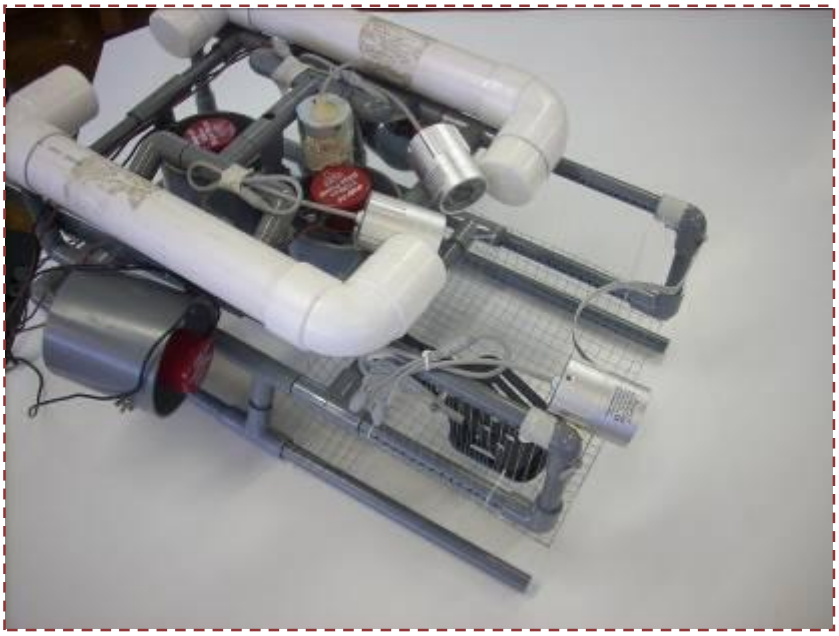
2008 MATE Center/MTS ROV Committee ROV Competition

Technical Report

The Methodist Church Hong Kong Wesley College

Wesley 1



Team Members:

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Tai Chin Fung, Kwan Wai Shing, Chow Tak Yee

Mentors:

Tsang Kwok Kin (Physics Panel)
Ng Lai Fun (Physics Teacher)
Chung Wing Fai (Design And Technology Panel)

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Abstracts

We come from the MCHK Wesley College which is in Hong Kong, China. There are two of us are the form four students and the others are form six. We would like to participate in a ROV competition. There are two teachers are the main helpers for us. One is our design and technology teacher and one is our physics teacher.
We have designed and built an underwater robot that can operate with four cameras in the three different tasks:

(1) Collect up to 3 vent crabs,
(2) Collect up to 3 samples of a black smoker,
(3) Measure the temperature of hydrothermal vent fluid.

Task 1

Collect up to 3 vent crabs. We have to find the vent crabs in the open or tucked into nooks and crannies in the bottom topography and return to the surface. Finally, we will deploy a ROV with its attached communication cable.

Task 2

Collect up to 3 samples of a black smoker. We need to collect 3 samples or a black smoker and return the samples of black smoker to the surface by controlling the ROV.

Task 3

Measure the temperature of hydrothermal vent fluid. In this task, we need to locate the hydrothermal vent, to insert a temperature senor into the venting fluid. After measuring the temperature of the venting fluid, the reading will be displayed on a video monitor or as a read-out at the control shack.

Proposed solution

ROV Specifications:

Size: 60 cm (L) x 38 cm (W) x 24 cm (H)

