AUVSI DESIGN COMPETITION

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Overview

"The goal of this project is work effectively as a team to create the best possible aircraft for future success at the 2016 AUVSI SUAS Competition."

FIPSE- Fund for the Improvement of Postsecondary Education

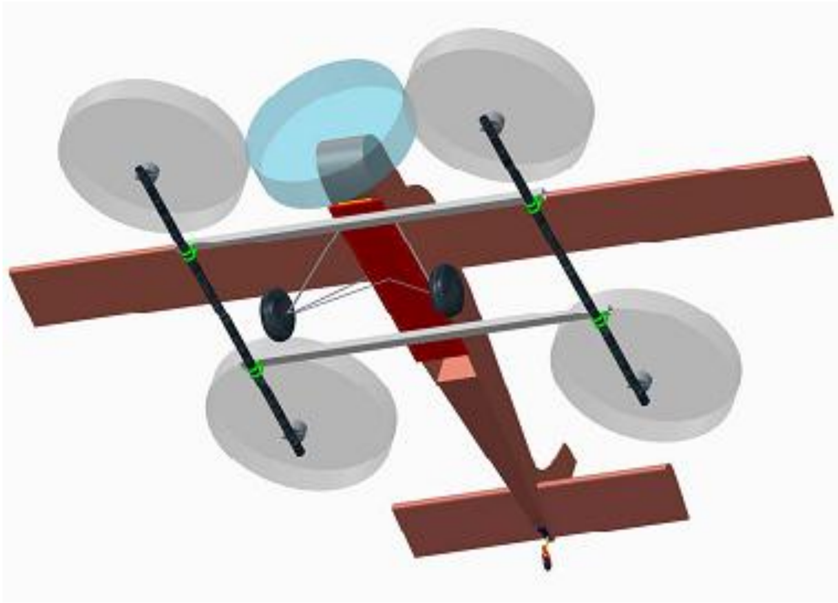
- Two members of Team 8 studied in Itajuba, Brazil during Fall 2014
- International experience
- Communication and teamwork skills

Tasks:

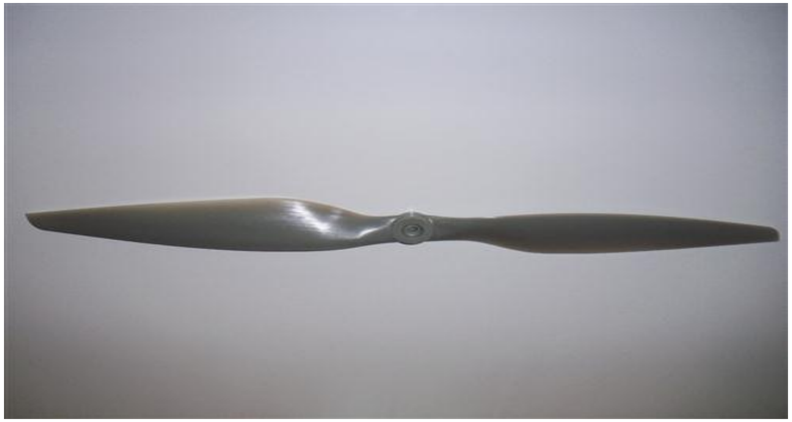
- **Design** aircraft and optimize for competition
- **Build** and modify existing Senior Telemaster plane
- **Program** aircraft for stable VTOL
- **Test** aircraft and improve functions

Progress

Progress:
- Calculations complete and vehicle specifications determined
- Final design chosen
- Parts selected and ordered
- Entering building phase

