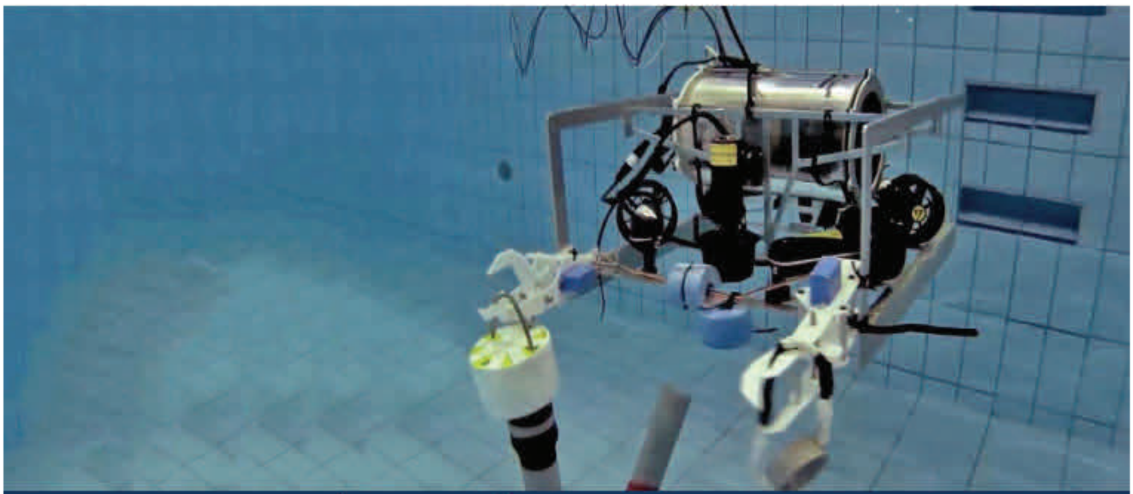


tigersharks co.

Taipei American School Taipei, Taiwan

Company Specs

Company Name: Tigersharks Co.
School: Taipei American School
Organization: MATE ROV Underwater Robotics
Home Country: Taiwan, R.O.C.
Distance to St. John's, Newfoundland and Labrador: 11915 km
MATE ROV Participation History: Participated every year since 2010
Team: returning and new members ranging from 9th to 12th grade

ROV Specs

ROV Name: Mk-VI
Total Cost: 108,8
28.84 NTD (3613.23USD)
Materials: aluminum, acrylic, plastic
Dimensions: L:73cm W:40cm H:40cm
Total Mass: 10.0 kg
Safety features: 25 amp fuse, current sensor, reverse polarity protection
Special features: servo cameras, modular control system, Logitech game controller, servo powered claw

Company Photo

Main photo (left to right):
Rafael Garcia (Mentor)
Phillip Teng (Regulatory Officer)
Christopher Yen (Documentation Specialist)
Xiao Yang Kao (CEO)
Edmund Tong (CTO)
Jin Suh Park (CEO),
Ray Ku (Pilot)
Tiffany Chen (Financial Specialist)
Jonathan Wu (Integration Officer)
Trisha Sinha (CFO)
Not pictured:
Tiffany Chiang (COO)

Table of Contents

Abstract

As the recipient of last year's Design Elegance Award and the best Engineering Evaluation, Tigersharks Co. is ready to attend this year's competition by improving upon last year's experiences to venture into the 2015 competition with a more robust ROV than ever. This year, the TS-06 ROV will venture into the arctic seas in order to perform a variety of missions, which include scientific observations under an ice sheet, subsea pipeline repair and inspection, and offshore oil field production and maintenance.

The custom-made ROV constructed by Tigersharks Co. is prepared to accomplish these tasks. The ROV has a compact plasma cut aluminium frame designed to navigate the limited space under the ice sheet, along with easily maneuverable Seabotix thrusters. Moreover, the TS-06 is equipped with manipulators to collect samples and objects, such as the wellhead.

This technical documentation details the functions and features of TS-06 and presents in the vehicle systems, design rationale and making processes for each component. This report also elaborates on the safety guidelines, troubleshooting techniques, and improvements that can be made. Finally, it includes a financial report detailing the price and quantity of the components used for the vehicle, team member reflections, and acknowledgements to the individuals and organizations that have generously helped us succeed.

Founders' Remarks

Back in 2009, I founded the Tigersharks Company with a passion for marine exploration and a vision of creating efficient and affordable underwater ROV for the world. The company faced many obstacles in its first year - we lacked funding and the technological know-how in many aspects of the ROV. I was very fortunate to have Alex, Kevin, Justin, Derek, Gaga, and Hanpin in helping me to steer the company through its fledgling first year.

