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PANTHER-J AUV development in the IEEE-OES Malaysia Autonomous Underwater Vehicle Competition Challenge 2017

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ABSTRACT – This paper describes the development of PANTHER-J AUV for a competition that gives participants the opportunity to experience the engineering challenges of autonomous underwater vehicle systems and develop skills in underwater technology. The competition was held in the Malaysia Autonomous Underwater Vehicle Challenge (MAUVC), in conjunction with the Kuala Lumpur's 7th IEEE International Conference on Underwater System Technology (USYS) in 2017. Design configuration and challenges in controller development of the AUV is described in this paper. Arduino UNO is used as the main controller for the AUV. The AUV is also equipped with three thrusters, inertia measurement unit (IMU), depth sensor and rechargeable batteries.

1. INTRODUCTION

In 2017, a team from Universiti Teknikal Malaysia Melaka's responded to a challenge in an autonomous underwater vehicles competition held in Singapore Polytechnic [1,2] and International Islamic University Malaysia [3]. This paper presents the preparation and the development of Panther-J AUV for the Malaysia Autonomous Underwater Vehicle Challenge (MAUVC) in 2017.

2. DESIGN CONFIGURATION

PANTHER-J AUV (J for Junior) is an educational derivative of a remotely operated vehicle called OpenROV 2.8. It comes with the BeagleBone Black single board computer as a processor and integrated with Arduino MEGA microcontroller for sensor detection and thruster control. The ROV weighs around 2.5 kg with dimensions of 15 cm x 20 cm x 30 cm and uses IMU and pressure sensor are used for movement and depth calibration up to an operational pressure of 30 bar. A 1080p high-definition webcam with 120-degree field-of-view is used in the telemetry system, which is displayed in the OpenROV cockpit through I2C protocols. There are 3 thrusters used for forward, upward and downward movement. Figure 1 to 3 shows the AUV design and pressure analysis conducted by using numerical flow simulation [4].

Figure 1 OpenROV 2.8

Figure 2 UTeM Panther-J AUV based on OpenROV platform.

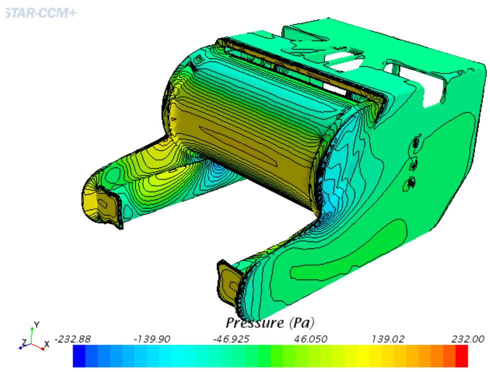

Figure 3 Pressure analysis of the OpenROV platform.

3. RESULTS AND DISCUSSIONS

Since PANTHER-J only requires basic input output operation, the Arduino UNO is the best option for the AUV controller development. Table 1 shows the OpenROV 2.8 and PANTHER-J AUV configurations. Time and knowledge constrain have left the team with the alternative to use Arduino UNO as the single board controller on the PANTHER-J AUV, instead of using the original integrated BeagleBone-Arduino MEGA controller. Table 2 shows the difference between Arduino UNO and BeagleBone capability.

Table 1 The ROV and AUV configuration

Name	Open ROV 2.8	PANTHER-J AUV
Controller	BeagleBone Rev A5 + Arduino MEGA	Arduino UNO Rev 3
Camera	1080p HD Webcam	Not installed
Gyro	IMU/Compass/	IMU/Compass/
Depth Sensor	Depth Module	Depth Module
Thruster	Three thrusters	Three thrusters
Battery	rechargeable lithium batteries	rechargeable lithium batteries
Tether	100m	Not installed

Table 2 The difference between Arduino UNO and BeagleBone capability

Name	Arduino Uno	BeagleBone
Model	Rev 3	Rev A5
Price	RM 30	RM 450
Size	68.6 × 53.3mm	86.4 × 53.3mm
Processor	ATMega 328	ARM Cortex-A8
Clock Speed	16MHz	700MHz
RAM	2KB	256MB
Flash	32KB	4GB microSD
Input Voltage	7-12v	5v
Min Power	42mA(.3W)	170mA (.85W)
Analog Input	6 10-bit	7 12-bit
Dev IDE	Arduino Tool	Python,/Linux
Ethernet	N/A	10/ 100
USB	N/A	1 USB 2.0

The team has decided to use Arduino UNO since it is the easiest board to be linked to external sensors and outputs, and at the same time can be integrated with the previous program from the older TUAH AUV. The different voltages output of 3.3v and 5v of the board make it easier to connect to external devices. On the contrary, the BeagleBone only operates with 3.3v devices and requires a resistor or other external circuitry to interface to another device with different voltages requirements. Both the Arduino and BeagleBone have analog to digital interfaces that can be easily connected for output with varying voltages. The BeagleBone has slightly higher resolution analog to digital converters which can be useful for more demanding applications [5]. The reason for this is that the BeagleBone runs with the Linux operating system. In contrast, the Arduino is very simple in design and can run one program at a time in low level C++. The Arduino uses the least power, compared to the BeagleBone, for AUV application. Arduino can also work with a wide range of input voltages. This allows it to run from a variety of different types of batteries and keep working as the battery reduces its power. The BeagleBone however, is a great flexible platform that can be integrated with any Arduino family platforms, using its fast processor and full Linux environment. Simultaneously, it has good input/output features and can easily connect to the network, which can be operated through a web server.

4. CONCLUSION

A group of student team up in the development of an autonomous underwater vehicle (AUV) for a competition that gives them the opportunity to experience the engineering challenges and develop skills in underwater technology. An AUV is a robot that travels without requiring input from an operator. The implementation of Arduino Uno microcontroller, inertial measurement unit and depth sensor provide a successful navigation and propulsion control. Minor problems that occurred such as leakages and short circuitry during the previous challenges are improved, with provision made in the use of a standardized seal and wiring compartment for the development of PANTHER-J AUV.

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