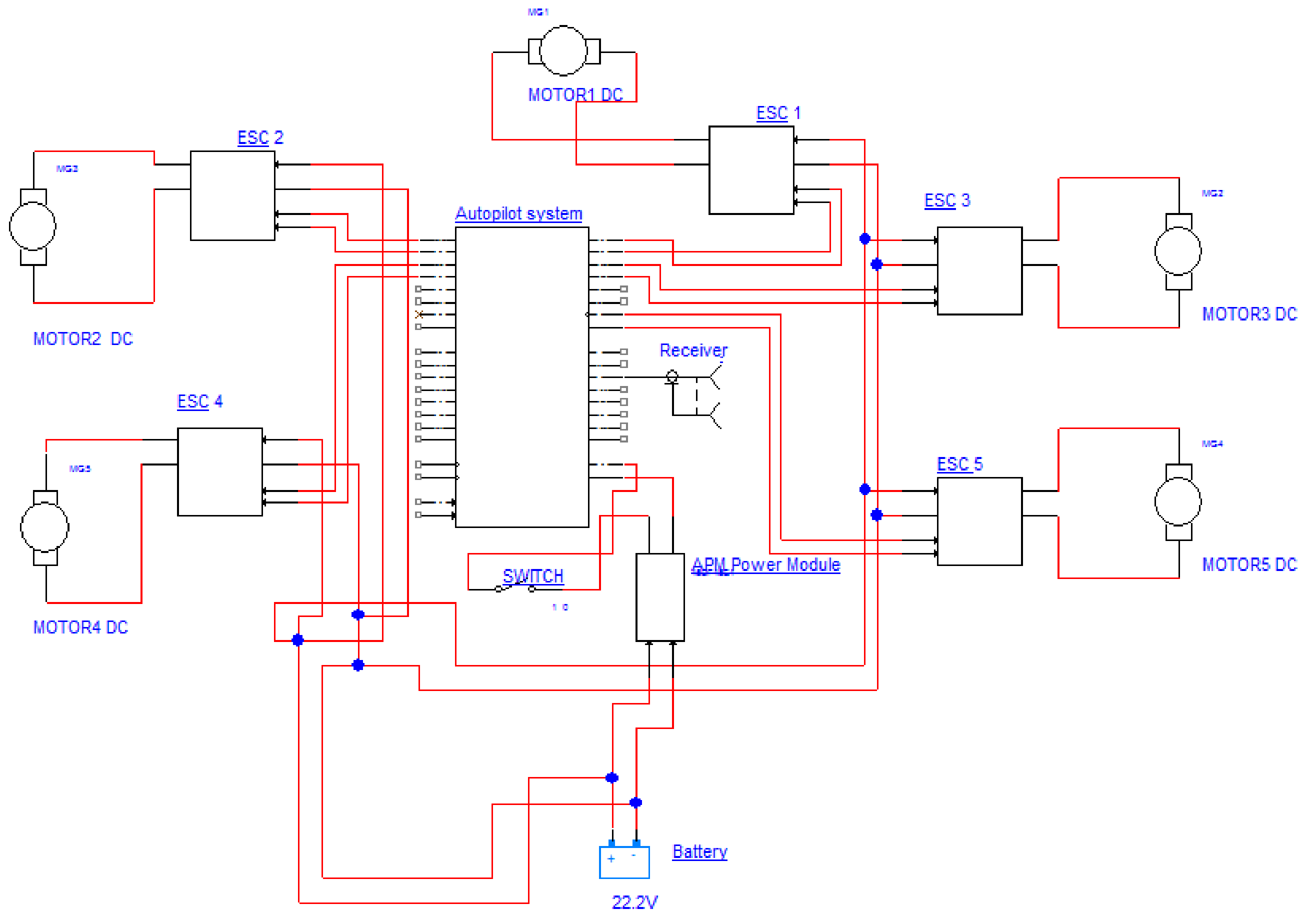


Motor Selection



- **Motor**: 4 Cobra 4510
    - Specifications: KV = 420 RPM, Motor I=38.76A, Input V = 22.2
- **Propeller**: 4 APC
    - Specifications: Diameter = 18 in, Pitch = 5.5 in
- **Effective thrust:** 6.62 kg per motor/propeller combination
- **Total effective thrust:** 26.48 kg
- **Greater than 2:1** thrust to weight ratio (total weight 10.92 kg)

Circuit schematic



Gavarni Leonce

Autopilot and ESC Selection

Autopilot selection:

- **Ardupilot 2.5**
- Fully autonomous waypoint Navigation for multi-rotor vehicle
- Failsafe programming options if device loses signal
- Relay real-time telemetry data to ground system

ESC selection:

- **Cobra 60A Opto multirotor ESC**
- Permits device to operate with minimal radio interference at high currents
- If the autopilot system loses signal, the system will automatically switch to idle

Electrical Power Calculations

Remaining battery capacity if aircraft land and takeoff for 40s

= (battery capacity – (discharge time * current drawn)