It feels unreal to see how much the company has grown in the past 3 years. With sufficient funding and innovative recruits, the company has become an industry leader in design and manufacture of underwater ROV. I am glad to see that the current CEOs, Xiao Yang Kao and Jin Suh Park, have taken the company in the right direction towards success and continual improvement.

I believe that my vision will continue to be fulfilled by those who share my passion, and I am very grateful for the tremendous amount of effort that everyone has put in for the company and the underwater ROV industry.

Lawrence Chang

CEOs' Remarks

As CEOs of TigerSharks company, we are incredibly proud of what our team members have done. We both remember our fledgling days in the company, and the mentorship that has allowed us to rise to this position. In turn, we have provided the guidance that has allowed the team to flourish. Despite the fact that many of our team leaders went to college last year, we dared to try new designs and continue innovating to serve our clients better.

This year, we are particularly proud to be able to present a vehicle that is capable of tackling one of the most daunting issues our world faces today: research into sustainability in the most remote regions of the world. Our devotion to this issue stems from both the engineering challenge that it offers and our belief that such research will be necessary for the survival of the human race.

Thus, we hope that you will enjoy our product demonstrations and the below technical documentation, which will showcase the different pieces of engineering work that make our ROV what it is - a solution to a global problem.

XiaoYang Kao and Jin Suh Park

Mission Overview

For a vast expanse of apparent nothingness, the Arctic's importance cannot be overstated. From being a reflector to a temperature and ocean current regulator, this white desert preserves our Earth in many ways. Seemingly beyond life--icy and treeless, this polar region hosts a surprising amount of life, ranging from bacteria to beluga whales. Furthermore, the Arctic cools the oceans and maintains the sea level. However, our knowledge of the Arctic is still limited, and scientists describe the experience as similar to "doing research on the moon". Like our moon, the poles are clearly crucial to Earth's wellbeing. Living on Taiwan, an island, the Arctic and its health is thus greatly relevant to us, despite our position near the equator.

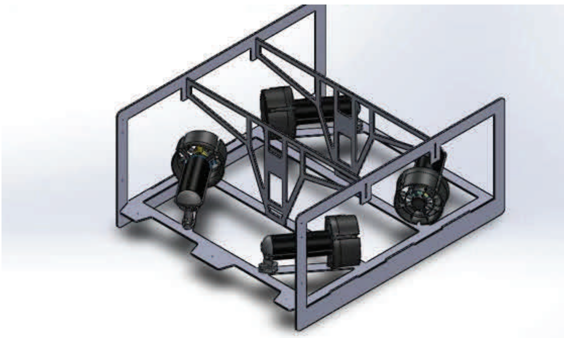
In designing and constructing the ROV, our very own "moon rover", we aimed to create an efficient and effective vehicle that could potentially explore and assess the frigid waters of the Arctic. We improved on the designs from previous years, especially with the frame. This opened opportunities for a more accessible control system, as well as a more controller-friendly arm design. In building upon our past work and creating this ROV, we hope to contribute to a better understanding of this precious region and to a sustainable future.

