HKTA The Yuen Yuen Institute No.2 Secondary School

The YY2 Robot Team

Robot name: Underwater friend

Technical Report

ROV 2007 Ranger class (Hong Kong)

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Teacher: Mr. Wu Lai Ming

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Abstract:

YY2 Robot Team is a newly formed Robot team that aims to do scientific investigation design to help people improve life and promote environmental care. We care for our earth and are willing to share our ideas through web message and scientific design. We use simple, friendly and spiral design method to accomplish our underwater mission. We promote fundamental design attitude that stimulate and promote students in future ROV design. We avoid wasting money buying expensive equipment because practical tools should come in handy that are readily available to ALL students. YY2 Robot team uses critical thinking and spiral engineering design principle that work together as a team to share and improve design. We believe robot design should be "**Simple is Great**".

Background information:

The Yuen Yuen Institute No.2 Secondary School is a learning school that promotes students' initiative in Scientific Investigation. The Yuen Yuen 2 Robot team started in Sept 2006 and actively joined various scientific competitions, e.g. The Solar model car competition, The wind power electricity competition, The model plane design competition, and The Internet Robot competition. We care to protect our earth and contribute our effort to do more. We know that **"t**he oceans contain 99 percent of the living space on the planet." [1] We care to do something to protect the ocean life. Moreover, we have the opportunity to experience authentic science in real time competition and care about the living water creature in Polar Regions too. Being able to involved in this International Polar Year activities are extremely important to us. Participating in ROV design is one of our learning goals, being able to help other classmates care and concept for Polar region environment is another important learning lesson for us.

Challenges:

Experience: All teachers and team members are newly recruited, and most of the students do not have any previous robot design experience. Therefore, we openly discussed and shared ideas with team members to overcome difficulties.

Budget: Our team has limited financial support and lack of proper equipment. We need to save money and cut down ALL unnecessary expenses. We aim to use CHEAP and EASILY available tools to help us. We do not want to waste money on unnecessary part or wasting money in market available item. We want to design our unique and innovative ROV.

Environmental friendly: We try to use SIMPLE and readily available device and tools to help us build this ROV. We try to avoid using too many mechanical or electrical devices in this ROV. We try to build the ROV with fundamental materials that will do as little damage as possible to Polar environment.

Academic challenge: During the past few weeks, our school students were busy with Uniform-test and exam. All teachers and students were facing their own academic challenges and they had to use their spare time to discuss the ROV project.

Trouble shooting Techniques:

Experience: We had no experience in buying equipment needed for this ROV project. In order not to waste time and money on shopping for ROV parts, we start small and worked from there. We concluded that we should think before we buy and build. We truly believe that "Simple is Great".

Mission task: Since we were all new to robot building and lacked of experience, we discussed with each other. Gradually, we built up our team cooperation spirit and build up step by step. Money can buy technology BUT what good it does to our ROV design and future development. Finally, we decided to start from SIMPLE and environmental friendly tools like gardening tools, fishing net and floating tank.

Discussion: When we faced difficulties, we shared and asked. We use blackboard to draft and exchange ideas. Our work starts from scratch and gradually builds up our project corporation with periodical adjustments. We employ "Spiral Engineering" techniques to help us solving problems.

Design theory:

Simple is Great:

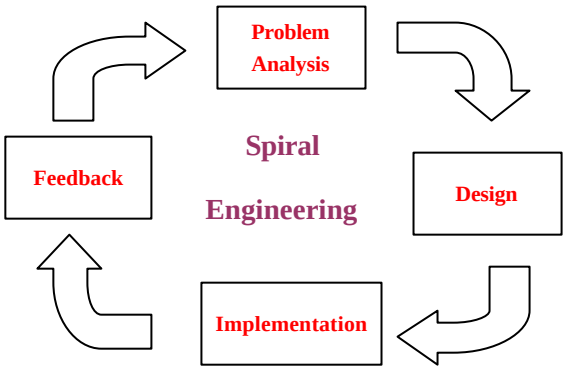
We want to use "Simple", "Daily life available" techniques and tools to finish the missions.

Cheap is Environmental friendly attitude:

We believe "Money can buy technology". Each team can spend thousand or 10 thousands dollars in buying "market available robotic arm or gear set". But, what good it does to promote innovative and user-friendly ROV. Therefore, we try to use the minimal amount of money in designing mission tools and making the ROV. ALL out mission tools and design are easily available and we welcome them to exchange ideas with us.

