ALAMO COLLEGES DISTRICT
San Antonio College

MESA Mathematics Engineering Science Achievement

Building Bridges
PUENTES PROJECT
"Bridging the Gap"

Sonar Imaging in an Unmanned Underwater Vehicle

SAC Undergraduate Research Program
8/14/2017

Participants

Irene Salazar - Project Manager

Dominic Ochoa - Mechanical Designer

Julio Banda - Electrical Designer

Eben Pfeil - Programmer

Cesar Ventura - Programmer

Klaus B. Bartels - Faculty Advisor

Background

- Need exists for safely locating and identifying objects in turbid water
- Team partnered with Hays County Emergency Services and San Marcos Area Recovery Team (SMART)
- Need an underwater robotic device to lower the risk to diver safety in murky water or where dangerous conditions exist
- Inspired by National ROV Competition teams

Goal and Objectives

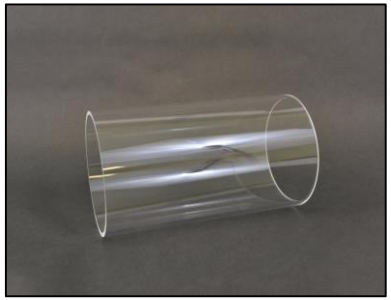
Goal: Design a prototype remote unmanned underwater vehicle (UUV) for safe exploration and navigation in turbid water

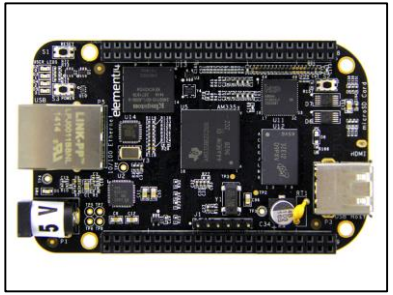
- Obj. 1: Develop a small-scale, remote-controlled UUV with an imaging system that can be used to detect objects in confined, sub-aquatic spaces such as shallow water and flooded or submerged structures in clear and turbid water

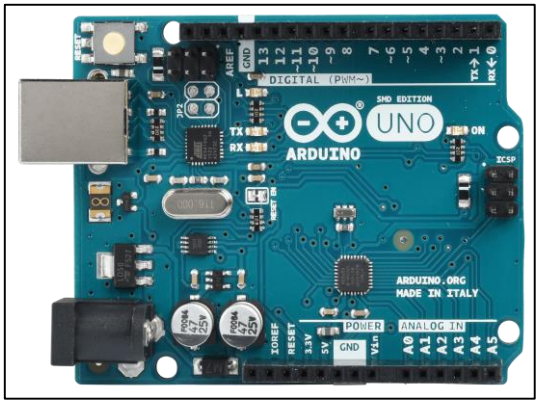
- Obj. 2: Build knowledge in mechanical and electrical design of underwater robotics and remotely controlled systems