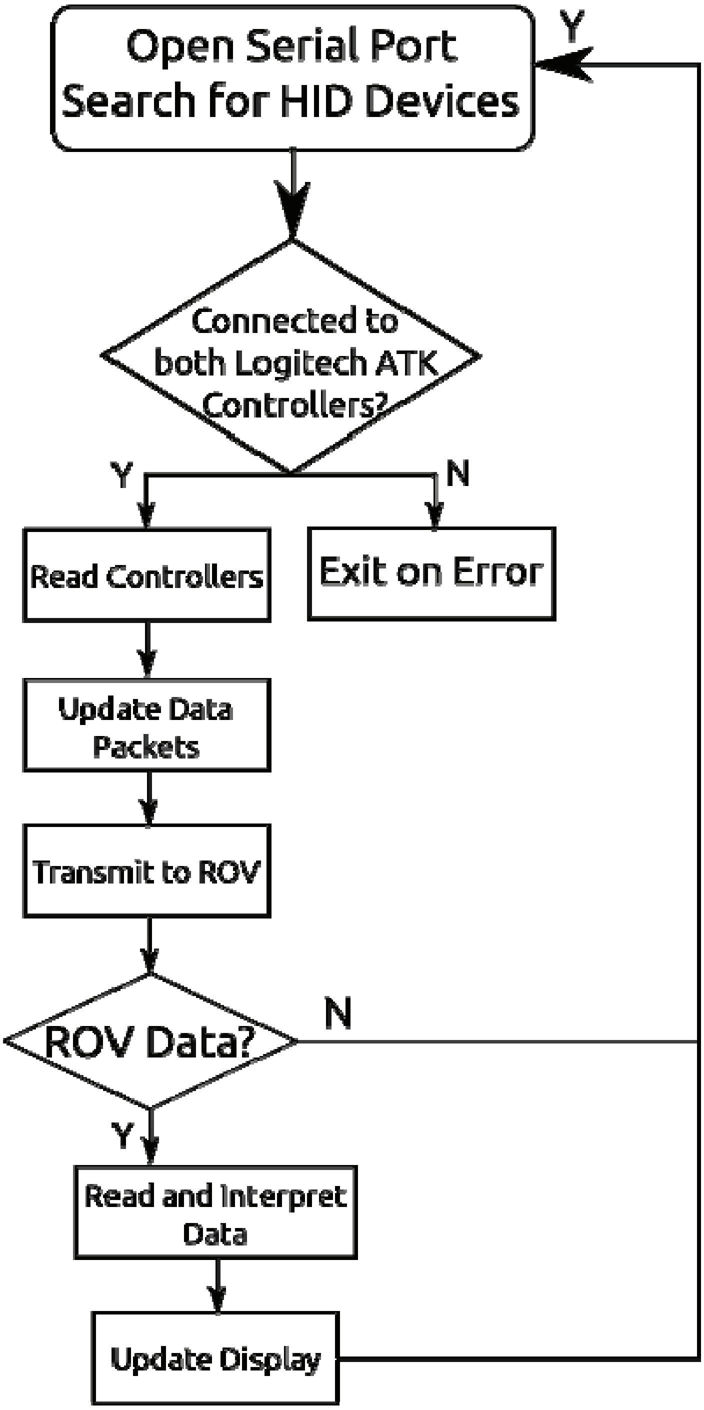
Design Rationale—ROV Components

Structure: Frame and Propulsion

Design Description

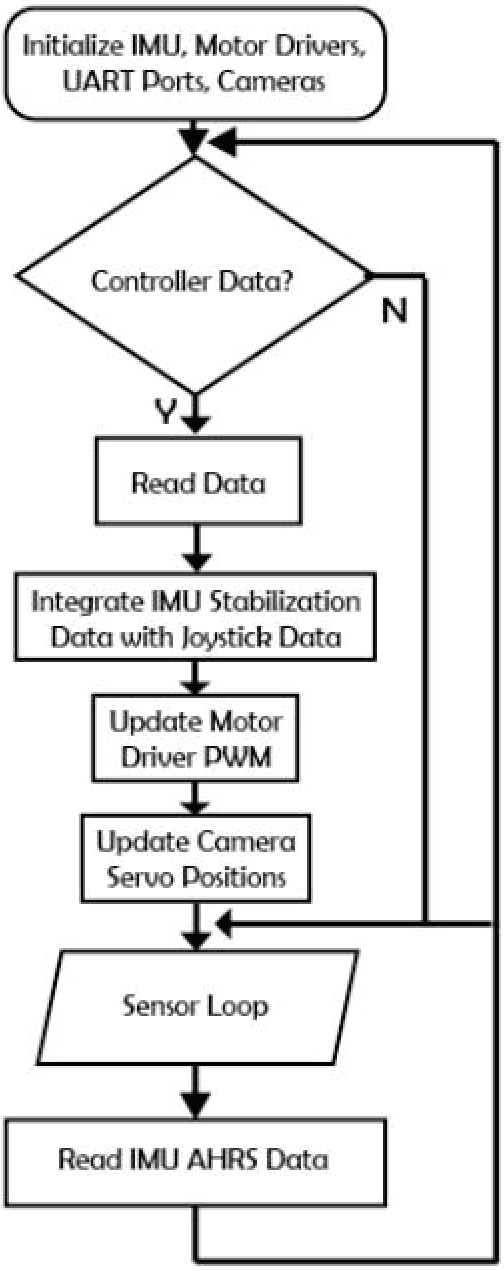
This year marks a significant leap in the company's ROV frame design. In previous years, the frame was designed around the materials (e.g. PVC pipes, aluminum channels) due to the lack of manufacturing availability. This year, with the extensive usage of CAD (computer aided design) and the purchase of the plasma cutter, Tigersharks Co. was able to design and build a frame customized to fit the components of the ROV rather than having to alter components to fit





Onshore Software Flowchart

ONBOARD



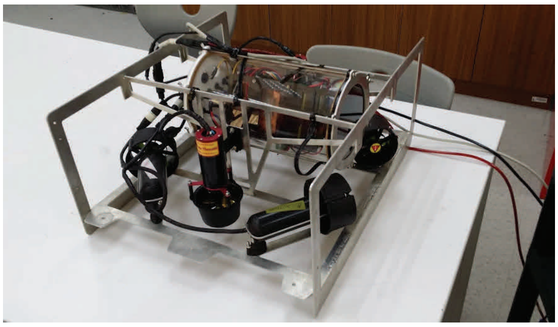
Offshore Software Flowchart

the frame.