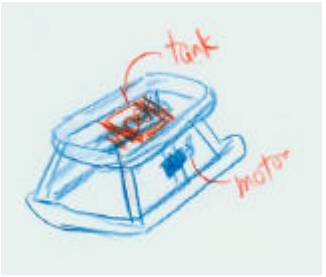
Spiral Engineering design principle:

We use the "Spiral Engineering concept" in this ROV design. The project is a challenge to us, but it is also a good leaning experience for ALL of our team members. Through group discussion and implementation, we can build up friendship and cooperative attitude with critical thinking techniques.

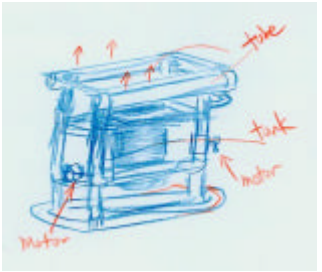


In order to overcome different missions' difficulties, we constantly improve the ROV design and come up with 3 versions of ROV. Version 3 is the winning ROV of our team in HK.


ROV design version 1



ROV design version 2



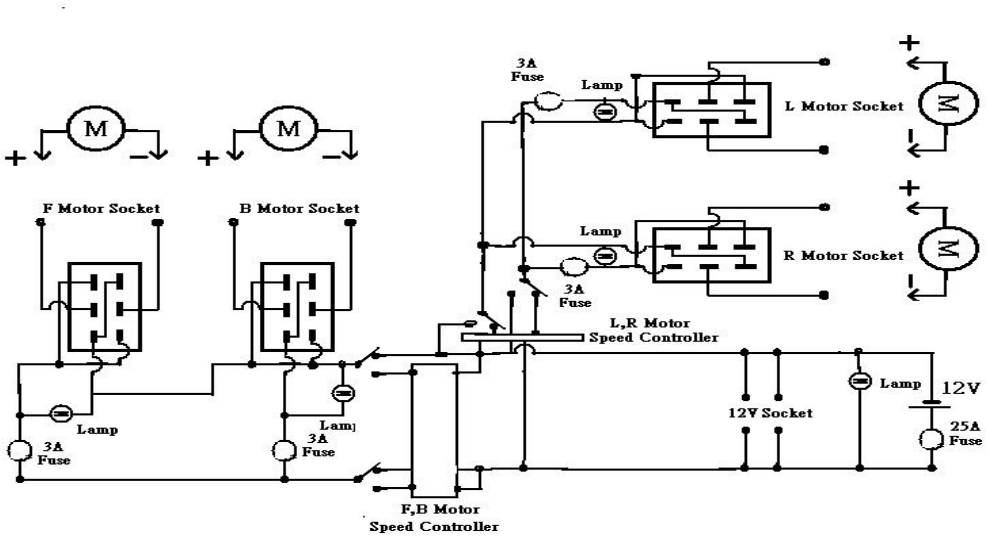
ROV design version 3

The evolution of this ROV design can help our team to build up team sprite and promote critical thinking and communication technique.

ROV design:

Circuit design:

Challenge: Circuit design and protection is crucial and important in Environmental friendly ROV. We make sure ALL electric parts are fused and lighted with lamp that can reflect circuit error immediately that avoids wasting time in locating electric fault. This trouble shooting device in circuit fault can act as a back-up circuit for this ROV. In case of those electronic control parts errors, we can use direct control through manual switch that by pass delicate switch in order to continue the mission or retrieval ROV immediate.

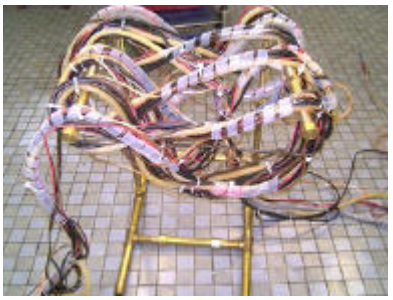


12V Motor Control Circuit

Tether design and management:

Challenge: A large bundle of 20 m wires that consists 4 motor wires, 3 camera AV wire and 1 air-tube can be messy to handle. We design a tether handling stand that can be assemble and re-structure according to Mission environments. Moreover, we employed nylon ribbon that tidy up the loose wire and provide extra buoyancy to long and heavy wire.