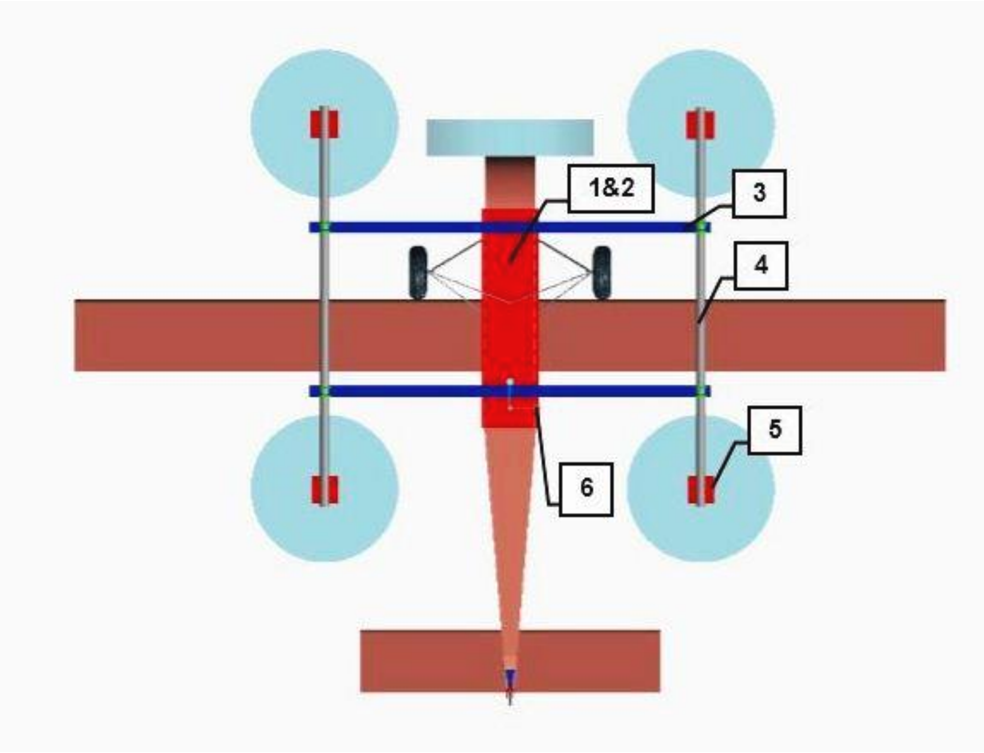
Potential hovering time = (battery capacity *60min)/(current drawn)

Max total flight time = Takeoff time + potential hovering time

Recommended flight time = 0.8*Max flight time

Initial battery capacity	Remaining battery capacity from VTOL of 40s	Potential hovering time	Max total flight time	Recommended flight time
10AH	8.28AH	5.175 min	5.84 min	4.6733 min

Frame Design



Design Criteria:

- Light Weight
- Aerodynamic

<u>Material Selection:</u>

1. G-10 Garolite for the Base
2. Quick-Recovery Polyurethane Foam as a Spacer between the frame and plane
3. 6061 Aluminum Cross Beams for Carbon Fiber Attachment
4. High-Strength Rigid Carbon Fiber rods to serve as motor mount supports
5. G-10 Garolite cut to be Motor Mounts
6. Industrial Strength Velcro to fasten the base to the plane