The frame houses buoyancy tanks, cameras, and two vertical and four horizontal seabotix BTD-150 thrusters aligned to create a holonomic drive. The front section of the base houses the mission payload such as the Direct Motion Translating Arm (DMTA) and the manipulator. The mission payload section was designed to be interchangeable so the contents of the payload can be changed depending on the mission.

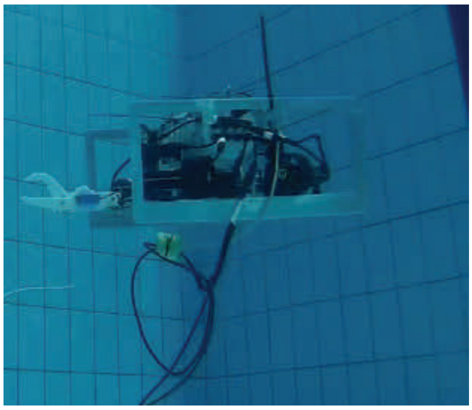
Design Rationale

The usage of fabricated aluminum plates customized by CAD software allowed us to build an accurate base. The base build of aluminum plates



provides compact housing for thrusters and reduces the fluid drag on the ROV. The interconnected design of the plates guarantees not only robust structure, but also a sustainable base which can be used for future missions. The double decker base was build for this purpose as the bottom base containing mission props can be interchanged depending on the mission.

Due to this year mission, the general layout of the frame was designed to satisfy the demand of stability and accuracy. The control box which also acts as a buoyancy tanks, are situated on the top of the frame while the horizontal thrusters are placed on the bottom; therefore, the center of mass is concentrated in the lower part of the frame. When placed in water, the ROV is ensured a stable movement in all axes. For the four horizontal thrusters, the thrusters aligned in a holonomic drive allows the ROV to move in any direction, independent of rotation. A holonomic drive is useful in situations that require for higher mobility and and less traction than a standard drive system. It able to cater to the pilot's preferences, requiring less



thought to adjust to the various conditions during a mission.

Onshore Control System

Design Description

The onshore control system involves two human interface devices (HIDs), Logitech ATK Controllers, that are connected to a Raspberry Pi, which uses a 20" LCD display. The input is processed via PyUSB, and is reflected on the graphical user interface (GUI) designed using PySide, which shows the direction in which the ROV is moving. A current sensor is placed in the box to monitor current usage and allows the driver team
to monitor any fluctuations in current usage. The current sensor (ACS711) also contains a protection circuit which cuts the circuit when the current exceeds the maximum current allowed (25A.) There are two polarity controlled Speakon ports for power input and power output. On the back of the box there are two RJ45 jacks for communication with the ROV. On the right side, there are RCA ports for video signals.

Design Rationale

The transition to two Logitech ATK Controllers was made this year in order to make fine adjustments to ROV movement possible. By implementing holonomic drive, the pilot's job is made easier given the intuitive controls. In addition to larger controls, the ATK Controllers also offer a high number of buttons for control that are located nearer to the hand than on a typical console. Therefore, accomplishing tasks such as opening and closing the arm are made easier. Another feature that was added this year is the implementation of precision mode. Especially given the high power of the vertical thrusters, this mode allows the speed to be decreased by 33% to allow for even finer adjustments when the ROV is near to the target area. Originally, we were going to use Java due to familiarity with the language, but the libraries required, especially for Linux-based systems, were difficult to manage and were often inconsistent. Therefore, we switched over to Python, which had better support for serial ports and HID devices.

Offshore Control System

Design Description

The underwater control system is used to control sensors, motors, and cameras on the ROV itself. It receives commands from the onshore system and controls the various systems accordingly. The underwater control system also has an Inertial Measurement Unit (IMU) that gives positional data of the ROV vessel. Two independent voltage regulators supply power to the arm and the cameras.

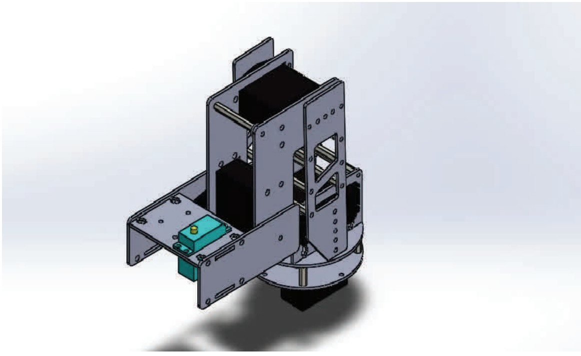
Design Rationale

Having issues with lack of space in the control box last year, the enclosure on the MK-VI was made to be more than twice the volume while being more hydrodynamic. Made out of a solid and clear acrylic pipe, the 4.7L control box houses all the primary motor drivers, monitoring circuits, and indicator lights for the vehicle. The circular shape allows for significantly better hydrodynamic characteristics, which improves the speed of the vehicle while under the water. The two end caps are laser cut out of 5mm acrylic with a rubber gasket as a seal. Threaded rods hold the two sides together. An advantage of this design is that as the vehicle descends, the pressure is acting to further improve the gasket seal.