Messy and untidy tether



Tether management with nylon ribbon (flexible and reconstruct able)

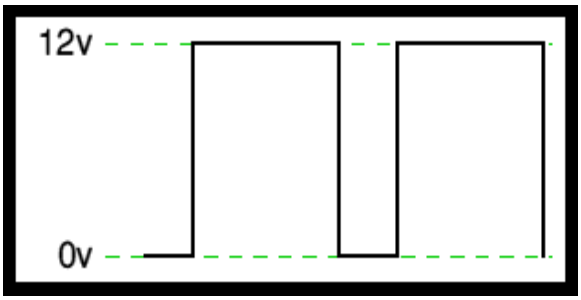
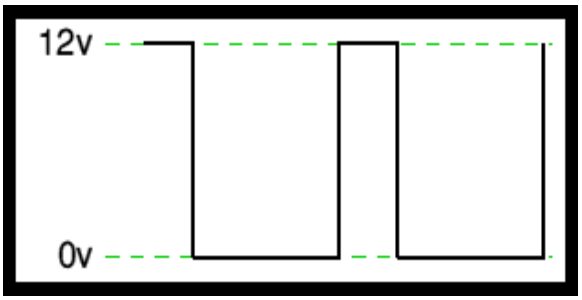
ROV stability:

Challenge: Underwater ROV should be very stable and moving with high degree of accuracy in order to accomplish different missions. We design floating tank and hand-pump to adjust the ROV overall density to water environment's density. The manual air pumping device can pump or release air inside the tanks in order to adjust the weight of water displace so that the ROV can be very steady inside the water environment.

On the other hand, the digital speed controller of the ROV uses the PWM (Pulse Width Modulation) technology. The ROV can approach the creature with quiet, steady and smooth manner. Moreover, PWM technique can help the ROV accomplishing missions with delicate manner.

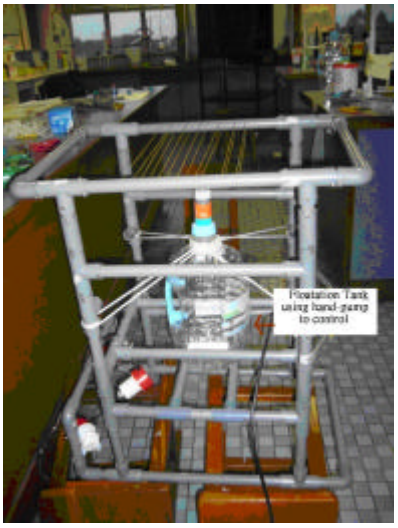
PWM controls the speed of motor by varying the width of the positive pulse - the 'average' voltage.

Scenario analysis of PWM technology

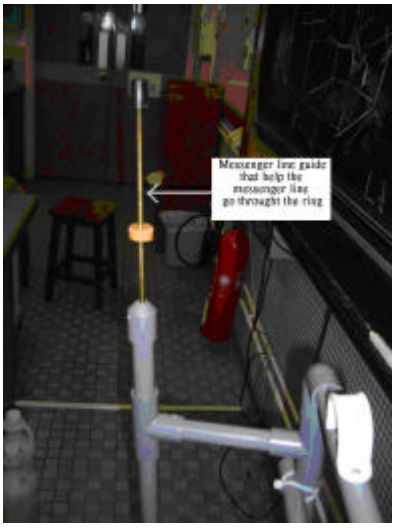
Case 1: The greater the voltage, the faster the speed	Case 1: The smaller the voltage, the slower the speed
	
If the switches keep the input voltage at 12v for 3 times as long as at 0v, the average will be 25% of 12v = 9v	If the output pulse of 12v lasts only 25% of the overall time, then the average is 25% of 12v = 3v

Mission 1:

Challenge: Using motor to control the stability of ROV is difficult especially during missions. Our ROV using manual air pumping device has the power to lift over 10kg of weight. On the other hand we use simple messenger line guide to guide the line through the weight and retrieval the end of the messenger line back to water surface. The messenger line guide is so cheap that it costs only HK$10.



The floatation tank employed the Archimedes Principle to keep the ROV stable

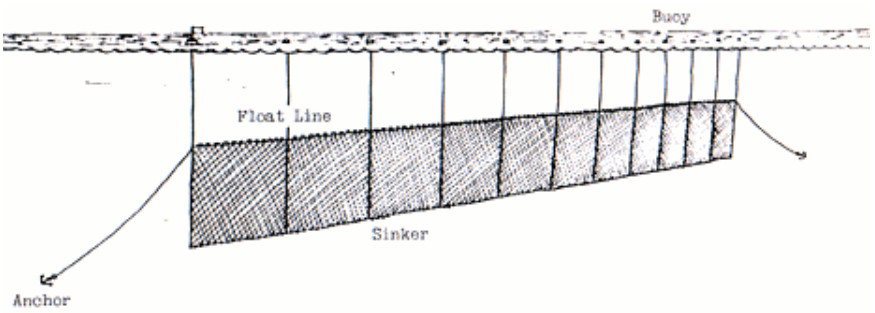


The messenger line guide is a simple and reusable tool in different mission.