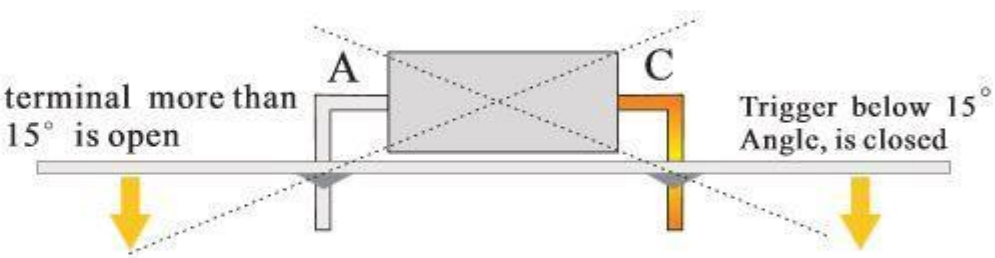
Frame Design Weight and Cost

Component	Description	Weight (lb)	Price	Qty.	Total Weight (kg)	Subtotal
G10	Base	1.392	$0.00	1	0.631	$0.00
G10	Motor Mount	0.055	$0.00	4	0.096	$0.00
Carbon Fiber	Parallel Arms that Support Motors	0.716	$35.87	2	0.650	$71.74
6061 Al	Attaches Carbon rods to Base	1.015	$23.38	2	0.921	$46.76
Foam Spacer	Padding to Plane	0.406	$34.03	1	0.184	$34.03
D.B. Orange	Epoxy to Attach Motor Mounts	0.000	$16.00	1	0.028	$16.00
Velcro	Holds Base to Plane	0.250	$20.00	1	0.028	$20.00
Zip Ties	Secures Carbon Fiber to Al6061	0.000	$10.00	1	0.028	$10.00
Hardware	Screws, Bolts, Etc.	0.000	$20.00	1	0.028	$20.00
				Total	2.595kg	$218.53

Preliminary Stability Testing

Sensor:

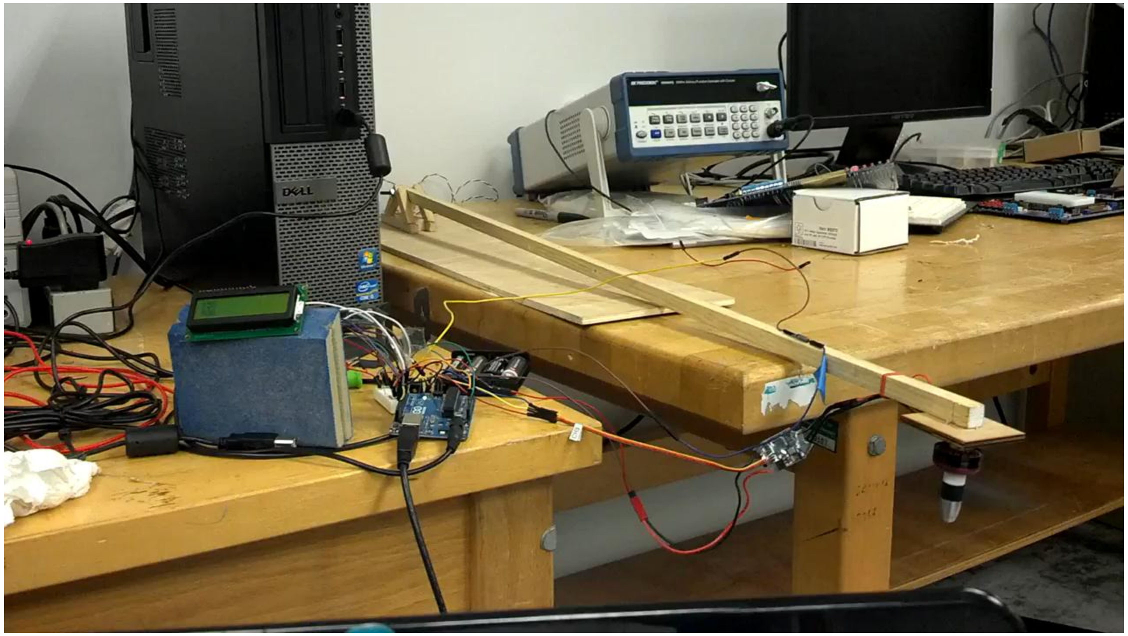
- **Proof of Concept**
  - SW-200D
    - Roll Ball Switch
- **Positives**
  - Able to detect values other than “full on” or “full off
- **Negatives**
  - Severely Affected by vibrations



Preliminary Testing Video

Leveling Components:

- **Sensor**
  - SW-200D
- **Micro-Controller**
  - Arduino Uno
- **ESC**
  - FMS 12A
- **Motor**
  - Mini Brushless

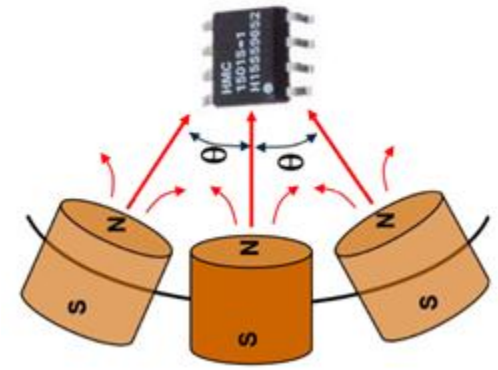


Future Testing

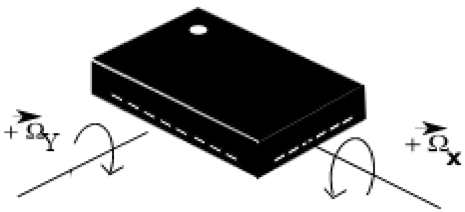
Desired:

- **HMC1512**
  - Dual Hall Effect Sensor
  - Detects Angular Displacement
    - VA= Vs*S*sin(2Ө)
    - VB= Vs*S*cos(2Ө)

- **LPR410AL**
  - Dual Axis Gyroscope for angular rate measurements

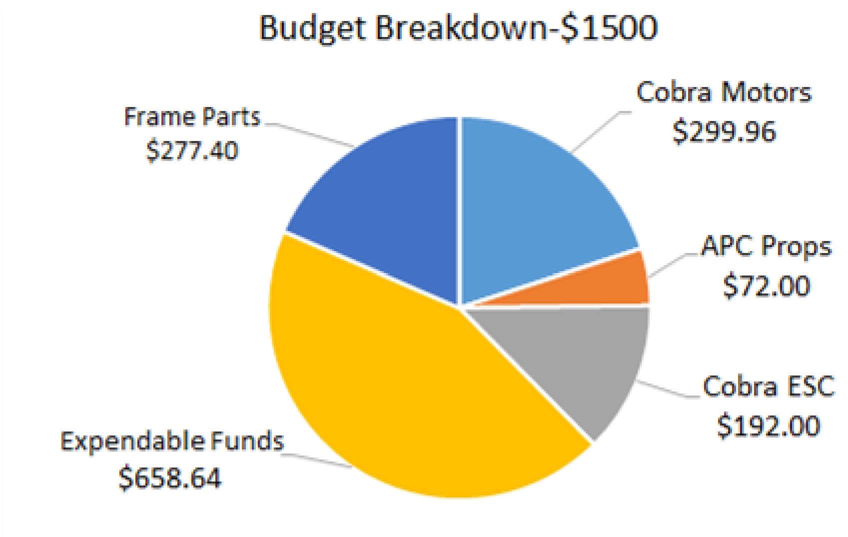


HMS1512 Detecting magnetic angular displacement



Schematic of the 2-axes that are measured for rate of rotation

Cost Analysis and Procurement



Procurement:

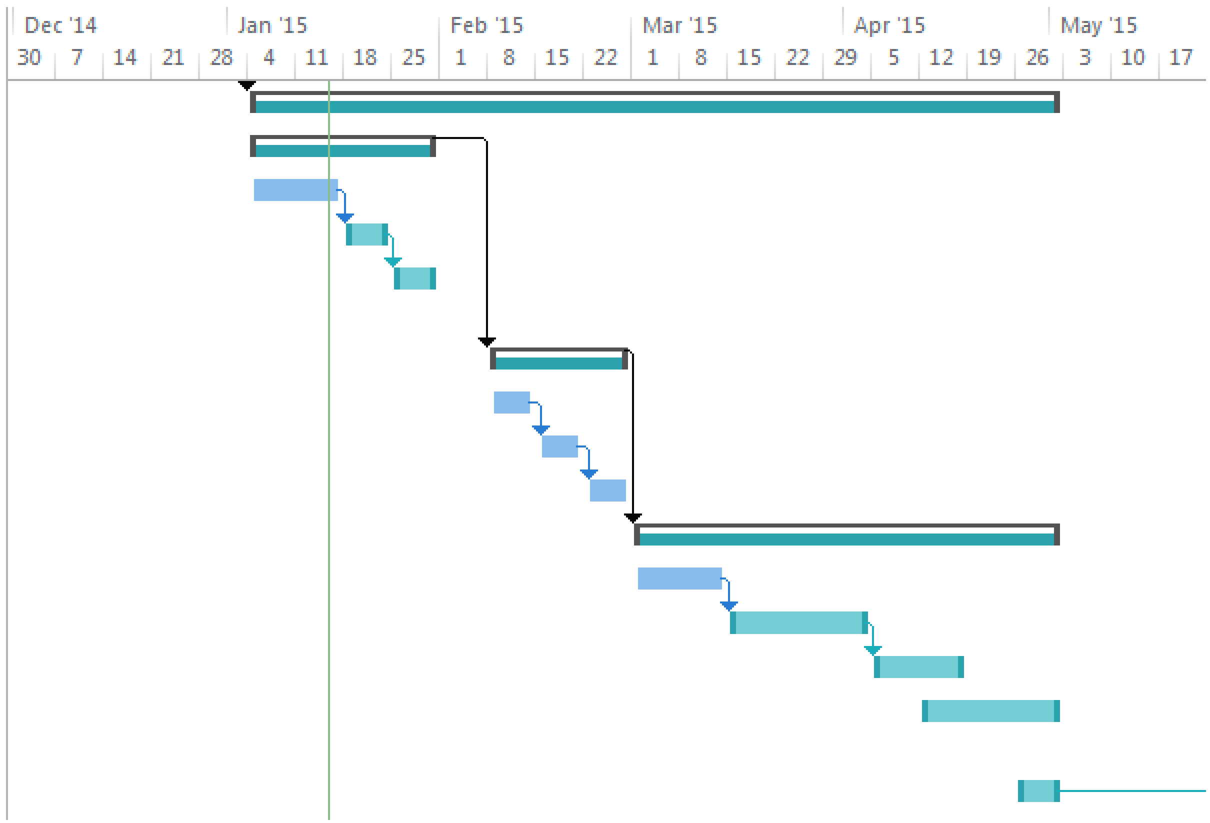
- All frame parts in possession
- All additional parts ordered