Mission 1: Collect up to 3 vent crabs

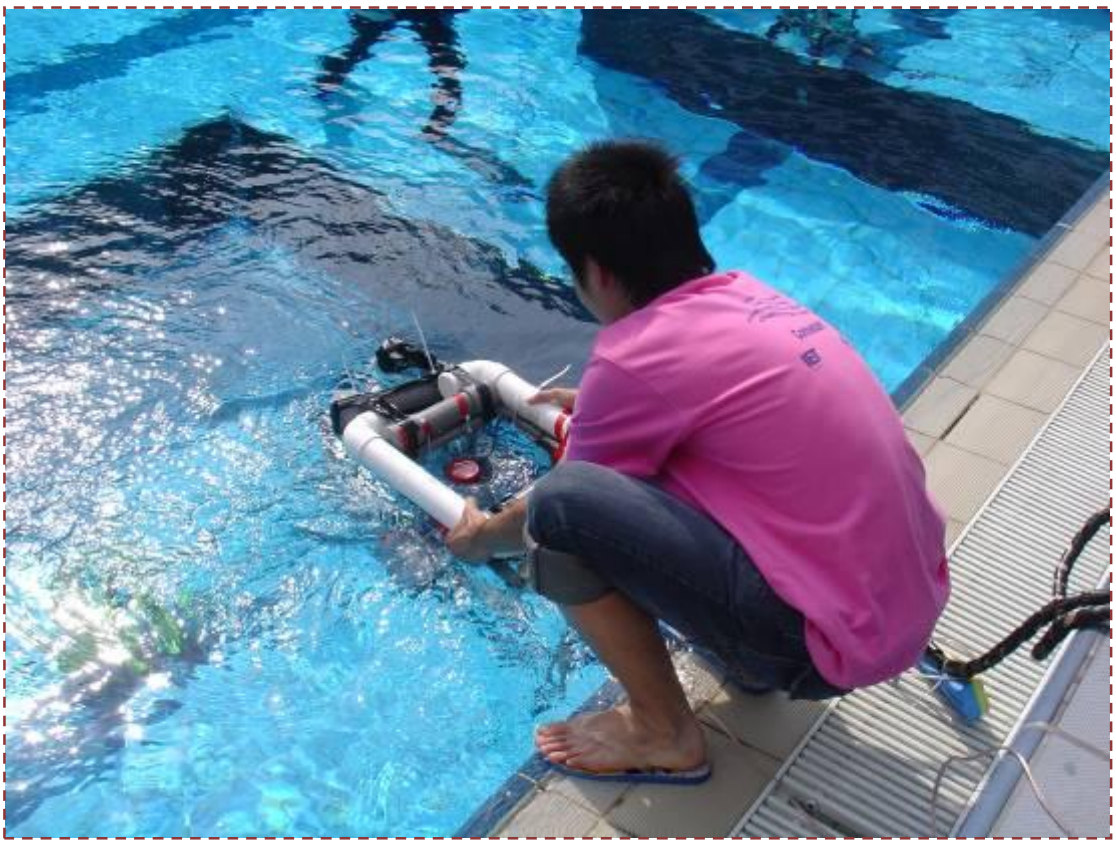
The mission task involves:

** collecting up to 3 vent crabs

** returning the vent crabs to the surface

To achieve this task, we decided to use the conveyer belt for catching crabs.

Testing And Modifications



Design Rational

Size of ROV

** It is difficult to control the ROV, the ROV is always tilted. So we separate the buoys to stabilize the ROV. We find it useful.

** It is difficult to complete the missions. We find that the positions of cameras are very important. So we enlarge the size of ROV.

** As a result, we decide it to be 66 cm (L) x 34 cm (W) x 25 cm (H)

Position and power of Motor

** The positions of motors are also important. It will influence the movement of ROV.

** When we change the positions of motor, the floating power is also affected.

** When we tested the ROV, the wires were too heavy. We have added some foam boards to raise them up.

** When we tested the ROV in the pool, the floating power was different. So we have prepared different sizes of buoys and foam boards.

The cover of propeller

** We design a tube to cover the propeller, so that the water can flow in one direction. We find that the efficiency of the propeller is increased.

Control system

** It is difficult to keep the ROV at different depths, so we use the bi-directional DC motor speed controller.

Frame

** We have chosen PVC as the material for the frame of Wesley 1. It is because of cost effectiveness and the availability of the material. There are different types and configurations of connectors to make our design flexible.

Materials

** For the safety, all the materials are non-corrosive.

Propulsion

** Our propulsion system is composed of four bilge pumps with plastic 5 cm two-blade propeller. For the left and right motors we have chosen bilge pumps that are rated 1892 litres per hour. Because of our design of the ROV, these two motors are able to create enough thrust to move the ROV forward and backward efficiently.

** The other bilge pumps are rated to move 3784 litres per hour and are used for vertical propulsion. These motors, with the aide of the buoyancy system, create enough thrust to move the ROV vertically under different loads required throughout the competition tasks.

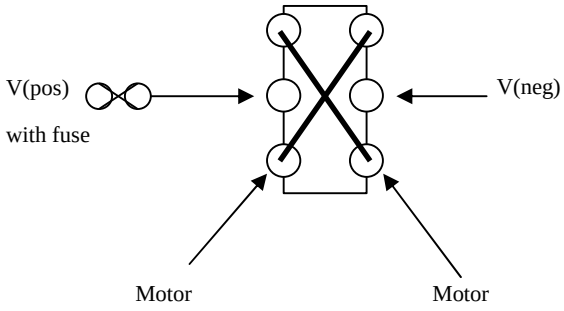
Control system

Bi-direction DC motor speed controller

We use the electronic circuit for controlling the speed of motor. Therefore the ROV can be stably driven at different depths.