To accommodate for the two Hi-Flow brushless thrusters, two independent 30A electronic speed controllers (ESCs) were added to the system. This gives a 2:1 redundancy for the four remaining Seabotix thrusters. Each Hi-Flow thruster is rated for 130W (approximately 11A at 12V) of continuous operation, so 30A ESCs are well over the safety margin.

A dedicated Arduino Micro microcontroller is used to control the seven servo actuators on the manipulator. This communicates to the primary controller through I2C to minimize the latency coming from the onshore system.

The connector system remained the same as the MK-V system, except with color coded wiring to



allow the operator to quickly change and replace parts if necessary. Inline IP68 connectors were chosen for the sake of availability and cost, as dedicated marine connectors are very expensive. PG7 cable glands with lubricated o-rings were used.

Two internal power regulators were used, a 6V one for the manipulator servos and another filter for the cameras. Each of the seven servos have a stall current of approximately 1A, so a 10A 6V regulator was chosen. The regulators for the cameras include a LC filter to remove power noise coming from the thrusters.

Manipulator (Direct Motion Translational Arm)

The direct translational arm on the ROV is a manipulator on a versatile arm consisting of 4 waterproof servo motor which allows 3 degrees of freedom. The DMTA is operated by a control unit on shore which is a smaller replica of the arm. Each joints are connected to a potentiometer which translates the exact movement of the Control unit to the actual arm on the ROV.

Cameras

After testing with 1080P high-definition cameras, we reverted back to the regular SD board cameras used on the MK-V. The transmission of the high-definition signal through two active converters introduced significant latency in the range of 200 milliseconds, which is too much for proper visual feedback while driving the vehicle. Although it is nice to have a clear and crisp video stream, we deemed it to be more work than necessary. A 2.1mm wide angle lens was attached to the board camera, which eliminated the need for a servo-tilt camera.

Two cameras are used on the vehicle - one forward facing, and another looking directly down. The enclosures are both made of 7cm clear acrylic piping. A problem with the MK-V of last year was that the acrylic pipe was not optically clear - to solve this issue, cast acrylic tubes instead of extruded ones were sourced. Cast acrylic has significantly better optical qualities compared to extruded acrylic.

To address the issue of lighting, a ring of 18 white LEDs are used for both cameras. These are in series chains of 3 each, for a total current consumption of approximately 200mA. The level of brightness can be adjusted to account for varying lighting conditions while underwater.

The signal from the camera is fed through a 75 ohm - 100 ohm balun, which maintains signal integrity over the 20M CAT5 tether.

Tether

The tether consists of a CAT5 cable, two 10 gauge power cables, and a long foam rod for buoyancy. All of the cables and foam rods are encased in a cable mesh to maintain neat organization and to facilitate quick deployment. A cross section of the tether would reveal a total of 10 individual conductors - 8 from the CAT5, and two for the power. Four of them are used for camera signaling, another four for command signaling, and the last two for power transmission.

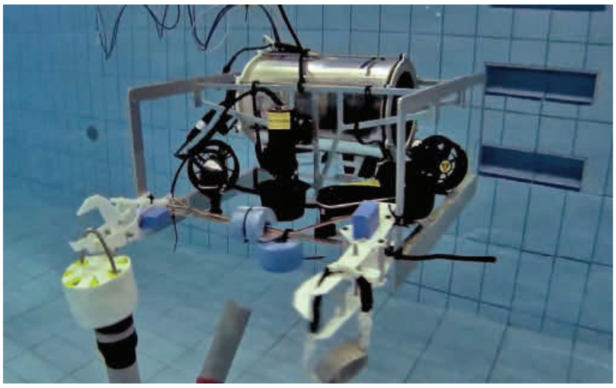
Troubleshooting Techniques

To maximize efficiency during the troubleshooting process, each part of the ROV was prototyped separately, and final components were tested under deep water conditions before the final ROV was assembled. During the prototyping period, problems in the prototypes' performance are taken into consideration before the final design is built. This reduces the number of issues we need to troubleshoot in the final components. Also, based on our experience from troubleshooting in previous years, the Mk-6 was designed to be easily disassembled for individual component testing. For example, the control box and camera chamber, areas most susceptible to damage from water, are attached to the frame with removable straps and bolts, and therefore easily accessible for checks and repairs.