- Obj. 3: Promote STEM to potential engineers and scientists

Main Components

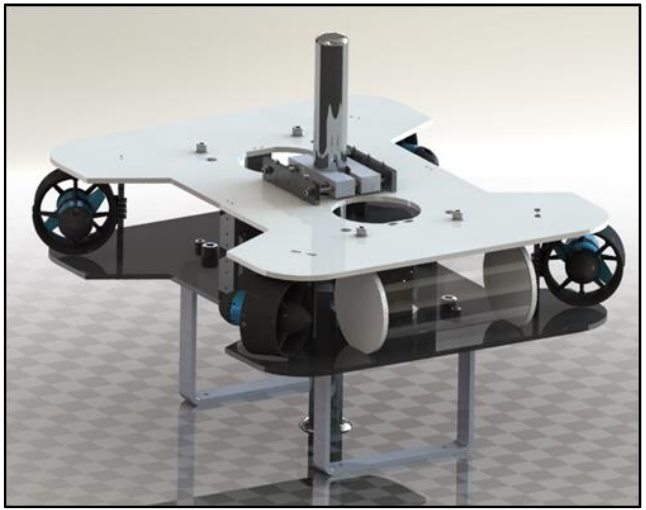


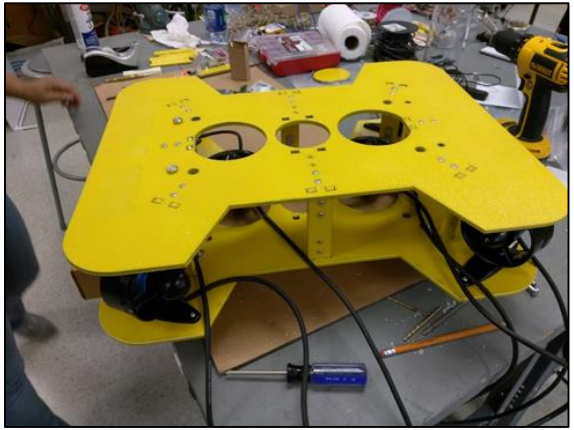




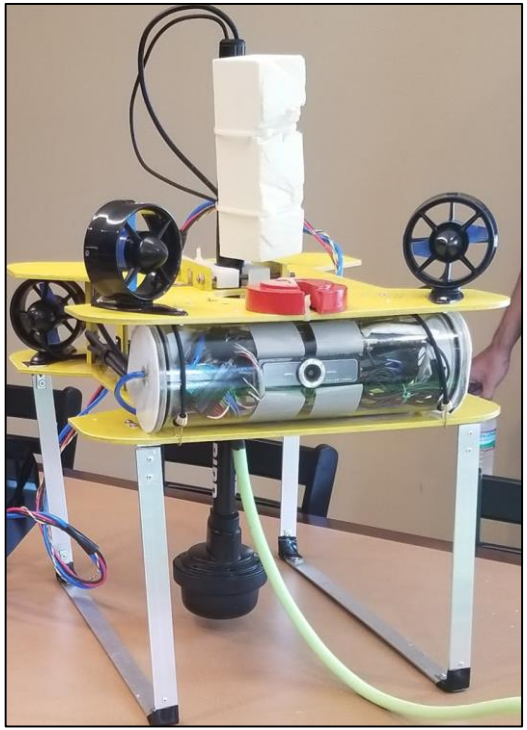
Mechanical Preliminary Design

- Design Matrix led to the “sandwich” design
- Materials Matrix determined ABS plastic was best for the chassis
- The Humminbird ONIX CI SI drove how the sonar was mounted to UUV
- Designed a 30° angle thruster configuration
- Designed on Solid Works then laser cut on ABS
- Electronics stored in acrylic container





