Technical Report

American International School - Eagles

MATE 2015 ROV Competition – Ranger Class

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Eagles:

Billy – CEO

Dean – Design / Communications

Thomas – Electrical Engineer

Ronald - Electrical Engineer / Programmer / Pilot

Jeffery – Programmer

Justin – Mechanical Engineer

Young-Jin – Mechanical Engineer

Introduction:

Eagles, a young, innovative company dedicated to sea exploration technology, was formed on August 2014. Eagles is notable for its diligent employees who worked late nights to engineer their first product – The Fried Seagle. Its employees are the elites of American International School, who has been selected through rigorous examinations. Members of the team work on what they enjoy: coding the human-machine interface program, water-proofing wires, assembling and positioning the components of ROV. Although seemingly branched out, all members are knowledgeable and familiar with the product.

- Comment from CEO:

Dream team! Managing and overlooking production for this company is barely needed. Our employees are knowledgeable, committed, and eager for the completion of our products. What they do not know will lead their curiosity to experiment or ask other employees. Eagles provides a welcoming-environment, where employees are considered family and all opinions are heard and considered.

- Comments from Founder:

I am pleased at the progress our company has made in its first year. The dedication and determination of our young engineers had been an inspiration to me. I envision a bright future for this company as employees display their collective drive and thirst for ocean exploration and technology.

From left to right : Billy Chan (CEO) , Justin Bae (Engineer) , Dean Kim (Design & Communications) , Ronald Ng (Programmer) , Jeffrey Kam (Programmer) , [back] Young-Jin Hong (Engineer) , Thomas Low (Engineer)

Rationale for Design:

- Frame

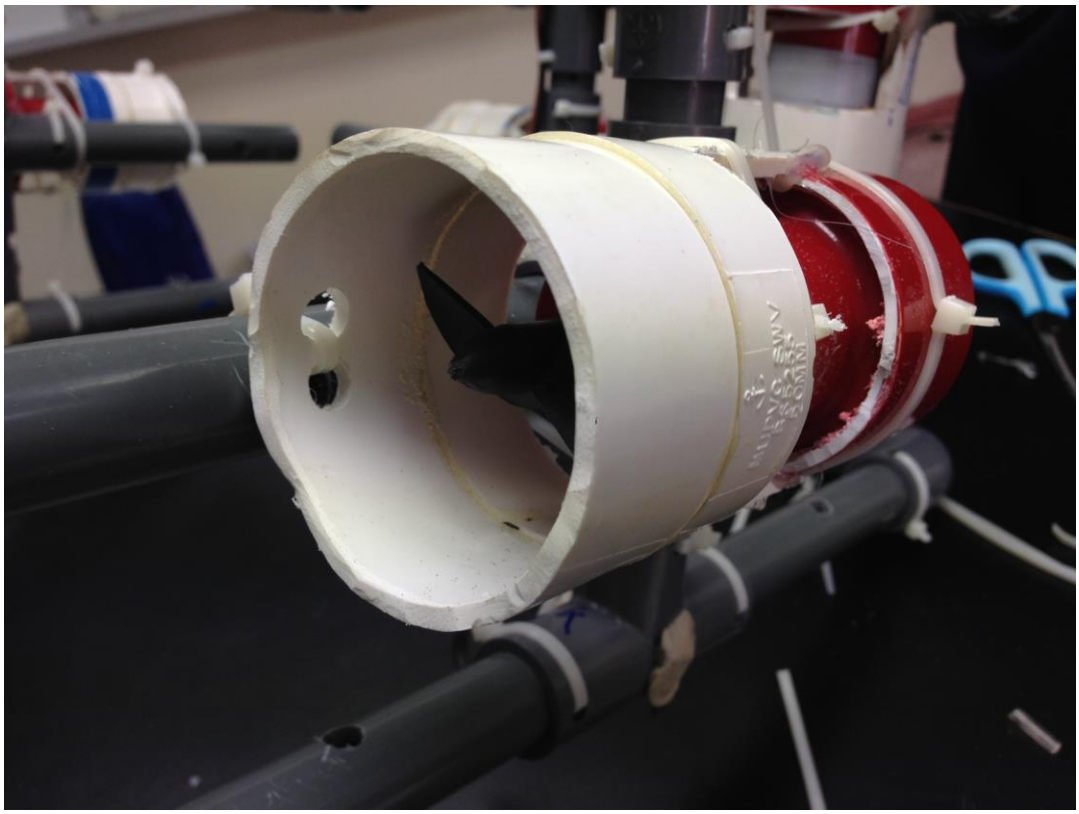
A cubic frame design has been selected. PVC pipes and joints (L & T) are used for this particular ROV. There are many advantages of using a PVC pipe. First of all, the low cost of PVC is definitely and attractive aspect. The light weight of PVC is another advantage since it ensures unrestrained movement and less force is required to move the ROV. Durability is also achieved by the cubic shape as there is no overall weak spot due to the symmetry of the shape. The design allows easy modification: addition of parts such as lasers, sensors, cameras, and storage units can be done easily. This model also leaves space inside the ROV so larger components could be attached inside the cube and remain protected from collision.