Vehicle Systems

This year, we continued our vision of creating an original vehicle that would be able to work effectively with as few commercial systems as possible. To us, a successful work of engineering means creating something that is new and even better than currently available products. As such, our frame is designed and cut to be custom to the mission, our IC boards are originally designed, and the waterproofing is all done by team members.

In fact, this year, we attempted several radical changes, including but not limited to our first onboard control system housed within a buoyancy tank and switching to a new programming language for our onshore code. The switch in control system housing definitely caused a few problems as waterproofing became a challenge, but



we overcame these with research and many trials. Likewise, the use of Python instead of Processing meant that our team members had to acquire new skills and spend more time to perfect our systems, but we knew that the end result would be a vehicle that we could proudly call the TS-06.

One of the few parts that we did commercially purchase was our Seabotix motors as well as enhanced vertical motors. We found that attempting to create these ourselves would not only take much of our time, but would also decrease the efficacy of the motors and the other parts of the vehicle.

Safety

At Tigersharks Co., safety is our number one priority in both work sessions and product testing. With the addition of many new members and machinery, we compiled and distributed a lab safety checklist to every member to ensure safety in the laboratory. In addition, all machine operators are trained in the proper usage and safety procedures. Also, we continue to follow the Standard Operation Procedure (Appendix B) to maintain safety and organization during water tests. When the ROV is in operation, leaks or damaged parts can be hazardous to divers and onshore personnel, so we always check all electrical parts in a small water tank and onshore before testing in the pool. We make sure that our adult mentor and a lifeguard are present during all water tests, and that divers are at least five meters away from the ROV when it is in operation.

Aside from the safety procedures, the Mk-6 is designed for safe manual handling and operation. All edges of the Mk-6 frame are designed to be round, and are filed smooth; the thrusters, which have sharp rotor blades inside, are wrapped with mesh to protect personnel handling the vehicle. The electrical components are isolated in waterproof chambers to avoid exposing any live wires to water. Waterproofed wires outside the control and camera chambers are secured to the frame, away from any moving parts to prevent damage. Additionally, electrical components are covered with a rubber gasket (main control tube and cameras) and grease (thrusters) to prevent permanent damage in case of a leak. To ensure electrical safety, a current monitor that will highlight any discrepancies from normal operation is used. A reverse polarity protector consisting of a power transistor is used as well to ensure that no electrical equipment will be damaged by operator error. Furthermore, to prevent overheating caused by excess current, a fuse is implemented in the Mk-V's onshore control system. This will ensure the safety of all personnel and restrict the potential damage to nearby equipment and the ROV.

Challenges

Challenges are something that we embrace here at the TigerSharks Co., as persevering through them and engineering solutions are our specialty. One challenge that we encountered was the lack of available materials in Taiwan and the metric measurements that are used here. Therefore, instead of following the instructions from the prop construction manual directly, we had to improvise and determine which pieces we should use based on its required function. We typically had to modify props to become smaller since those were the pieces available in metric units. In one instance, we even had to laser cut disks in order to assemble a 4" end cap for the wellhead.

Scheduling was also a constant challenge for our team. All members of our team had numerous activities that would coincide with build sessions. While it may appear as though the team is unfocused, the truth is quite the opposite. Different members of the team step in and do more than their part at different times of the year to make the company successful.

Lessons Learned & Skills Gained

Through the process of designing and making our vehicle for this years missions, we all learned several important lessons and skills that we could use both next year in ROV, as well as in college or in other engineering courses. For example, one important lesson that all of us learned is the fact that the robot components must be made to be durable and strong. During our initial prototyping process, our robotic arm was designed out of a thin sheet of 3 mm acrylic. However, this acrylic easily snapped, as the torque experienced by the arm was too much for the acrylic. Thus, new supports were made in the particular weak spots to prevent the arm from breaking again. Another lesson learned by all is to be extremely careful when handling, transporting or fixing the vehicle. For instance, one employee accidently tried to move a part of the vehicle without knowing that the component wasn't secured to its base, resulting in him dropping and shattering the component. Thankfully, the component was easily fixed, but from this experience, all of us here at TigerSharks Co. learned to be extra careful around the vehicle, as accidents around the vehicle could cause serious problems.

Aside from learning general lessons from working on the ROV, many of our team members gained a variety of different skills from building and testing the vehicle. For a start, many of the new employees here at TigerSharks Co. learned how to use the different power tools here at our lab, such as the band saw, drills and the milling machine. Some of our members also gained proficiency in making CAD files with 3D modeling software in order model and create different parts of our vehicle using the 3D printer, plasma cutter and laser engraver. By gaining these skills, the first year members were able to take on bigger responsibilities and contribute more to the construction of our vehicle. However, new members aren't the only ones who've gained new skills, as our experienced members continued to learn more techniques in order to better our vehicle. For instance, an experienced employee designed and created an arm that is capable of mimicking the motion of another arm onshore. The new skill of mirroring gained allows for a whole new area of exploration and application during our missions. Another experienced member took up the new skill of learning Python in order to code the actions of the vehicle more effectively. Undoubtedly, all of the skills gained by both the experienced and new members of Tigersharks Co. will serve to improve our vehicle and its performance at its tasks.