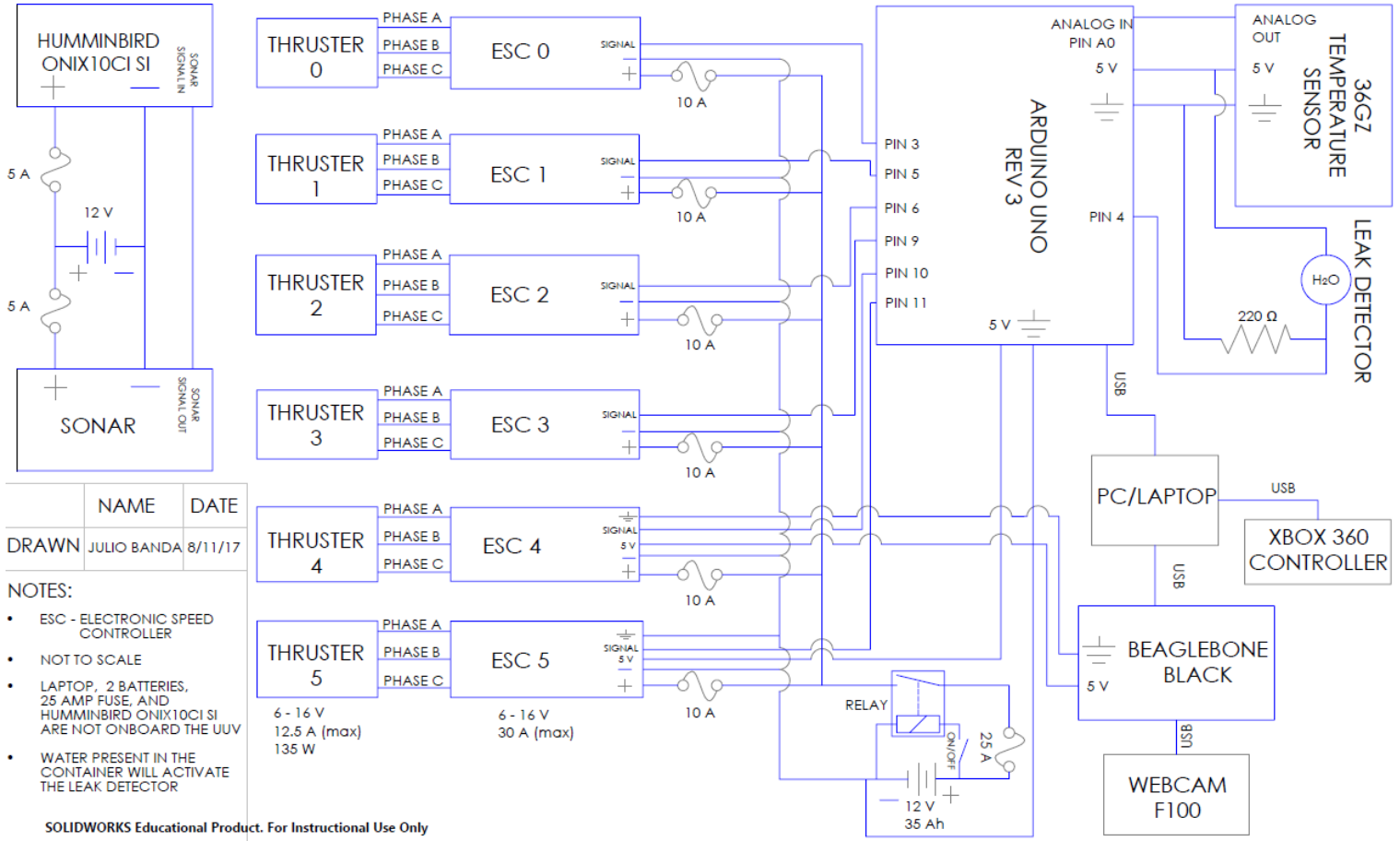
Final Mechanical Design



Major Electrical Components

- T-100 Thrusters - Allowed UUV to move in all directions
- Electronic Speed Controllers (ESC's) - Ran the three-phase brushless thrusters
- Batteries - Power all UUV electronics and sonar
- Arduino - Programmed to control ESC's for thruster speed
- Beaglebone - Runs the camera and feedback to laptop
- Camera - Provided live view from the UUV
- Sonar - Used for 360 underwater imaging
- Laptop - Displayed electronics feedback

Electrical Design



	NAME	DATE
DRAWN	JULIO BANDA	8/11/17

NOTES:

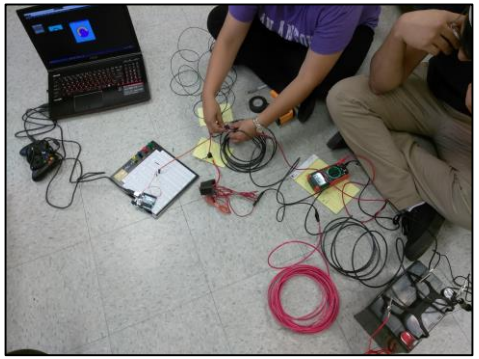
- ESC - ELECTRONIC SPEED CONTROLLER
- NOT TO SCALE
- LAPTOP, 2 BATTERIES, 25 AMP FUSE, AND HUMMINBIRD ONIX10CI SI ARE NOT ONBOARD THE UUV
- WATER PRESENT IN THE CONTAINER WILL ACTIVATE THE LEAK DETECTOR