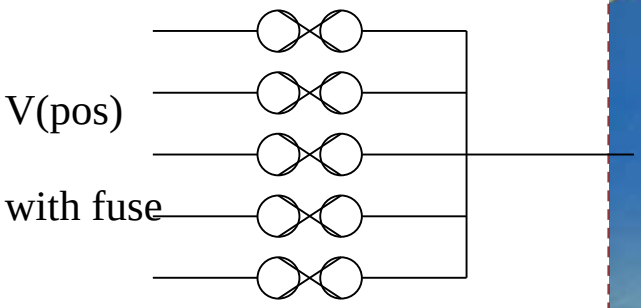
Safety

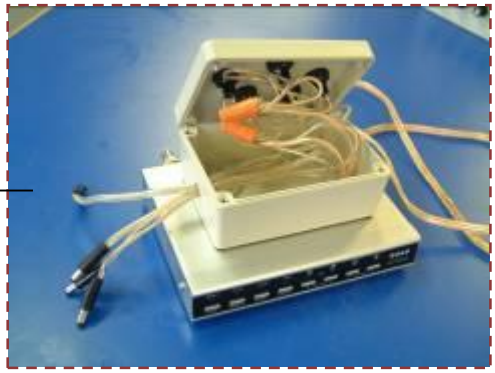
Each circuit includes fuse to prevent current overflow.



Connection of each switch with fuse

Connection of each camera



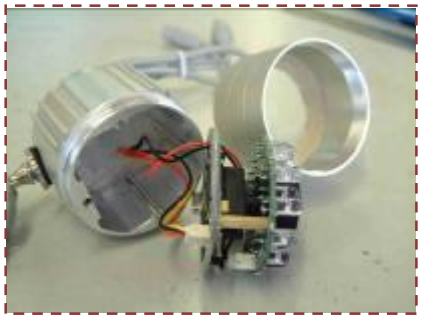


Buoyancy

We prepare different sizes of buoy for balance in different loads required throughout the competition tasks.

Water-proofed Cameras

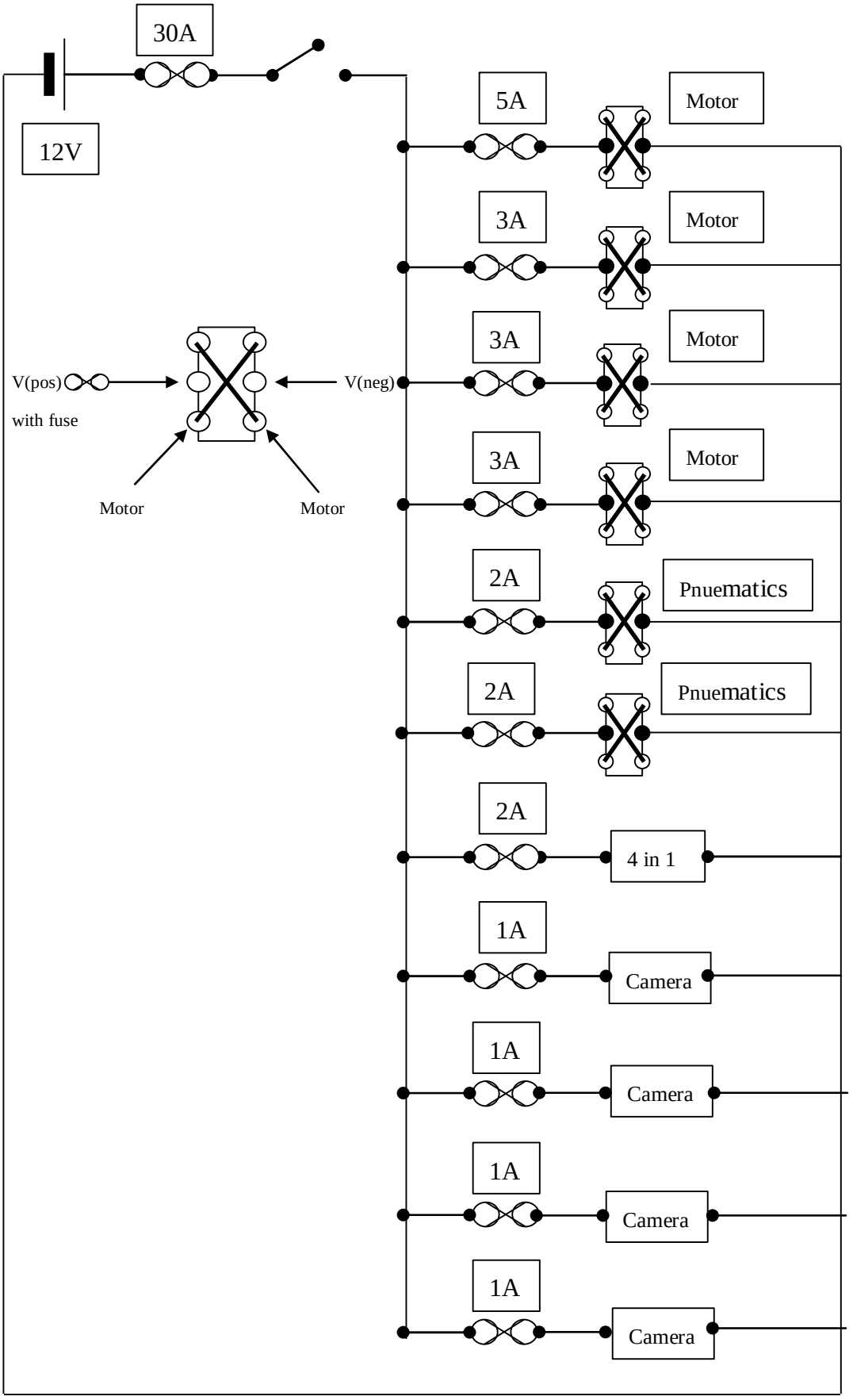
Smear the silicon Sanitary Sealant over each joint to prevent the water from seeping through.