Reflections

Jonathan, Grade 10

When I was employed by the TigerSharks Co. this year, I was delighted to join a group of engineers with whom I would get to work with to solve real world problems underwater. Since this is my first year in the company, I learned a lot from the different experienced team members, such as how to operate the different machines in the lab, how to build a vehicle, as well as how to test and run the robot underwater. Due to the fact that some of our experienced members are leaving next year, a large part of my job is also to learn the different skills needed in order to help run the company next year with my fellow remaining members. Aside from skills, ROV has also taught me how to communicate with and collaborate well with others, as teamwork is a central part to making and operating the vehicle. I have really enjoyed working with my fellow employees here at TigerSharks Co. and I can't wait for the competition this year!

Ray, Grade 9

I'm really glad to be accepted by the TigerSharks Co. As a first year member of Tigersharks Co. I had lots to learn before I actually start to help building the props and the vehicle. I was lucky to have the chance to try out all the machines and tools in the lab. Also, since this is my first year in the company, I felt privileged when I was selected to be the pilot for the vehicle this year. Since this was my first year in ROV, I had little/no experience at all before. I really appreciate the patience that the members had shown towards me. In addition, I was also able to further improve my skills in collaborating with others because I had the opportunity to communicate and work with my fellow teammate to achieve the common goal together. I really look forward to the MATE competition in June.

Trisha, Grade 11

My second year as a member of Tigersharks Co. has been even more exciting and informative than the last. Building on my knowledge from last year's competition, I was able to be a more effective and organized member of this year's team. The construction of the props went more efficiently this year because we started working as soon as possible, and our teamwork this year is cohesive and smooth. We learn from and consult each other whenever we have any questions or suggestions, and I'm grateful to be able to work with such a talented and friendly team. I look forward to what this team will offer at this year's competition!

Future Improvements

As with everything, the vehicle we have created for this year's competition is not perfect. However, each year here at TigerSharks Co., we challenge ourselves to reflect and improve upon past failures in order to design the best vehicle possible. Thus, there are some improvements upon our vehicle that we wish to implement in the future.

One of the main problems that we face here at TigerSharks Co. is the issue of buoyancy. Often, minor changes in the placement of the camera, control box, and arm causes the vehicle to loses neutral buoyancy, and as a result hinder our testing process as we waste precious time cutting up and attaching floatation devices and weights. An easy way to fix this problem is to securely fasten the different components into the metal frame, so that different parts do not easily shift during testing. Also, next year when designing the robot, we could utilize symmetry to ensure that all sides have similar, if not identical masses and volumes so that the vehicle will not tilt towards one side or another.

Another one of the future improvements that the TigerSharks Co. can make is to fix the leaks that happens during some of the practices. Leaks are a big problem, as water leaking into the control box often causes the vehicle to malfunction and sink. The leaking problem has caused us to spent our valuable and limited time on fixing the vehicle instead of testing and practicing to maneuver the vehicle. One possible solution to this problem is to ensure the vehicle is completely waterproof before the water testing period, and to seal any leaks found with materials such as rubber. We also wish to test for leaks by placing the control box in the deeper end of the pool, as different pressures will affect the speed and severity of leaks.

By fixing the buoyancy and leakage issues in the future, we believe that we can spend more time on building and making the vehicle better, as well as gain more practice maneuvering the vehicle in order to be at the top of our performance during the competition.

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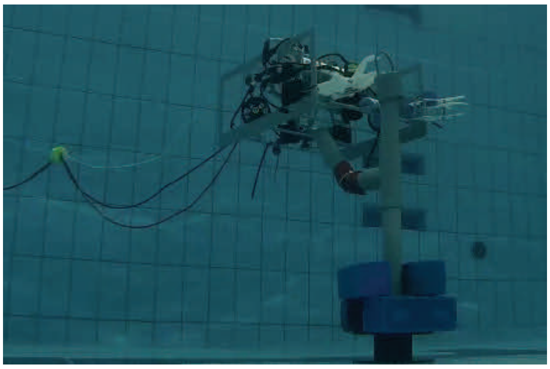
Acknowledgements

- Dr. Hennessey, our superintendent, and Dr. Hartzell, our principal, for their financial funding and confidence in us. It is their support that allows *Tigersharks to respond quickly to client's needs.*
- Dr. Garcia, our mentor, for giving up his valuable weekend and holiday time for our work sessions and water tests. We would also like to thank him for his patience and guidance.
- Marine Advanced Technology Education Center, our competition organizers who have challenged us to create a greater product, and for providing this wonderful opportunity for us to compete with so many different teams across the world!
- The PTA, Friends of TAS, and donors of the Robotics Lab for giving us such a wonderful workspace and giving us access to high-tech equipment.
- The Taipei American School for allowing us to explore our passions and for letting us use its facilities!



