Pacific Nautilus
Autonomous Vehicles
Land, Sea and Air Vehicle Team

Sensing the World Through Robotics

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Introduction

Pacific Nautilus is a Not-For-Profit Student organization dedicated to increasing the number of high school, community college, and minority students to participate in cutting edge and hands-on engineering projects with an interest in autonomous vehicles. In its 5th year as an organization Pacific Nautilus will make its 4th entry in the Association of Unmanned Vehicle Systems International (AUVSI) Foundation & Office of Naval Research's (ONR) 13th International Autonomous Underwater Vehicle Competition which will be held in San Diego, California, USA SPAWAR TRANSDEC facility from July 13-18, 2010.

This year's entry has progressed from last year by utilizing the existing custom designed and built acrylic hull that implements a double hull structure to insure that our custom built circuit boards are protected. We have added smaller pressure, tilt and gyroscope sensors to our custom half brain. The inner and outer hull is securely sealed using gaskets and an aluminum outer plate to increase structural integrity. The electrical system has been designed to utilize Lithium Ion batteries for their lightweight high power-density allowing the vehicle longer run times between recharges as well as minimal impact on over-all weight. Computational algorithms are carried out via Microchip microcontrollers.

PURPOSE

◦ Pacific Nautilus provides us first hand on real-world engineering problems.

◦ The goal is to apply our knowledge in the sciences to produce solutions in a professional setting.

◦ To produce a fully functional AUV (autonomous unmanned vehicle) to compete in this year's AUVSI and ONR competition.

◦ Lastly, our final purpose is to come up with creative and innovative ideas to make the AUV greatly improved for next years competition and future ventures.

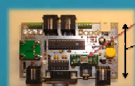
Methods

Temperature Compensated Gyroscope

·Prior to testing, a list of all materials and procedures must be documented, for future volunteers to understand the process which was taken.

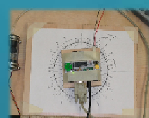
Dana writing up documentation

·The half-brain was mounted on top of a 3"x3" wooden board then placed on top of a radian chart. 5V was applied across the half-brain using the 12V power supply and linking it to a laptop to gather data.



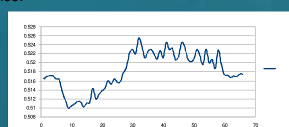
Gyroscope (EVAL-ADXRS610Z

Half-brain (Microchip PIC 18F2525)

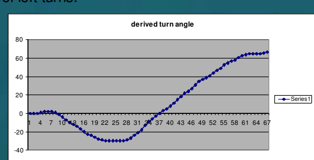


Half-brain mounted on 3"x3" flat board with radian chart

·Created simulation by manually rotating the half-brain in various degrees of rotation, analog data was obtained. We then converted the data into a 10 bit digital number between 0 and 1023 then graphed in Open office.



·This data is then converted into angles by a derived formula, the yaw sums up 8 periods of 8 measurements each with 64 samples total. Getting an average reading over the 8 periods (approx. ½ sec) divided by 2 filters out some of the noise and gives the average turn rate in the range of 0 to 511 with straight ahead being a reading of about 256 (plus/minus 8), and subtracting 264 from the prior graph gives a positive number for right turns and a negative number for left turns.



Securing the Hull/Inner Circuit Box For Leaks

·All gaskets and seals were placed in designated areas, and screwed shut as if it were in actual competition. Then placed in a 5 gallon bucket of water with weights to keep it submerged. From careful observation bubbles were spotted indicating that there were leaks.

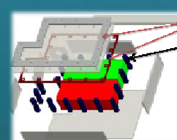
·After locating all possible areas that contained miscellaneous cracks and holes. The hull/inner circuit box was unscrewed and unsealed.

·Loose threading for screws were re-glued back on to the hull, minor cracks and holes were filled in with adhesive silicone, and seals were re-lubricated.

Bryan checking the Delta A for leaks.

Pro Engineering Wildfire 4.0 rendering of Delta A.

Inner circuit box



Rubber gaskets

Threading for screws

Hydrophones

Lab-Core Systems Custom Hydrophones

·Hydrophones are underwater microphones.

·We plan to use three in the shape of an equilateral triangle, so we can determine the direction of incoming sounds.

·With all three hydrophones picking up the same signal at different time stamps, we will be able to determine which direction the sound is coming from by rotating the vehicle to allow the 2 base hydrophones to pick up the same signal at the same time.

Pressure Sensor

·Due to our budget we had to design and create our own pressure sensor.

·The challenge was to create a mechanism that could produce a close-to linear correspondence between the vehicle's depth and the output of the GPS.

·The first was a cylinder/piston design made with a plastic syringe which was scrapped, for lack of response. The next two designs had much more promise. One was a rubber diaphragm stretched over a hard plastic housing attached to the sensor with plastic tubing. The second was a rubber bulb attached directly to the pressure sensor. Both were about the same size.

Left , Christopher Carter; Middle, Dr. Colin Bradbury; Right, Frank Yepiz.

Dr. Bradbury giving Frank an option for pressure sensor.

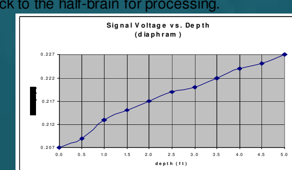
·After running both mechanisms through the same series of tests, it was determined that both produced very similar results. In the end, the diaphragm design was able to be made much smaller than the prototypes and it was settled on as the mechanism to be used.

Franks' pressure sensor (Frankenstein pressure sensor) .

·The vehicle determines its depth by way of a custom-built pressure assembly that incorporates an off-the-shelf gas pressure sensor and a diaphragm mechanism. This configuration was chosen to maintain budget constraints and still have reliable, accurate data.

·The gas pressure sensor is an MPX5700GP from Mouser Electronics. This sensor is actually a gauge sensor that was adapted to function as an absolute sensor by covering its reference pressure port.

·The sensor is connected across 5V from the half-brain by way of a single cable that also carries the analog signal back to the half-brain for processing.



·Because a gas pressure sensor is being used, a flexible intermediary was needed to translate changes in water pressure to changes in air pressure.

RESULTS

Temperature Compensated Gyroscope

·The simulation data corresponds to our predictions and the data is clear and comprehendible.

·With this new information we forwarded our findings to the software engineer.

·He then coded a program which allows the AUV to know at which rate it is turning from left to right. This allows the AUV to not flip or go off course.

Securing the Hull/Inner Circuit Box For Leaks

·Hull and inner circuit box was successfully sealed and secured.

Hydrophones

·When implemented to the AUV it was a success. The programmer was able to come up with a program that was successfully able to direct the vehicle to the frequency we specified.

Pressure Sensor

· After much investigation into the response of different materials and designs to pressure, a diaphragm-type mechanism was settled on to fill the role. This design has the advantage having a small size and being easily constructed with materials readily at hand.

·Together, these two parts form an assembly that delivers a functionally linear correspondence between depth and output voltage for the operational range of 4 feet.

Conclusion

·In conclusion we were able to conceptualize the mechanics of autonomous systems. We were also able to work efficiently in a cooperative and individualized type setting.

·From this opportunity we established communication with industry professionals.

·It gave us insight and exposed us to the daily tasks of real world problems in the field we are pursuing or related to.

· We acquired new knowledge but also had the chance to use our own experience and academic knowledge and applied it to produce solutions.

Acknowledgements

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