Structure

After testing, we have enlarged the size of our ROV for maintenance & troubleshooting.

Electrical Schematic



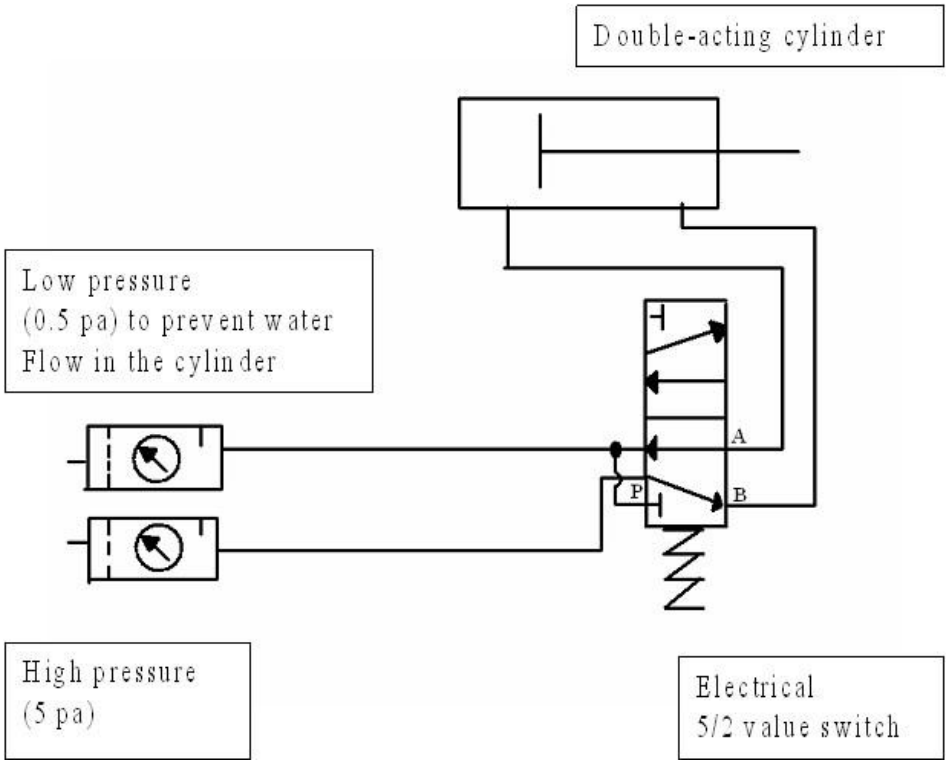
Troubleshooting Techniques

Mission 1: Collect up to 3 vent crabs

** To collect the crabs, we finally decide to use pneumatics circuit with claw, which is made by turner and iron bars.

** Moreover, there is an extendible railway for the claws to expand and contract.

Pneumatics Circuit



Air filter pump

To get rid of humid from the air.