Cubic frame resting on a shelf

- Propulsion:

The ultimate aim for the propulsion system is to provide flexible underwater movement to the ROV so that it could successfully accomplish

the missions with great efficiency. Our propulsion system involves six motors to allow maneuverability in any direction. Motors are made from bilge pumps, carbon-hydro propellers, and PVC pipes. The large-diameter PVC pipe is used for shielding. Shielding the propeller is integral to the performance of the propeller: not only has it prevented cavitation, but also improved the power of the propeller by minimizing energy loss.

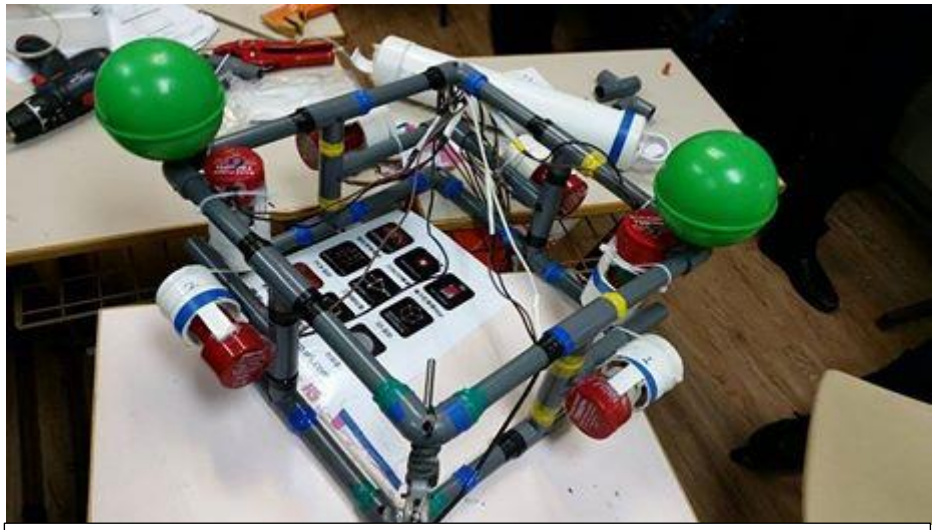


One of the motors of The Fried Seagle's Propulsion system

Positioning of Propulsion

To achieve balanced propulsion for The Fried Seagle, four horizontal motors are placed symmetrically at each corner of the cubic frame, relative to where the ROV is facing forward, all in different directions.

This positioning allows shifting of the ROV in all horizontal directions and even provide a vertical motion. Additionally, the positioning provides a maximum torque when the ROV is performing rotation.



The first prototype of The Fried Seagle with donated floats from a workshop

- Camera:

Seemingly simple to construct, camera plays a vital role in the functioning of the ROV (after all, clear vision is a must-have for accomplishing any mission).

The Fried Seagle is equipped with three cameras, frontal camera, down camera, and full view camera.

- The front camera is the main camera as it shows what is in front of the ROV. It would be used mainly during inspection missions.
- The down camera is used to identify objects that are under the ROV. As the ROV is handling tasks underwater, materials might sink and fall to

the bottom. Hence, a down camera could effectively aid in retrieving any objects sank at the bottom using the hooks.

- Interestingly, the back camera is attached to the wires rather than the ROV itself. Since it is located above the ROV, it provides a third perspective to the ROV and hence it can view the surroundings better and make correct judgements.

All the cameras are based off Spy-Hole B/W Camera K701. These camera were chosen since they are slim and easily be customizable. Each camera is inserted into an 11 cm long clear acrylic tube and linked to 5 meter long cable (directed to a CCTV module, which displays on a portable computer). It is waterproofing the camera determines the fate of the ROV. To ensure perfect seal to prevent water from contacting camera and the soldering inside the tube, 2-part epoxy is used.

- Human-Machine Interface – Programming

Swift Seagle is the program in which human interaction with The Fried Seagle is made possible. Swift Seagle is composed of sophisticated arithmetic and logical coding, allowing the Fried Seagle to maneuver at controlled speeds in 3 dimensions with the input of a PlayStation 2 controller. The swift eagle uses the x and y values to generate different speeds for each individual motor in order to move in curve path through various speed. The analog stick of the PS2 controller returns a value of its x and y value which are between 0 and 255. The way we code the swift eagle

is to think of the x and y values as coordinates, and divide the analog stick into 4 quadrants, like the Cartesian plane, with the x and y values of the analog stick at stationary point as origin.