SOLIDWORKS Educational Product. For Instructional Use Only

Voltage Drop and Current Testing

Objectives

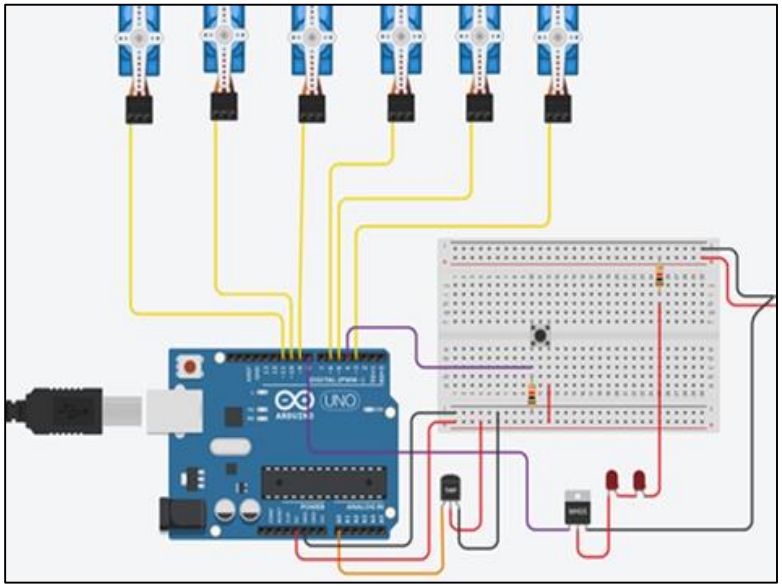
- Determine voltage drop from topside 12 Volt battery to UUV thrusters using 50 feet of 10 AWG power cable
- Max 6 V drop allowable for proper thruster and ESC operation
- Measure max current draw from thrusters to determine size of power line fuse



Thruster Setting	Current (amps)	Voltage at Battery with load (volts)	Voltage at ESC with load (volts)	Voltage Drop (volts)
1	0.18	12.66	12.58	0.10
2	0.66	12.57	12.37	0.20
3	1.43	12.48	12.06	0.42
4	2.58	12.39	11.65	0.74
5	4.03	12.31	11.17	1.14
6	5.75	12.25	10.64	1.61

