**University of Florida**

**Department of Electrical Engineering**

**EEL 5666**

**Intelligent Machines Design Laboratory**

**Weekly Report 2**

**Summary**

Calculations were redone for the more accessible, single chamber, PVC body. Important issues including the initial wing design, power requirements and battery requirements were addressed. Servo and solar charger purchases were finalized although final sensor selections are still in progress. A lab journal has been started to record important concepts.

**Structural Layout**

Accessibility is a primary design consideration for the basic structure of the updated Solar Ray design. PVC tubes with screw in connections are utilized for the three primary tubes. The final design will consist of 6 main parts: 2 wings, 3 PVC tubes, 1 connection tube and 1 “jacket” made out of swimsuit material with a solar panel sewn into it. Wings will be connected to outside tubes with circular clamps.



**Figure 1. Layout Design and Parts (Without clear PVC cap, battery holders, voltage divider, solar panel, sonar, demonstrated with uncut PVC pipe)**

**Actuators and Sensors**

Two servos with higher torque capabilities (486oz-in max) will be used to actuate the wings. However, these servos must be waterproofed first, unlike the 125 oz-in waterproof servos ordered previously. The higher torque should allow for larger heavier wings and substantially exceeds the amount of torque anticipated to be necessary. The waterproof servos with less torque may be used to form a type of tail later. All servos have been received. This week, Norcross marine was contacted to determine if they would sponsor the project by providing two D11S sonar depth finder units to mitigate the rapidly increasing price of the project. 2 CdS sensors, 2 bump sensors and possibly a camera will also be incorporated into the final design.

**Finalized Calculations**

The important calculations necessary to ensure a feasible design are shown below. Ensuring a positively boyant vehicle with enough actuation torque to flap at a kinematic profile known to produce thrust (around Strouhal number=0.3 or above) were primary considerations. Balancing the battery power and solar charger were also important. The charging will take longer than hoped, but for a prototype, the charging performance will be considered acceptable.

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| --- | --- | --- |
| **Anticipated Movement** |  |  |
| Vmax=Max Forward Velocity | 0.5 | m/s |
| Vcruise=1/2 Max Forward Velocity | 0.25 | m/s |
| **Kinematic Profile** |  |  |
| Wing Beat Frequency (Max) | 0.5 | Hz |
| Wing Beat Period | 2 | s |
| Phase Lag (TE to LE) | 90 | degrees |
| Flapping Amplitude | 0.3 | m |
| Strouhal Number (A/Vt) | 0.3 | none |

|  |  |  |
| --- | --- | --- |
| **Boyancy Check** |   |   |
| Air Displaced Main Cylinder | 0.0036939 | m^3 |
| Air Displaced Dual Cylinder | 0.0032835 | m^3 |
| Air Displaced Connections | 0.00139 | m^3 |
| Max Air Displaced | 0.0069774 | m^3 |
| Max Boyant Force | 6.9689612 | kg |
| % Electronics Main Cylinder | 0.3 |  |
| % Electronics Dual Cylinders (est) | 0.1039135 |  |
| % Electronics Dual Cylinders | 0.1 |  |
| Real Air Displaced | 0.0069308 | m^3 |
| **Total Boyant Force** | 6.9225015 | kg |
| **Weight Check** |  |
| PVC main tube & caps: est | 0.2 | kg |
| PVC dual side tubes & caps: est | 0.1666667 | kg |
| Basic Wing Structure  | 0.5 | kg |
| Servos | 0.18 | kg |
| Pressure | 0.025 | kg |
| Camera | 0.198 | kg |
| Sonar: est | 0.85 | kg |
| Batteries | 1 | kg |
| Solar Charger | 0.29 | kg |
| Skin: est | 0.2 | kg |
| Structures: est | 0.35 | kg |
| Board | 0.05668 | kg |
| Random Wiring | 0.1 | kg |
| **Total Weight of Robot** | 4.1308467 | kg |

