Barone2 Report Week of 2/20/21

Sprint 3,

Prepared by George Hernandez

**Executive Summary of Progress:**

First, we wanted to incorporate changes to the team dynamic in order to improve our productivity and ensure we were able to properly demonstrate and defend our progress made. The first goal was successful overall, with some room for improvement. We incorporated changes in our Discord chat that we primarily use for communication and meetings, the Trello board for progress, and a few other administrative changes. Although these were non-technical changes, we wanted to place some focus on these changes due to our performance at the last progress review. On 2/19, we had our last meeting with Alexey before the next design progress review, and we showed a lot of improvement in our slides and presentation that will help us better convey our thoughts and progress. The changes also helped us stay more accountable, and believe they will help us be more successful. The one problem we did face, was we were not realistic about our technical goals, which affected our sprint velocities.

Second, we wanted to get ourselves into a position to begin the final design. On the technical side, we had many incompletes which is obviously not something we are proud of. We had an overall velocity of 0.47, far below where we should be. However, we did make good progress and the progress is more concrete than the previous sprints. The administrative changes to produce better results did take some more time, and that along with some poor estimation on learning times meant we made unrealistic goals. In the end, we did complete drag analysis and an updated CAD model, forces incorporated into simulation, an RC throttle adjustment, differential forms of forces for control design, a beginning test for sensors, an updated power budget, and a PCB layout change to allow for surface mounting. Although we did not reach a point to head into the final detailed design, we feel once we complete the incomplete tasks we can begin. Also, the sprint velocity is low, but almost all the incomplete tasks still have some significant progress made so we should be able to catch back up to where we would like to be soon.

**Progress made toward acceptance criteria:**

| Task Deliverable/  Acceptance Criteria | Status | Responsible Party | Anticipated Hours | Details |
| --- | --- | --- | --- | --- |

**CAD Design:**

| Envelope Design-Drag Analysis | Complete | Dylan | 9 | Found the changes in drag forces for different elliptical lift bag designs. Provided a good approximate to begin detailed bag design. |
| --- | --- | --- | --- | --- |
| CAD Draft 2-Lift Bag and Frame | Complete | Dylan | 4 | Update CAD design with new lift bag dimensions, including component dimensions |
| CAD Draft 2-electronics | Incomplete | Dylan | 2 | Update CAD model with realistic electronics. |
| 3D force diagrams | Incomplete | Dylan | 3 | Create 3d force models for visualization and more detailed physical analysis. Faced problems in SolidWorks, may need to do 2D instead |
| Decide on motors and servos | Incomplete | Dylan | 2 | Dependent on force diagrams, so not finished |

**Drone Simulation:**

| Add forces to objects in Vrep | Complete | Isaac | 8 | Forces can be applied in all directions and works on testbench. |
| --- | --- | --- | --- | --- |
| Created GUI to interact with forces | Incomplete | Isaac | 8 | Created a GUI for the user to apply forces to the testbench object |
| Import new CAD design | Incomplete | Isaac and Dylan | 2 | Relied on finalization of CAD draft 2. |

**Controls Design:**

| RC Throttle Control | Complete | George | 2 | Generate new throttle control to prevent unintended roll moments to save energy. |
| --- | --- | --- | --- | --- |
| Define Differential Force Equations | Complete | George | 7 | Define force equations to be used in making a control system. |
| Find Transfer Functions | Incomplete | George | 5 | Started changing to state space control based on our control needs. Did not make enough progress in defining the plant. |
| Design Overall Controls | Not started | George | 10 | Dependent on transfer functions |
| Use simulation to find gains | Not started | George | 2 | Dependent on overall controls |
| Implement C libraries | Not started | George | 10 | Dependent on gains |

