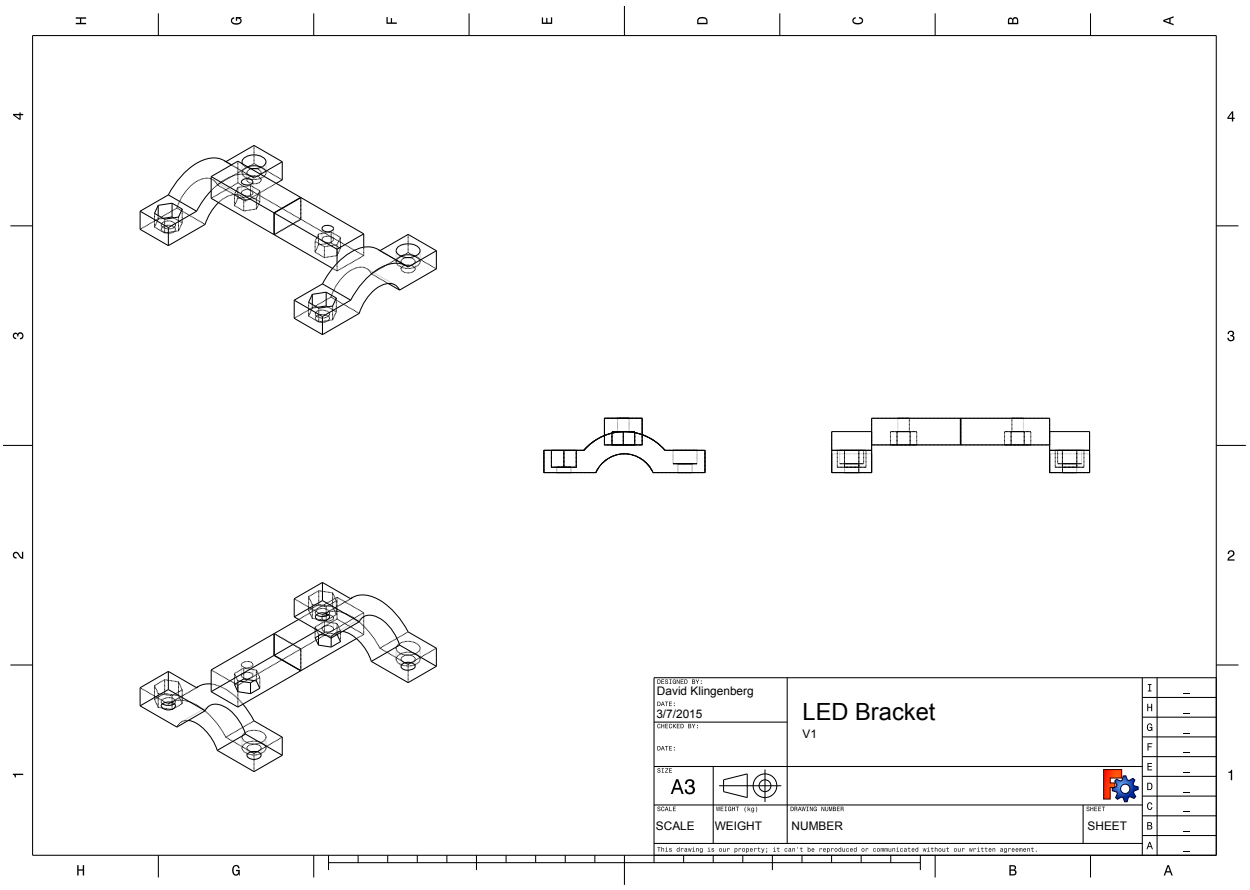


Figure 18: LED Bracket