Cost Analysis:

1. Utilized 56% ($841.36) of budget
2. Efficient Spending
3. Surplus Added

Schedule for Spring 2015

Task Name	Duration
Spring Semester 2015	**17 wks**
Build Design	**4 wks**
Complete design build	2 wks
Drawings of assembled design	1 wk
Troubleshoot and order supplementary parts	1 wk
Forward Flight Test	**3 wks**
Test forward flight	1 wk
Troubleshoot	1 wk
Supplemental test if necessary	1 wk
VTOL Test	**9 wks**
Mount Motor/Rotors to Frame	2 wks
Test VTOL/Stability	3 wks
Touble Shoot	2 wks
Supplemental Test for VTOL/Stability	3 wks
Assessment and Future Plans	1 wk



Future Work

Spring Semester:

1. Machining and Preliminary Build
2. Forward flight testing
3. Troubleshooting
4. Vertical flight testing
5. Troubleshooting

Future Semesters:

1. Research on transitional flight
2. Selection of secondary tasks
3. Optimization

Task Name	Duration
Fall Semester 2015	**17 wks**
Transitional Flight	**14 wks**
Research Transitional Flight Options	3 wks
Implement the best option for transitional flight	6 wks
Test Transitional Flight	3 wks
Troubleshoot and supplemental test	2 wks
Competition Secondary Task	**3 wks**
Research and select secondary task	1 wk
Designs for secondary Task	2 wks
Spring Semester 2016	**17 wks**
Autopilot	**8 wks**
Optimize autopilot code	5 wks
Test Autonomous Flight	2 wks
Troubleshoot Autonomous Flight	1 wk
Secondary Task	**7 wks**
Build/Code Secondary Objectives	3 wks
Test Secondary objectives	2 wks
Troubleshoot/optimize design	2 wks

Final Summary

1. FIPSE sponsored team working on aircraft based on AUVSI specifications
2. Aircraft design completed; motor/propellers, electrical components, and physical frame selected
3. Beginning build phase
4. All parts ordered and in the process of shipping
5. Future work includes extensive testing and troubleshooting

References

1. http://www.arcturus-uav.com/aircraft_jump.html
2. http://mcmaster.com
3. http://theepoxysource.com
4. http://www.cobramotorsusa.com/motors/cm-4510-28-side-l.jpg
5. http://flyduino.net/T-Motor-MN4010-475KV
6. http://www.foxtechfpv.com/5008340kv-brushless-motorblack-p-1149.html
7. http://www.apcprop.com/ProductDetails.asp?ProductCode=LP18055MR
8. http://innov8tivedesigns.com/cobra-60a-opto-multirotor-esc
9. https://store.3drobotics.com/products/apm-2-5-kit
10. http://m4.sourcingmap.com/photo_new/20111024/g/ux_a11102400ux0010_ux_g03.jpg
11. http://www.beelee-switch.com/uploads/soft/120516/200D.pdf
12. www.st.com
13. www.honeywell.com/magneticsensors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