Figure of Double-acting cylinder and air filter pump

Wire netting

To keep the crabs.

Mission 2:

The mission task involve:

** collecting up to 3 samples of a black smoker

** returning the samples of black smoker to the surface

We decide to use the knife and the net to collect the samples of a black smoker.

Since the “knife” did a good job in the pervious text, we keep the idea but move it to the bottom of the robot. Thus, it won’t be affected by the stream easily.

Mission 3

The mission task involves:

** locating the hydrothermal vent
** inserting a temperature sensor into the venting fluid
** measuring the temperature of the venting fluid and displaying the reading on a video monitor or as a read-out control shack.

We decide to use the electronic thermometer to measure the temperature.

Moreover, we decide to extend the connecting wire of thermometer, and thicken the wire in order to reduce the resistance.

To test the accuracy of the thermometer, we put it with another independent alcoholic thermometer into cups of water at different temperatures. Record the readings and compare to find out the error as well.

To guide the thermometer into the target hole, there is a funnel with some round holes. Therefore, we can increase the accuracy in locating the thermometer.

Challenges Faced

At the very beginning, we joined the workshop in the City University of Hong Kong in order to learn how to build up a robot. At that time, we did not have much communication among each other on account of not being very close friends. Therefore, we got into trouble allocating the work.

Besides, we have heavy academic workload in secondary six and four. Nevertheless, a number of problems of the ROV appeared, in which we had to spend more time solving.

What we have learned

Fortunately, the teachers gave us a hand on enhancing our cooperation. After that, we were into making the robot as well as working with our teammates.

Moreover, it had been pretty important in terms of how to manage our time between building this robot and doing our schoolwork. We feel grateful toward our teachers of The MCHK Wesley College, who showed understanding for us and supported us throughout the process.

We have learnt team spirit and communication skills during the competition, also not to make decision hurriedly. It is extremely essential to consider the consequence of every step we take.

Future improvement

Our future improvements include changing the switches of the controller into a joy-stick so that it will be more efficient and easier to control.

Another improvement is to promote the ROV to the public. A lot of students still don't know what the ROV is. This limits the donations from sponsors and mentors. Next year, we will have a promotion in school asking for more support, so that we can have enough funds for the competition.

Reflections On The Experience

On the whole, it is a rare opportunity for us to learn how to build an underwater robot. In fact, it is a really tough challenge for us.

While we were preparing for the competition, we faced many problems in building the robot. A lot of discussions were undertaken to solve the problems, such as the shape of the robot, the tools that we used in different tasks, the way to control the floating power and so on. Moreover, as there is no big swimming pool in our school, we could not test how the robot moved in water.

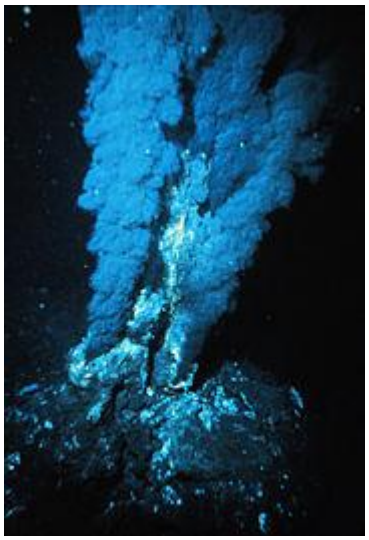
We built up our friendship and collaboration