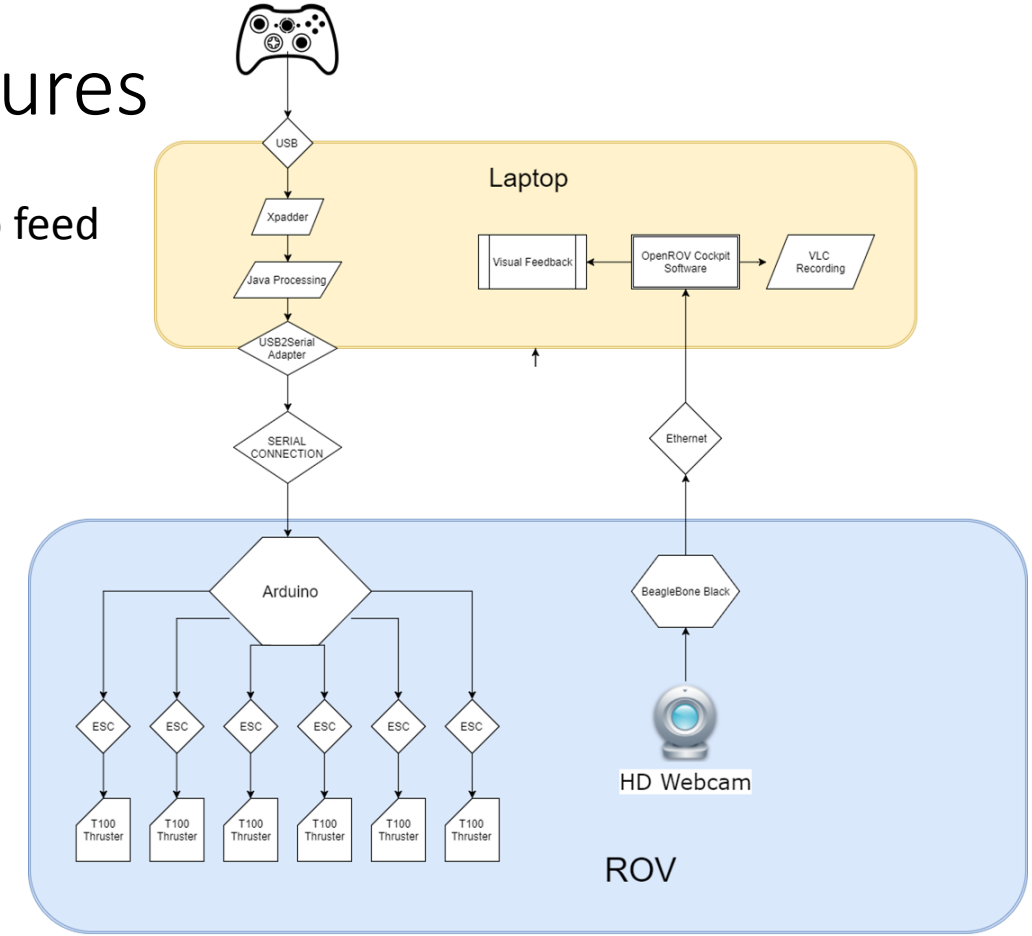
Software Design

- ESCs/thrusters designed to control like common servos with Arduino in C++
- Arduino controlled by user through processing interface on laptop
- Leak detector and temperature sensor controlled by Arduino
- Beaglebone microprocessor operates HD webcam with OpenROV software



Software Control Features

- Easy control with onscreen video feed and Xbox control
- Laptop interface features
  - Live video feed
  - Adjustable power gauge
  - Onboard temperature feedback
  - Leak alarm



Humminbird ONIX Sonar Testing

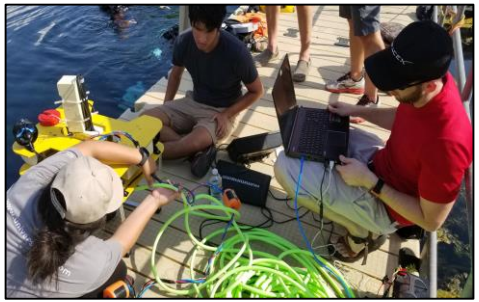
- Humminbird ONIX 10 CI SI for turbid water navigation and object detection
- Testing at San Pedro Springs Pool and Palo Alto College Aquatic Center
- Clear water testing at Aquarena Springs (San Marcos, TX)