**Sensors:**

| Get sensors and other parts working with Microcontroller | Complete | Leon | 8 | Wire up sensors with the proper connections, and verify that they are detected correctly in software |
| --- | --- | --- | --- | --- |
| Be able to read data from the sensors | Incomplete | Leon | 7 | Read data from sensors and verify data. GPS sensor not tested yet |
| Find an acceptable live stream camera setup | Incomplete | Leon and Ryan | 3 | All-in-one RX, TX and camera components selected but missing display output solution that accepts RX coax cable |

**PCB Design:**

| Work on second PCB design with surface mounting | Complete | Ryan | 4 | Replace all through hole footprint devices with surface mount footprint devices |
| --- | --- | --- | --- | --- |
| Implement Raspberry Pi into PCB | Complete | Ryan | 8 | Implement hardware connection between Arduino and Raspberry Pi Compute Module CM3+. implement hardware connection between Arduino and Raspberry Pi Compute Module CM3+ |

**Power Management:**

| Update and reformat Power Budget | Complete | Jeremy | 6 | Analyze and record all power usage of all parts in the bill of materials from the system as currently designed for a 1 hour cycle. |
| --- | --- | --- | --- | --- |
| Run Eagle CAD simulation | Incomplete | Jeremy | 6 | Run simulation with current components and schematic to test power use |

**Calculate sprint velocities:**

| Velocities | Estimated Hours | Total Hours | Velocity  (Total Hours/ Est. Hours) | Description (Reasoning for velocities < 1 |
| --- | --- | --- | --- | --- |
| Dylan | 20 | 13 | 0.65 | Had trouble with making force diagrams which set him behind schedule |
| George | 36 | 9 | 0.25 | Needed to make change to state space control, and introducing discrete time and required a larger learning curve than expected. |
| Isaac | 18 | 8 | .44 | Had a task dependent on force diagrams, which was not completed. |
| Jeremy | 12 | 6 | 0.5 | Updating the power budget took the full 12 hours that was estimated to complete both tasks |
| Ryan | 15 | 12 | 0.8 | Potential camera changes in the design based on the power budget hindered finalizing camera selection and incorporation |
| Leon | 18 | 8 | 0.44 | Camera changes affected velocity as well. Also, GPS was the only sensor that was unable to be tested, so additional hours were almost complete. |
| Team | 119 | 56 | 0.47 | Bad estimation of learning curves and administrative changes affecting time for task approval. (Task approval was harder to get, so took more time to prepare for) |

**Product Owner, Teaching Team, Client Feedback:**

| Functionality Demonstrated | Feedback | Team Response |
| --- | --- | --- |
| Envelope Design-Drag Analysis. Drag forces will be analyzed at different dimensions, and a max size was defined based on manufacturability of the final product. | Alexey-Good analysis and graphs. | Good analysis, good starting point for detailed design. Should start researching envelope materials for next step |
| CAD Draft 2. Updated CAD design with new bag dimensions and starting the analysis of envelope design (material and mass) | Alexey-Design looks good for this stage | Good iteration that can be the base for the final design, but it is still missing the detailed electronics. |
| Simulation Environment. Forces added to a testbench, and servos have the ability to rotate. | Alexey-Simulation looks good, the image of the simulation can be improved on so people know what they are looking at | Good progress on simulation and incorporating forces. |
| RC Throttle Control. Elimination of unintended roll moments. | Alexey-Looks good and appears to solve the moment problem. | Needs more simulation to confirm but looks good. |
| Sensors. Sensors set up for testing and testing started, with the exception of GPS. Can read data, ready to start calibration | Alexey-For presenting progress, a video demonstration and data showing the accuracy of sensors will be good | Good functionality, should have some data to present for design review. |
| Second PCB design. Surface mounted design and incorporated Raspberry Pi | Alexey-Setup looks fine | Good setup, should work with Jeremy to test power. |
| Power Budget. All current components added and their power usage analyzed | Alexey-Power budget looks good, but the data sheet should be cropped better in slides. | Power budget looks good, should continue to update it as we need to |