Budget

Material	Quantity	Costs
ROV		
PVC (dia. 9mm)	8 metres	HK$108
L – Joints	20	HK$40
T – Joints	18	HK$72
PVC(dia. 40cm)	1.5 metres	HK$32
Tube Cover	4	HK$17.2
PVC(dia. 50cm)	8 metres	HK$32
L – Joints	4	HK$20
Glue	1	HK$8
Motors(500GPH)	3	HK$570
Motor(1100GPH)	1	HK$250
Wires	57 metres	HK$399
Wires	15 metres	HK$250
Wires	1.5 metres	HK$14
Waterproof Box	1	HK$77
Fuse and fuse holder	5	HK$17.5
Switch	4	HK$60
Switch cover	1	HK$4.5
DC Motor controller	1	HK$108
Nylon Water Screws	4	HK$36
Waterproof Torch	2	HK$290
Terminal	52	HK$26
Badge	100	HK$25
Spiral Wrappings	1	HK$55
DC Plug	6	HK$12
	Total	HK$2523.2
Tools		
Aluminium	1	HK$20
Screw and nut	20	HK$48
Net	1	HK$10
Electronic Thermometer	1	HK$290
	Total	HK$368
Camera		
Camera	4	HK$1120
Wires for camera	4	HK$240
Silicon cement	2	HK$120
Colour Quad processor	1	HK$300
Box	1	HK$28
Fuse and Fuse holder	5	HK$27.5
	Total	HK$1835.5
Pneumatics system		
Double-acting cylinder	2	HK$267.6
5/2-way valve with electrical actuated, one side	2	HK$460
Pressure regulator valve with gauge	1	HK$416.5
Plastic tube	80metres	HK$400
	Total	HK$1544.1

Description of a scientist and/or research project that uses ROVs to study mid-oceanic ridges.

A hydrothermal vent is a geyser on the seafloor. It continuously spews super-hot, mineral-rich water that helps support a diverse community of organisms. Although most of the deep sea is sparsely populated, vent sites teem with a fascinating array of life. Tubeworms and huge clams are the most distinctive inhabitants of Pacific Ocean vent sites, while eyeless shrimp are found only at vents in the Atlantic Ocean.



Hydrothermal vent

There are some serviceable substance which are black smoker and white smoker. "black smokers" are the hottest of the vents. They spew mostly iron and sulfide, which combine to form iron monosulfide. This compound gives the smoker its black colour. "White smokers" release water that is cooler than their cousins' and often contains compounds of barium, calcium, and silicon, which are white.

Deep-sea hydrothermal vents form along mid-ocean ridges, the volcanic undersea mountain ranges where new seafloor is created. Before seafloor vents were actually observed, their existence was predicted because new oceanic crust cools more quickly than otherwise expected. Cold seawater penetrates deep into cracks in the earth's crust. Heat from the rock is transferred to the water along with many different kinds of minerals.

Vent clams

Although hydrothermal vents are what we would consider a harsh environment, they are teeming (abundant) with life. As long as the vents remain active, which is usually one to two years, animals thrive there. In fact, more than 300 species live around the vents and are unique to this type of environment. These creatures have learned to survive the complete darkness, the extremely hot vent water and the tremendous water pressure. There are many other reasons why scientists want to learn more about hydrothermal vents. These underwater geysers are believed to play an important role in the ocean's temperature, chemistry, and circulation patterns.

Scientists also are fascinated by the unusual life that inhabits vent sites. These creatures who live in darkness, from bacteria to tubeworms, may light the way to the development of new drugs, industrial processes, and other products useful to us all.

The scientist can uses the ROVs to do research on mid-ocean ridge systems, such as hydrothermal vent environments. Use the rov to catch the creatures which live in the deep sea. Check the temperature with the thermometer which set on the rov and collect the sample in the deep sea

References:

http://www.ocean.udel.edu/deepsea/level-2/geology/vents.html

http://www.ocean.washington.edu/people/grads/scottv/exploraquarium/vent/intro.htm

http://www.amnh.org/nationalcenter/expeditions/blacksmokers/black_smokers.html

http://en.wikipedia.org/wiki/Black_smoker

Photo journal

They are discussing the design.

Ng Hoi is cutting the net.

Tak Yee is counting the budget.

Thomas and Unique are using the computer for designing.

Jack is setting the control system.

Jack is asking mentor’s advice.

Acknowledgements

We would like to thank the Electronics Department of City University of Hong Kong for their helps, including offering the place for us to test the performance of our ROV and give us the endowment to support our disbursement of the competition. Naturally, we need to thank that they mete out the opportunity for us to participate in the competition which holds in u.s.a.

We would also like to thank the teachers of The MCHK Wesley College. They including our English teacher, who give a big hand in our English grammar and help us to improve our technical report. Certainly, we also need to thank our DT teacher. They render some useful advice for us to improve our ROV and provide the materials and site for our fabrication of the ROV.

We would also like to thank the following sponsors for their support and generosity.

Donations list

Team Wesley 1 has given help from many important people and corporations. Teams could not make it to San Diego without their help. We would like to give a huge thanks to:

The MATE Center