Mission 2:

We use simple fishing net (3) and trap design to catch the water creatures instead of using mechanical tools that may kill and hurt the creatures. The trap is so simple that we use elastic threat to weave the trap that costs HK$60 and can be used for over 100 times.

Elastic wire that weave like a fishing net that will not hurt the water creatures.



Gill net use by fisherman.

Gill net:

Challenge: We design trap to catch sea creature "alive" BUT not to kill them. Therefore, we use the design of gill net because fish are caught and trapped alive by their gills or caught

inside the elastic net. In order to avoid catching younger fish or fishes that are not our target, we design gill net with different holes size that can be re-sized according to mission needs.

Challenge: We design to do mission in peaceful and quiet manner. We rule out the use of robotic arm to catch water creatures, because water creatures will not stay there to let you catch. The only easier and less creatures' harmful way is to catch them with net. Moreover, robotic arm will create noise and produce unwanted mechanical waste underwater that may be harmful to marine creatures.

Mission 3:

Challenge: We want to promote friendly and easy assemble ROV that is available to ALL students. We use simple gardening tool to do all the mission work in this part. Each of those mission tool costs less that HK$20 a piece.

Final version of ROV design:

Size: 40cm width x 75cm length x 75cm high
Weight: approximate 20kg
Floating device: one manual hand-pump floating tank, and 2 floating tubes on top
Sensor: 3 12v IR colour waterproof camera
Thruster: 4 12v fused water motor: 4164 LPH Bilge Pump (two for forward and backward action, two for steering action)
Tether: 2x120/0.12mm cable, nylon thread and nylon ribbon, and tether handling stand

Frame: Most of the pipe join are secured with steel screw instead of PVC glue because it is more environmentally friendly, reusable and reconstruct able.

Design Principle:

ROV stability is one of the main problems of this design. Keeping 2-4 motors in action but keeping the ROV stable without turning over is difficulty. Finally we employed the **Archimedes principle**:

Weight of the floating body is equal to the weight of the fluid displace

Therefore, we use the cheap and simple design "Floating Tank".

Floating tank is a recycle water container that holds air and release air through hand-pump. By adjusting the speed and volume of air flow, the density of the ROV and water environment can be a dynamic equilibrium. It work much BETTER than motor and much SENSITIVE than motor.

Floating tubes is a supporting device that will keep the ROV stay on water level steadily. The floating keep the ROV stay horizontal on water level that either continue mission or swim back to controller members.

Future development:

Energy is getting limited and technology is growing fast. We do not like to leave technology trash or pollution in our beautiful ocean. We believed that the future ROV should less depended on traditional power supply and use more innovative and environmentally friendly power supply, e.g. current power or some kind of non-electrical power. In our future ROV, we continue to use hand-pump as a source of ROV power.

If we get the chance to improve this ROV in the future, we will continue **our main design principal:**

Cost: The cost for building future ROV should be "Simple and easy".

Friendly and easy: Everybody that care to save water creatures can build ROV with "Simple and readily available technology".

Environmental friendly: The future version of ROV must be "Quite and environmental friend" because we want to save, protect and study but not to disturb and kill.

Reusable: The building material should be "Reusable and reconstruct able" because we do want our ROV because another environmental trash that sink to ocean floor.

Lesson learned:

Environmental issue: Recently, scientists and educators constantly reveal abundant evidence of changes in snow and ice in Polar Regions. The International Polar Year is a large scientific programme focused on the Arctic and the Antarctic. IPY notices the changes in snow cover and sea ice that affect terrestrial and marine ecosystems. Moreover, the changes in the large ice sheets will impact global sea level, affecting coastal cities and low-lying areas especially Hong Kong and China. During our ROV design, we aware the weather and climate changes in Polar Regions will eventually affect marine ecosystems and fisheries too. We agree that the Polar Regions are sensitive barometers of climate change that eventually affect us. It is not a simple matter of Polar changes but remotely affect the daily living environment of more than 4 million people in the world. In this learning activity, we hope that our world will raise the concern of schoolmates and people in Hong Kong. It is to our hope that all citizen in Hong Kong will started to aware and contribute their effort to protect the environment.