**Possible Sprint Improvements:**

* **Team Improvements**:
  + A lot of incompletes and we need more realistic sprint goals. Otherwise, we made a lot of improvements from the last sprint and we feel this team wide change should put us in a really good position.
* **Individual Improvement**:
  + Dylan - Improve sleep schedule to get more work done earlier
  + George - Set more realistic goals. Especially with how fast I can learn stuff
  + Isaac - Keep motivation up as the sprint goes on
  + Jeremy - Set more realistic goals for sprint tasks
  + Ryan - Make sure every task is well defined, keep momentum & consistency going
  + Leon - Better time management with other classes & sleep schedule

**Next Sprint Goals:**

* Finish all incomplete tasks (ALL)
* Prep for design review, fix slides
* Fix slides by Tuesday meeting to send to Alexey for feedback
* Dylan - look more at UHMWPE, do analysis/pugh chart to decide on best material. Research manufacturing methods.
* Leon - demo for design review, like a video
* George - rough simulation of RC control and Autonomous control
* Ryan - verify Camera RX & TX works with display.
* Isaac - have my GUI working to demo
* Jeremy - use Eagle CAD simulations to get power draw of components

**Meeting Minutes for Sprint 3 Week:**

Sprint 3 Start

Long Flight Time Buoyant Drone February 11, 2021 7:30(PST)

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* Excused absences: N/A
* Unexcused absences: N/A
* Late: N/A

## AGENDA

* Administrative Stuff 7:30
  + New discord channels
    - Reorganized Discord into channels for each position
  + Changes to Trello cards
    - Added Help column
  + Slides
    - Only Ryan has new slide on PCB Design
  + Team Submissions
    - Microcontroller workshop turned in
* Define Goals (General, see where we need dependencies etc) 8:10
  + Dylan:
    - Optimize lift bag & envelope
    - Add detailed electronics to CAD
    - Force Diagram
    - Finalize motors and servos
  + Isaac:
    - Add physics to simulation environment(Need force diagram)
    - Fix CAD file exporting to simulation
  + Leon:
    - Get sensors and other parts working with microcontroller
    - Be able to read data from the sensors
  + George:
    - Complete root locus(control software) C library
    - Add throttle control for RC
  + Ryan:
    - Work on second PCB design with surface mounting
    - Implement raspberry pi into PCB
    - Help Leon with cameras
  + Jeremy:
    - Complete full power budget
    - Simulate power drain with first PCB design
* Define End Date 8:30
  + Sprint end: 2/20/21
* Tasks (Specific) List Requirement ID if available. Time estimate. 8:32
  + Leon (15 hours)
    - Program sensors with microcontroller and read data (15 hours)
      * IMU
      * Ultrasonic
      * Barometric
      * GPS
  + Jeremy: (12 hours)
    - Complete full power budget with Leon (6 hours)
    - Simulate power drain with first PCB design (6 hours)
  + Isaac (18 hours)
    - Implement buoyancy to balloon (6 hours)
    - Implement propeller forces (NEED FORCE DIAGRAMS) (6 Hours)
    - Implement servo movement (6 hours)
  + Dylan (18 hours)
    - Simulation for finding envelope design (8 hours)
      * Find and download drag simulator toolbox for matlab
      * Use matlab box
    - CAD Draft 2
      * Envelope/Balloon update (3 hours)
      * Update other parts to fit new envelope (2 hours)
      * Add in some electronics to gondola (2 hours)
    - Force Diagram (3 hours)
  + George (36 hours)
    - RC throttle control (2 hours)
    - Define characteristic differential force equations (7 hours)
    - Find transfer functions (5 hours)
    - Design overall controls (10 hours)
    - Use simulation to define gains (2 hours)
    - Implement in C libraries (10 hours)
  + Ryan (15 hours)
    - Work on second PCB design with SMD(4 hours)
      * Capacitors
      * Resistors
      * Diodes
    - Implement raspberry pi into PCB (8 hours)
      * Connect Arduino and Raspberry Pi compute module data bus
    - Help Leon with cameras, update block diagram with cameras (3 hours)
      * Decide on camera, transmitter and receiver components