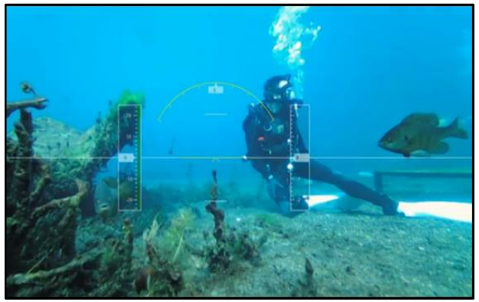
San Pedro pool stairs

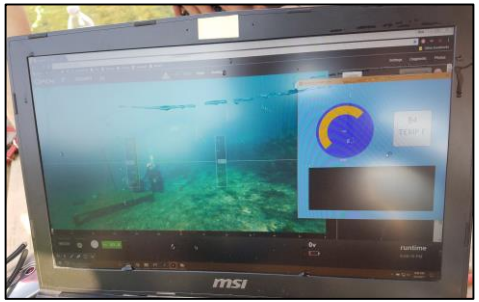
Palo Alto College pool

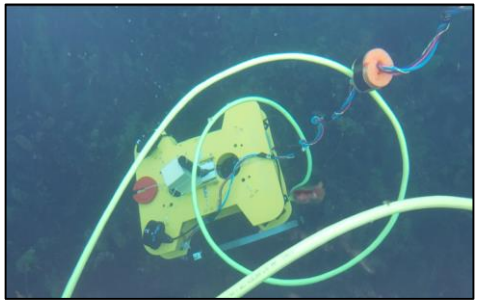
Testing at Aquarena Springs (San Marcos, Texas)

- Tested with San Marcos Area Recovery Team (SMART) divers
- Webcam images of ～20ft depth
- Added pool noodles to make the cables buoyant







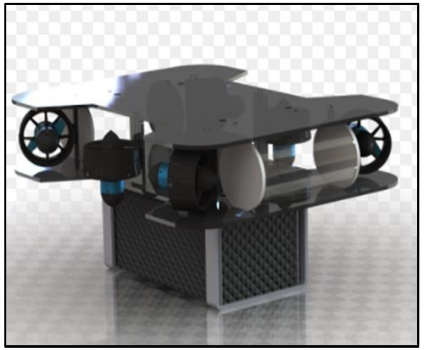


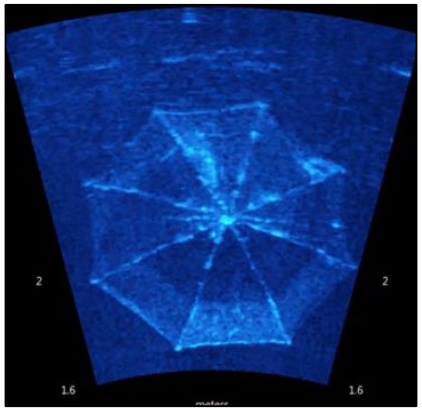
Results and Conclusion

- Designed and built a UUV that contains a sonar tested at 4 clear water locations but did not test in turbid water
- Built team knowledge in mechanical and electrical design of underwater robotics and remotely controlled systems
- UUV has promoted STEM to potential engineers and scientists
- Prototype UUV proved concept and goals/objectives met

Future Discussion

- Students needed for follow-on team
- Additional testing in different water environments needed to determine best operational design
- Possible future testing in Fall 2017 with higher resolution sonar (Aris 1200)
- Possible additional features: compass, accelerometer, laser, lights and mechanical arm
- Final Goal: Fully operational UUV that significantly improves performance and safety of underwater emergency search operations





Acknowledgments

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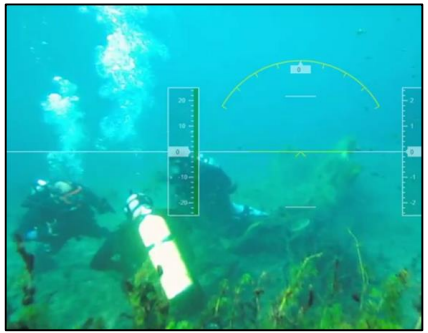

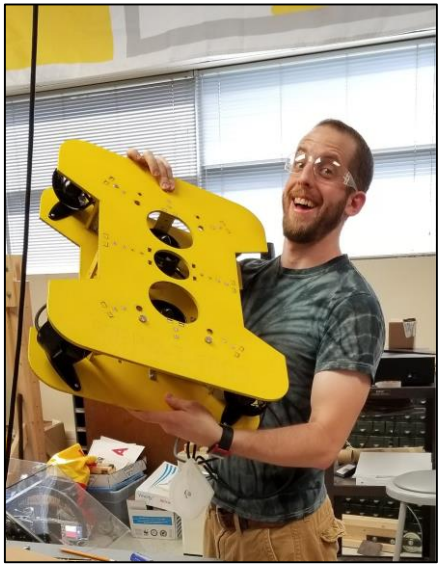

Questions?