Technical issue: Time and design are the main limitation of our work. We highly appreciated our effort in this ROV building in such a short period of time. Team building and critical thinking are our excellent learning experience. We believe sincere and open discussion can promote communication. Through work delegation, team member can contribute his own special talent in ROV design. Finally, we enjoy the challenge and learn a lot about underwater world and science. Participation is one of the rewarding lessons to promote underwater protection. Hopefully, we will continue contributing the work of underwater creatures' protection in next year.

Budget:

Initial project funding is 100% from The Yuen Yuen Institute No.2 Secondary School. School teachers and team members contribute some of the transportation fee involved in this education program. During the international challenge, Yuen Yuen Institute establishes a scientific research fund for our school. On the other hand, the later stage of ROV improvement and air traveling expenses are sponsor by different organizations in HK.

Date	Dep. or Exp.	Description	Notes	Amount	Balance
17/5/2007	expenses	Air Ticket London - Canada	$4929 x 6	HK$29,574.00	HK$29,574.00
21/5/2007	expenses	Air Ticket HK - London	$6259 x 6	HK$37,554.00	HK$67,128.00
May - Jun 07	expenses	Transportation		HK$3,000.00	HK$70,128.00
May - Jun 07	expenses	tools and consumable item		HK$3,000.00	HK$73,128.00
May - Jun 07	expenses	report, paper and stationery		HK$1,500.00	HK$74,628.00
May - Jun 07	expenses	Monitot controller		HK$400.00	HK$75,028.00
May - Jun 07	expenses	ROV box and container		HK$1,000.00	HK$76,028.00
May - Jun 07	expenses	control box and switch		HK$2,500.00	HK$78,528.00
May - Jun 07	expenses	wire and pipe		HK$1,500.00	HK$80,028.00
May - Jun 07	expenses	motor and propellers		HK$1,500.00	HK$81,528.00
May - Jun 07	expenses	ROV frame and fitting		HK$2,000.00	HK$83,528.00
May - Jun 07	expenses	tether handling stand and item		HK$1,500.00	HK$85,028.00
May - Jun 07	expenses	hand pump and accessory		HK$800.00	HK$85,828.00
May - Jun 07	expenses	glue and fitting		HK$500.00	HK$86,328.00
May - Jun 07	expenses	mission tools and accessory		HK$2,000.00	HK$88,328.00
May - Jun 07	expenses	IR camera		HK$5,500.00	HK$93,828.00
May - Jun 07	expenses	electrical parts and accessory		HK$3,000.00	HK$96,828.00
20-24 Jun 07	expenses	Dorm	Can $19.9 x 3 x 5	HK$1,800.00	HK$98,628.00
				Total expenses:	HK$98,628.00
May - Jun 07	Deposite	$6,000 per member & teacher	Air Canada	HK$36,000.00	HK$36,000.00
May - Jun 07	Deposite	$2,400 each from	Oasis HK Airlines	HK$14,400.00	HK$50,400.00
May - Jun 07	Deposite	Sponsor (in kind and cash)	CityU of HK	HK$20,000.00	HK$70,400.00
May - Jun 07	Deposite	Sponsor per team	WWF	HK$5,000.00	HK$75,400.00
May - Jun 07	Deposite	Sponsor (in kind)	Oceanway	HK$2,500.00	HK$77,900.00
May - Jun 07	Deposite	Sponsor from YY2 SI fund	Yuen Yuen Institu	HK$20,000.00	HK$97,900.00
				Total deposite :	HK$97,900.00
				Net balance:	-HK$728.00

Acknowledgements:

Being able to participate in this International Underwater Robot Challenge is an encouraging and learning experience for us. We would like to thank the following people and organization for their generous supports in all sorts of resources.

The Yuen Yuen Institute that subsidize our scientific research fund.

HKTA the Yuen Yuen Institute No.2 Secondary School gives us all kinds of support and encouragement for us to participate in this learning activity.

Mr. Lam Kwong Fai, the school principal that constantly and sincerely gives us warn and encouraging advices.

Mr. Wu Lai Ming, the Scientific Investigation mentor that constantly and sincerely gives stimulating advices for us.

Ms. Robin Sarah Bradbeer, Associate Professor of City University of HK, gives us ideas on making ROV.

The World Wide Fund (WWF) and The City University of Hong Kong, the organizing body of Hong Kong ROV competition, provide funds and opportunities for us to learn and experience.

The Marine Advanced Technology Education (MATE) Center and **the Institute of Electrical and Electronic Engineers, Inc., (IEEE)** provide funds and advices for use to learn and experience.

The Air Canada and **Oasis Hong Kong Airlines**, provide us air ticket sponsor.

The Ocean Way, provides funds to subsidize our expenses.

Reference:

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