Meeting End: 9:00

**2/12/21 7:30 - 8:00p**

* Dylan: Finalizing force analysis with drag force
  + Ellipsoid drag equation for envelope
* Leon: working on getting the sensors working together with the microcontroller
* Jeremy: Working on the power budget
* Isaac: Getting physics into simulation
* Ryan: 2nd PCB Design in progress
* George: Working on controls configuration for drone

**2/13/21 7:30 - 8:00p**

* Leon: Studying Sensors
* Jeremy: Power budget completed
* Isaac: Fixing servo motors to turn a certain direction
* Dylan: Working with matlab, ratio and weight of lift bag including drag
* George: Differential force equations and reviewing digital control
* Ryan: Replaced passive components to surface mounts in PCB, added 5V-1.8V and 2V regulator, fixed raspberry pi mount

**2/14/21 7:30 - 8:00p**

* Leon: Working with I2C with microcontroller
* Jeremy: Fixing Power budget with alternate voltage inputs
* Isaac: Adding forces to propellor and balloon in simulation
* Dylan: Will present slide tomorrow on ratio of balloon
* George: Started on differential equations, will reach out to Alexei if help needed
* Ryan: Connected raspberry pi compute module to arduino with SPI
  + Added 7.4V to 5V regulator

**2/15/21 7:30 - 8:00p**

* Isaac: Added motors to propellers, research on adding a GUI to control forces with propellers
* Leon: Will get more work done after tomorrow 171
* Jeremy: Done with V2 of power budget, working on CAD simulation of power
* George: Worked on setting up the differential equations, can implement buoyant force into equations
  + Need to linearize power
* Dylan: Completed slides for the best ratio for the size of the envelope
* Ryan: Been keeping up with documentation with schematics
  + May switch over to Allegroinstead of Eagle CAD
* Keep emailing Mircea for info about lab access

**2/16/21 7:30 - 8:30p**

* Leon: Working on speaking between arduino and the raspberry pi
* Isaac: Looking at tutorials for force simulation
* Dylan: Updated slides, did volume analysis of unused helium capacity
* Jeremy: Worked on getting force equation for thrust
* George: Finished re-deriving all force equations
  + Will set up control system based on force analysis
* Ryan: Helped Leon with software schematics
* Have slides ready for meeting on thursday

**2/17/21 7:30 - 8:30p**

* Zoom Meeting with Gordon tomorrow 6pm

**2/18/21 7:30 - 8:30p**

* Leon: Hooking up sensors at the same time to work together
* Jeremy: Working slides and updating power budget
* Isaac: Working on slides for simulator
* Dylan: Worked on CAD model and working on getting material for envelope
* Ryan: working on slides for each sensor
* Went over slides to show Alexei tomorrow

**2/19/21 4:30 - 6:30p**

* Meeting with Alexei
  + Specify conclusions for each slides
  + Formulate slides into a single task
    - Multiple slides can be for one task, but specify
* Updates
* Leon: Looking at IMU measurements
* Jeremy: Power budget due next Thursday
* Isaac: Working on getting servos to move
* Dylan: Working on new CAD design, need to add micros to finish
  + Start on force diagram tomorrow
* George: Finished RC throttle adjustments
* Ryan: Separate trigger pins used for ultrasonic sensors, fixed IMU I2C communication
* Need to schedule meeting with Mircea to discuss lab access and equipment use

Sprint 3 Conclusion Meeting

Long Flight Time Buoyant Drone 2/20/2021 7:30 - TIME(PST)

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* Excused absences:
* Unexcused absences:

## AGENDA

* **Review of progress:**
  + Dylan-7:34
    - Finding Envelope Design
      * Do a force analysis of drag in order to find optimal design
      * Complete and accepted by time
    - CAD Draft 2
      * Updating the CAD file with the new envelope and changing component sizes to fit the new design. FInally, include electronics
      * Incomplete. CAD file updated for envelope, but electronics not added in
    - Force Diagram
      * 3D force diagram based on new CAD model
      * Incomplete due to problems with solidworks. May change to 2D diagrams
    - Decided on Motors and Servos
      * Dependent of force diagram so incomplete
  + George-7:40
    - RC throttle control
      * Throttle adjustment to eliminate unintended yaw moment
      * Complete
    - Define characteristic differential force equations
      * Find differential equations of movement for the drone
      * Complete
    - Find transfer functions
      * Incomplete. Started change into state space design instead after seeing it is the best option and we have time constraints. Did not make significant progress due to struggle in generating differential equations and the learning curve needed for discrete time MIMO state space systems
    - Design overall controls
      * Incomplete
    - Use simulation to define gains
      * Incomplete
    - Implement in C libraries
      * Incomplete
  + Isaac-7:50
    - Added forces into objects on V-rep
      * Force can be applied in all directions by GUI
      * Testbench shows that the functions work
      * Complete
    - Created a GUI to work with the forces in the simulation
      * Corresponded rotor speeds to forces
      * Implement servo rotations to change direction
      * Incomplete more work will be done the following week
    - Import new CAD design
      * Move parts
      * Simplify polygons
      * Incomplete relies on CAD design Draft 2
  + Jeremy-7:52
    - Complete Power Budget
      * Analyzing the power requirements of all parts in the bill of materials within one cycle of the drone’s use
      * Complete
    - Simulate components with Eagle CAD
      * Use Eagle CAD software with PCB schematic of drone’s confirmed components to simulate their power draw in one cycle of the drone’s use
      * Incomplete
  + Ryan-7:54
    - Work on second PCB design with surface mounting
      * Replace all through hole footprint devices with surface mount footprint devices
      * Complete
    - Implement Raspberry Pi into PCB
      * Implement hardware connection between Arduino (ATMega328P) and Raspberry Pi Compute Module CM3+
      * Complete
    - Help Leon with cameras
      * Find an acceptable live stream camera setup
      * Incomplete- All-in-one RX, TX and camera components selected but missing display output solution that accepts RX coax cable
  + Leon-7:55
    - Get sensors and other parts working with microcontroller
      * Wire up IMU, ultrasonic, barometric, and GPS with the proper connections, and verify that they are detected correctly in software
        + Complete
    - Be able to read data from the sensors
      * Read from the sensors with the right protocol and verify that their data makes sense
        + Incomplete: IMU, ultrasonic, barometric sensors read from but not GPS sensor yet
* **Team Improvements**-7:57
  + Improvement shown from last sprint
    - Better goals, allocated time more reasonably
  + A lot of incompletes, need more realistic sprint goals
* **Individual Improvement**-8:00:
  + Dylan
    - Improve sleep schedule to get more work done earlier
  + George
    - Set more realistic goals. Especially with how fast I can learn stuff
  + Isaac
    - Keep motivation up as the sprint goes on
  + Jeremy
    - Set more realistic goals for sprint tasks
  + Ryan
    - Make sure every task is well defined, keep momentum & consistency going
  + Leon
    - Better time management with other classes & sleep schedule
* **Next Goals**-8:03:
  + Finish all incomplete tasks (ALL)
  + Prep for design review, fix slides
  + Fix slides by Tuesday meeting to send to Alexey for feedback
  + Dylan - look more at UHMWPE, do analysis/pugh chart to decide on best material
  + Leon - demo for design review, like a video
  + George - rough simulation of RC control and Autonomous control
  + Ryan - verify Camera RX & TX works with display.
  + Isaac - have my GUI working to demo
  + Jeremy - use Eagle CAD simulations to get power draw of components
* **Other Business**-8:09:
  + Mircea will be able to meet next week after Gordon finishes his Thesis
    - Ask for paperwork of confirmation that we can use Delaware labs
  + Motor workshop is on Monday, most of us should go

Meeting End: 8:20