Financial Report

Income					
Donations to TAS ROV Tigersharks		150000 NT*			
Expenditure					
Category	Description	Price (NT)	Shipping (NT)	Total (NT)	Remarks
Mission Props	PVC Fittings and Pipes	4,465	0	4,465	
Mechanical	Aluminum Sheets (Plasma Cutter)	7,000		7,000	Reused
	Acrylic Pipe and Plates	1,488	0	1,488	
Electronic	Electronic Parts	1,162	0	1,162	
	Integrated Circuit Microcontroller	3,518	298.15	3,816.15	Reused
	ROV Mainboard	2,174.68	596.24	2,770.92	Reused
Claw	Delrin Plastic Material				Donated
	Waterproof Servo	1,375.44	0	1,375.44	
Servos	Waterproof Servos	9,628.08	0	9,628.08	
Camera	HDMI Camera	1,999	0	1,999	
	HDMI CAT5 Extension	3,368	0	3,368	
Propulsion	Seabotix Thrusters	60,000		60,000	Reused
	Hi-Flow Thrusters	37,191.90	186.27	37,378.17	
	Thruster Mounting Brackets	4,314.84	0	4,314.84	
	Speed Controllers	2,390	0	2,390	
Other Supplies	Misc. hardware (heat shrinks, zip ties)				Reused
	Acrylic Sheeting	360	0	360	
	Waterproof Connectors	579	0	579	
	Mounting Hardware	463	0	463	

*New Taiwan Dollar 1 USD ≈ 30.66 NT

Travel Expenses	**Air fare (10 people)**	**59200 per person (Each Student Contributes 30000)**		**592,000**	**Paid by team members & school**
	Hotel Fees	**81,618.55**		**81,618.55**	**Paid by school**
	Transportation & ROV Baggage Fee	**30,000**		**30,000**	**Paid by school**

Total ROV Cost w/o Donated & Reused Parts: 68,970.53 NT
2,249.27 USD

Total ROV Cost w/o Donated & Reused Parts: 68,970.53 NT/2,249.27 USD

Account Balance: 7,442.4 NT/242.71 USD

R.O.V.S.O.P.

The Remotely Operated Vehicle Standard Operating Procedure (ROVSOP) is used as a checklist prior to every run. The purpose of the ROVSOP is to ensure the safety of all Tigersharks personnel.

Buoyancy System

	Visually and manually check for cracks, especially connections between acrylic and PVC before the ROV is placed in the water
	Manually check that the buoyancy system is firmly attached to the ROV

Cameras

Prior to System Plug-in:

	Check that all mounts are stable
	Examine if there are any cracks
	Double check the waterproofing connections
	Visually check for residual water or moisture in the camera cylinders

After System Plug-in:

	Check that the camera image orientation is correct
	Tightly seal the casing onto the module
	Make sure no wires are crushed together / caught in the threads of the casing

After Missions

	Check camera for leaks, identify the sources of leakage if there are any
	Clear the module by dumping the water out
	Wipe the module dry and let it sit outside to prevent corrosion
	Remove camera module from ROV and begin repairs.

Control System

	Ensure the waterproof box is sealed tightly
	Double check Seacon connections to box
	Ensure there are no visible shorts or disconnections in the on shore and below shore control system.
	Ensure that the correct plugs are plugged in and that they are not flipped
	Check if fuse is still working

	Test all motors and apparatus on the ROV
	Ensure there is proper communication occurring

Date: ________ **Completed:** __________ **Verified by:** ________________

ROV Development Schedule

		Week													
Project Manager	**Description**	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Xiao, Jin Suh, Edmund	Initial Design	■	■												
Xiao, Jin Suh, Edmund, Trisha	Reusability Evaluation			■											
Entire Team	Procure Parts				■										
Xiao	Control System					■	■								
Jin Suh	Frame Design					■	■								
Jin Suh	Manipulator Design					■	■								
Jin Suh	Manipulator Construction							■	■						
Xiao	Propulsion Casing								■	■					
Xiao	Camera Design & Construction									■	■				
Xiao, Edmund	System Integration											■			
Jonathan, Chris, Ray, Tiffany, Xiao	System Test											■			
Trisha	Tech Report												■	■	
Jin Suh, Xiao	Final Design												■	■	
Everyone	Pack for St John's														■

Systems Integration Diagram