|  |  |  |
| --- | --- | --- |
| **Force/Torque Calculations** |   |   |
| Min Drag Coeff (all frontal areas) | 0.3 | none |
| Estimated Drag Coeff (all frontal areas) | 0.5 | none |
| Max Drag Coeff (do something if this reached) | 0.8 | none |
| **Frontal Drag Force (est) = Thrust Req** | **18.479** | N |
| **Frontal Drag Force (est) = Thrust Req Cruise** | **4.620** | N |
| X Centroid of Wing | 0.273 | m |
| Y Centroid of Wing | 0.000 | m |
| Pivot X location | 0.159 | m |
| Avg Ang Velocity, Centroid of Wing, Max freq | 3.142 | rad/s |
| Avg Velocity, Centroid of Wing, Max freq | 0.357 | m/s |
| Total Drag Force on Wing as moves | 1.307 | N |
| **Torque Possible/servo (=486 oz-in)** | 0.350 | N\*m |
| **Torque Required/servo (=207 oz-in)** | **0.149** | N\*m |

|  |  |  |
| --- | --- | --- |
| **Power Check** |   |   |
| Max Pwr Req (P=TreqVmax) | 9.2392917 | Watts |
| Cruise Pwr Req (P=TreqVcruise) | 1.1549115 | Watts |
| Power Req (Actuators Only) | 9.2392917 | Watts |
| Power Req (Electronics Only)-guess | 4 | Watts |
| Total Power Req | 13.239292 | Watts |
| **Battery Calculations** |  |  |
| Battery capacity (per 6 pack) | 15 | Ah |
| Charging Time | 50 | h |
| Total Battery Life (est) | 13.595893 | h |

**Main Purchase List (with sources and part numbers)**

Note that the sonar and camera are the only things on this list that have not yet been purchased. Most items have been received, as shown in the figure on page 1.

|  |  |  |
| --- | --- | --- |
| **Purchases** | **Amount** | **Supplier** |
| 2” and 3” PVC pipe, PVC cement, PVC connectors, silicone gel | 50 | Lowes |
| Dark Navy Nylon Swimwear, thread | 30.25 | [www.fashionfabricsclub.com](http://www.fashionfabricsclub.com/)  |
| PV Board  | 128.1 | Prigin Vermeer Robotics |
| PV Board Programmer | 22 | Prigin Vermeer Robotics |
| 2x3 Battery holders, snap leads | 28.03 | [www.willyselectronics.com](http://www.willyselectronics.com/) |
| Batteries 16 batteries, 4 chargers | 60 | [www.techforless.com](http://www.techforless.com/) |
| Traxxas 2075 Digital High-Torque Waterproof Servos | 60.93 | <https://www.rcsuperstore.com/> |
| Threaded 2" PVC connectors | 16.97 | Lowes |
| 1' 3" ID, 2' 2" ID Clear PVC tubing | 49.88 | [www.aquaticecho.com](http://www.aquaticecho.com/) |
| LM317 Voltage Down Converter | 6.99 | Asia Engineer, ebay.com |
| HS-7950TG High Torque Servo x2, Hitech HPP-21 Programmer | 266.97 | [www.servocity.com](http://www.servocity.com/) |
| Clear 2" PVC cap | 25.02 | [www.usplastic.com](http://www.usplastic.com/) |
| LCD, CdS sensor x2, breadboard | 20 | [www.sparkfun.com](http://www.sparkfun.com/) |
| 2-3" #40 Circular Clamps x4 | 4.15 | Lowes |
| 12 Energizer AA NiMh 2500mAh Batteries, Mineral Oil | 36.27 | WalMart |
| Hawkeye D11S Sonar Depthfinder x2 (est) | 160 | [www.shopnorcrossmarine.com](http://www.shopnorcrossmarine.com/) |
| CMU3 Camera | 250 | [www.seattlerobotics.com](http://www.seattlerobotics.com/) |
| Powerfilm R15-30 300mA, 15.4V Solar Charger, cable, charge controller 12V, 4A | 135.5 | <http://www.siliconsolar.com/flexible-solar-panel--powerfilm-5-watt-p-48.html> |
| **Total Spent** | **1351.06** |  |