Teamwork:

Our company entered the MATE ROV competition for the first time; therefore, we did not have any experience of engineering a ROV. As we were constructing the ROV and going through all the trial-and-error, we discovered that teamwork is the most important aspect. Making this vehicle requires ample knowledge from various fields: designing, fluid dynamics, mechanical engineering, computer programming, and material engineering. The robot is the synergy of those skills and signifies how these skills produce a harmonious spark in technology. Ronald and Jeffery, who possessed talent and passion for computer programming, worked on programming the motors. Justin, Young-Jin, Jack worked on mechanical parts on ROV. Thomas provided us requisites for ROV, including tools and materials for ROV frame and camera and worked on electrical parts for ROV. Dean worked on technical report since he acquired an overall knowledge about ROV. As a president of Engineering Club, Billy managed the team and allocated our work efficiently and showed us great responsibility to this task. Unite, we stand – Our team boasted one's unparalleled strength and each member contributed to the strenuous task of construction a ROV. We discussed with each other and shared each other's ideas. We would seek ways to improve and modify. The fruit of the hard discussion was a collage of ingenious ideas weaved together. Without doubt, teamwork was the MVP of our success in the first attempt to construct an underwater ROV.

Safety:

Safety of the ROV is one of our primary concerns when we were designing the ROV. The Fried Seagle has been designed to meet the competition's safety requirements. The team followed strict safety procedures during the engineering of the ROV. We ensured that all electric parts must be sealed perfectly to eliminate gap for water to leak in and cause a short circuit. During our construction of the ROV, the crew must adhere safety procedures. We ensured that the proper safety equipment are worn when using specific tools including saws and drill. Propeller For instance, shields had been used to prevent people from accidents caused by the blade of the propellers. Each engineer has received training on the correct use of the tool that were used during construction and every one followed a strict safety protocol to ensure the highest degree of safety.

Reflection:

Considering the size of our team, insufficient manpower, and lack of time, our engineering team has gained an ultimate success in completing a full-functioning ROV. We understand the down-sides of our vehicle, Eagles is proud to present The Fried Seagle as the first Engineering club at the American International School, and to represent our great school against others. With flaws, we find solutions, and with these solutions, we have learnt great lessons on how to deal in situations. We are looking forward to further develop and burnish our lessons and knowledge to culminate a more advanced, well-reflected vehicle.

A proud team after the completion of the first prototype

Future Improvements:

Since we were novice to constructing ROV, for the first 2 months, our team worked inefficiently. Having obscure plans for constructing ROV, our club members did not work efficiently and had to rearrange our frame design a lot. Every procedure of constructing ROV was a new challenge that almost everyone had not encountered before; as a result, we constructed our basic Frame of ROV ineptly, causing re-work of our whole processes. We need to have clear and detailed plan about ROV construction before we engage the construction. By doing that we can save more time and consider about our mechanical and mathematical parts of ROV. We need to calculate actual mechanical physics to decide with backing proof that our decisions are the best ones. The team's ambition, excitement, and impulsiveness has produced a ROV that can and will be even better.

Discussing solutions to a problem.

Troubleshooting Techniques:

For the efficiency of the work, our company had set up 2 protocols for troubleshooting. One is used for programming components of the ROV, while the other manages the mechanical components of the ROV:

I
- Debug the logic of the code by printing out all the output values

II
- Print the value with a description of what this output means and chec k if it corresponds with the reality

III
- check if the pin is working properly

IV
- draw diagrams on paper to make a thought experiment on how the wi re will be connected and how the code will be executed

V
- Check the voltage and current passed to the pwm and the voltage and current needed for the motors

VI
- If doesn't detect ps2 controller, try adding a 2k resistor for the data wi re.

- Programming

Budget:

As newly-born club, the Engineering Club does not receive a budget from the school. However, the ambitious members would not allow such a chance to pass away with the inability to attempt The MATE Competition merely due to a financial situation.

Starting Budget (Donated from various members of the Eagles company): 3,000 HKD

Item	Quantity	Price per unit	Sub-Total
PVC pipe (2 cm diameter)	3m	20HKD/m	60 HKD
PVC pipe (8.5 cm diameter)	0.5m		10 HKD
PVC cap (for 8.5 cm diameter)	x2		10 HKD
PVC joints (10 L-joints, 8 T-joints)	X18		90 HKD
Two part epoxy	X2	270 HKD/set	540 HKD
Speaker wire	50m	30 HKD/5.7m	263 HKD
Video wire	12m	3.5 HKD/0.3m	140 HKD
Camera	X2	280 HKD/unit	560 HKD
Already water prepared camera	X1		DONATED
PWM	X6	90 HKD/unit	540 HKD
Arduino Mega	X1	220 HKD/unit	220 HKD
Arduino Leonardo	X1		DONATED
Plastic enclosure	X1	75 HKD/unit	75 HKD
Cable Wire	X3	30 HKD/pack	90 HKD
Sony PlayStation 2 Controller	X1	80 HKD/unit	80 HKD

Heat Shrink	??		~30 HKD
CCTV module	X1	398 HKD/unit	398 HKD
CCTV module-video wire adapter	X4	40 HKD/unit	160 HKD
Male to Male video wire	X4	18 HKD/unit	72 HKD
800GPH Bilge Pump	X3	280 HKD/unit	840 HKD
750GPH Bilge Pump	X3		DONATED
Food for workshop	X3 sessions	~20 HKD/person	~80 HKD
Tools (Wire stripper, solder, scissors, etc.)	X6		360 HKD

ROV net Total : 2,793 HKD

System-Integration Diagram: