GΣ3K

Air Force Academy High School
Robotics Team 2011
Chicago, Illinois

CEO	George Onofre
CFO	Rashaad Dinning
COO	Christopher Odor
Pilots	Julian Martinez
	JohnPaul Nelson
External Communications	Mario Rios
	Grace Mei
Engineers	Dionte Collins
	Christian Jackson
	Michael Nguyen
	Jeffrey Bridges-Reed
	Blake Kennedy

Advisors:
Aaron Lee, Air Force Academy High School
Dr. Robert Friedman, Adler Planetarium

Abstract

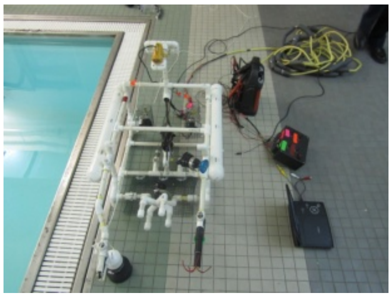
In the Gulf of Mexico, in 2010, an accident aboard the oilrig "Deepwater Horizon" caused 11 deaths and released 4.9 million barrels of oil into the Gulf. Excessive environmental damage resulted from the open wellhead at the bottom of the Gulf. The wellhead continued to gush oil for three consecutive months after the disaster. A remotely operated vehicle (ROV) was needed to cap the wellhead and prevent further damage.

In order to meet this need, the Geek Corporation designed the N3RD. The N3RD is a remotely operated vehicle (ROV) capable of minimizing the environmental effects caused by a Deep Water Oil Spill. This vehicle has all the capabilities necessary to cap a wellhead including: cutting and removing the a riser pipe, closing the wellhead valve, inserting and operating a top kill manifold, and capping the well head to ensure that no more oil escapes. Additionally, the N3RD is capable surveying the environmental damage caused by a spill. It can collect desired samples of potentially contaminated water and biological samples which may have been affected by the spill.

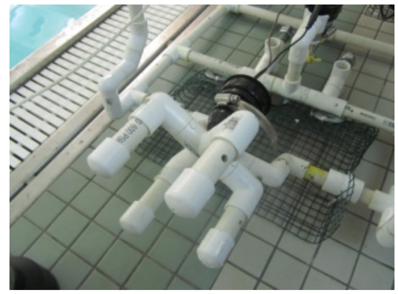
The N3RD ROV took a team of 12 staff, technicians and engineers 3 months to build. At a cost of just over a thousand dollars per unit, this ROV will prevent unnecessary environmental damage if another accident occurs.

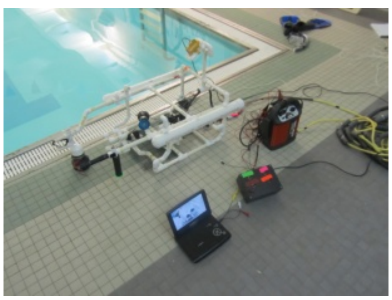
Table of Contents

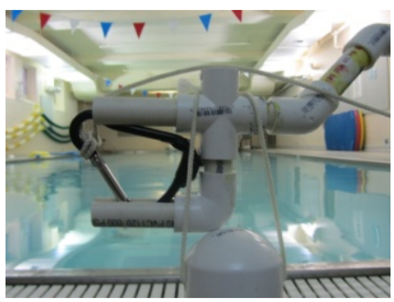
Photographs


Back View


Velchronic Hook Arm


Four-Pronged Valve Spinner


Side View


Carabineer U-Bolt Coupler


Camera Mount


Wellhead Cap

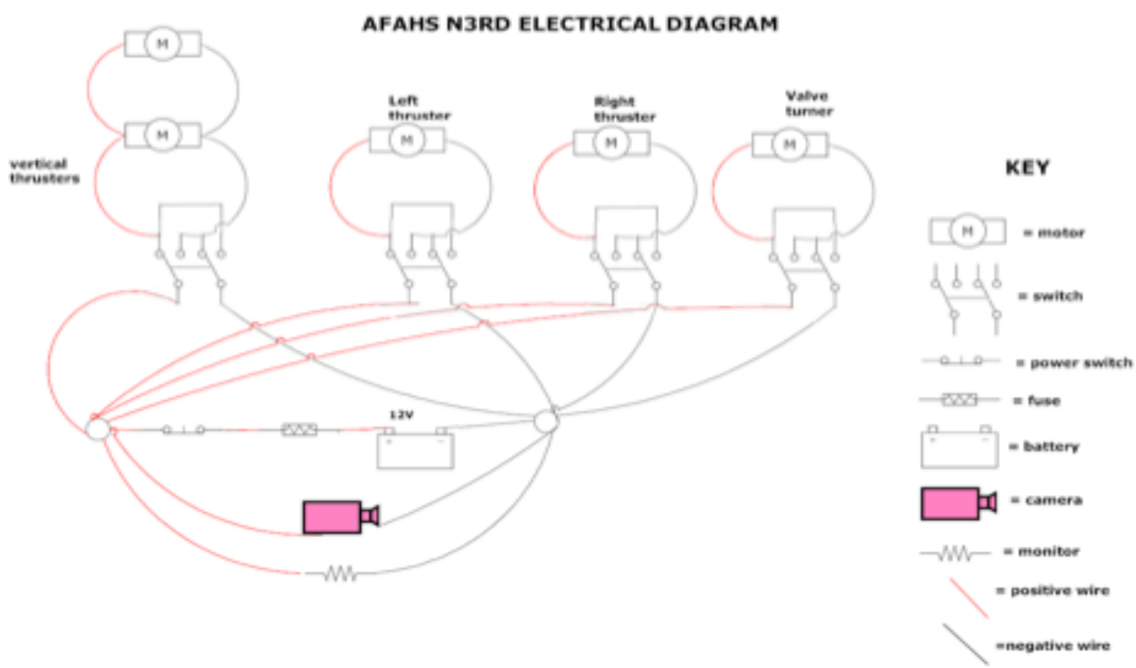

Syringe Arm


Motors

Budget

Item	Origin	Qty	Cost	Total Cost
Navroute Octopus 360 Degree Camera	Purchased	1	$250.00	$250.00
Navroute Tiburon Camera	Reused	1	$139.00	$139.00
Johnson 500gph motors	Purchased	3	$20.00	$60.00
Johnson 750gph motors	Purchased	2	$25.00	$50.00
Carabineer	Purchased	1	$8.00	$8.00
Wire Hanger	Free	1	$0.00	$0.00
PVC pipe (ft)	Purchased	44	$0.50	$22.00
Assorted PVC Joints	Purchased	N/A	N/A	$75.00
14 gauge wire (ft)	Reused	200	$0.30	$60.00
Chicken Wire (pack)	Purchased	1	$5.00	$5.00
Asst. Electrical Connectors & Switches	Purchased	N/A	N/A	$75.00
Misc. Expenses (tape,screws,etc.)	Purchased	N/A	N/A	$55.00
360gph Bilge pump	Purchased	1	$12.00	$12.00
Platypus bag	Free	1	$0.00	$0.00
Vinyl tubing (ft)	Purchased	2	$3.00	$6.00
Flex tubing (ft)	Purchased	1.5	$0.50	$0.75
Pyle 7" TFT Display	Purchased	2	$60.00	$120.00
Aluminum Attache Case	Purchased	1	$25.00	$25.00
Plexiglass Sheet (sq ft)	Purchased	4	$3.50	$14.00
Black & Decker Electromate	Purchased	1	$100.00	$100.00
TOTAL COST OF ROV				**$1076.75**

Electrical Schematic



Design Rationale

The following is a description of our ROV written by the team's leading technicians and engineers.

The Geek N3RD went through an evolution of modifications. The changes were needed in order for the ROV to be successful at completing mission tasks. The changes we have made include the frame structure and the special components that make up our ROV. There have been four different versions of the N3RD. In each of the design versions, we improved a component to work better than the last version of it. Some of the components we have changed in our ROV have made a great impact on the hydrodynamics, frame structure, and performance of the ROV.

<u>ROV Frame</u>

The original design of the ROV frame had a trapezoidal shape with a narrow square bottom and wide top. The most current version has a box shape making it more compact.

The compact design improves the hydrodynamics and prevents the ROV from tipping over in the water.

Four- Pronged Valve Spinner

The four-pronged spinner is used to turn the valve on the wellhead. We initially constructed a two-pronged spinner, but after testing it in a pool we learned that it was too long and it was difficult to line up to the valve. The current version of the spinner is a four-pronged arm. The outstanding design we came up with made our task easier to complete. Unlike the two-pronged spinner, the four-pronged spinner is shorter and has four prongs hence the name of the arm. Also, having a more compact spinner will result in using less of the motor's torque to turn the spinner, and leave more torque to turn the valve.

Carabineer U-Bolt Coupler

The carabineer is used to attach a rope to the u-bolt on the riser pipe. We designed a mount to hold the carabineer in place until it clips on to the u-bolt. Once the carabineer is hooked on to the u-bolt the ROV is reversed, and the carabineer detaches from the vehicle and stays hooked onto the u-bolt until pulled off by human force. The Carabineer Attachment consists of a carabineer held by two pieces of PVC and magnets. The Carabineer Attachment is located on front right side of the vehicle, which gives us a clear view of the carabineer from the camera mount.

Hydrodynamic Chicken Scoop

The scoop attachment is a design based on a plastic dustpan, which was initially used but when we attempted to move the ROV there was too much resistance, and it stopped it. We recreated the dustpan using chicken wire because it is full of holes, making it more hydrodynamic. We cut the front of the scoop to make it jagged because it would allow more grip in picking up items from the sea floor.

Camera Mount

The camera's position on both the first and second designs of our ROV was flawed. In both designs, the camera was too close to the other equipment on our ROV creating a view of what we were trying to see that was too narrow. So, to receive a better perspective of our components on the ROV we moved the mount to be located on at the back and above the ROV frame. The mount of the camera would allow us to view our equipment and not have it interfere with anything inside the ROV either.

Ballast Tanks

The ballast was designed to be capable of going into deep waters without having it's structure compressed. Our design of the ballast tanks would include two PVC caps glued to the ends of a 2" PVC pipe. The ballast is sealed with glue making it waterproof.

Description of Challenges

Being a first year robotics team, we were faced with many uncertainties. We had to challenge ourselves to master skills we did not have within our group. One of the greatest challenges that impacted our group was the fact that we were all unorganized. Although we may have legitimate reasons for being disorganized, our group could have strived to manage ourselves even better.

Still, our group has overcome our inner child foolishness. We are now able to work consistently. At the establishment of the robotics team, we were unable to accomplish important tasks in building the ROV. For example, some of our teammates decided that it would be fun to swing PVC pipes at each other. Events like this would result in a limited amount of work accomplished. We soon overcame the constant bickering with one another, and the frustrations of teammates horse-playing.

The end of our immaturity has not only allowed us to become young independent adults, but we finished building a ROV that we had initially thought would be incomplete. We are proud to have overcome the obstacles and challenges we faced together as a team.

Troubleshooting

Our team has made dramatic changes in improving the quality of our vehicle. We made the changes due to what we observed while testing our ROV at the local YMCA pool. Our team visited the YMCA pool on multiple occasions. There we simulated the mission tasks using props we built to spec according to the MATE ROV guidelines. Our advisors also got into the pool to record and relay back information about the ROV. Lastly, to improve ourselves, we timed the practices to see how fast we could complete the objectives.

One of the features that we have added to our current ROV is a chicken wire motor casing. The chicken wire prevents the carabineer line from getting caught in the propellers by having it wrapped around the motors on our ROV. Another feature we added was the off switch button in our control box to prevent accidental triggering of the motors, when the ROV is attached to the control box by the tether and powered. We also made changes to our scooper and the hook arm. The scooper, which is intended to scoop up living species failed to cooperate with the vehicle and in return it made the ROV stop completely.

Techniques that we used for safety were an emergency off switch we built for the control box just in case somebody is work on the ROV, and the wire is together, and we put a fuse in the control box.

Description of skills and lessons learned

We have all learned many different things during robotics. Some have learned basic engineering and design skills. Others have learned excellent administrative skills. These are all very great things, but one thing we all learned is how to work as a team to accomplish a common goal, an amazing skill to have in the future.

We have learned to all put together a robot using PVC pipes, glue, and some motors. This is not a very common skill. However, skills only get you so far. There are more important things in life that will get you further. Teamwork, dedication, discipline, and the ability to learn and adapt will get you further. We have all learned this, our work has displayed this, and we will use it to benefit our future. Without it we would not have even made it to where we are today.

Teamwork means learning how to work together in a job or society. Dedication means we do not give up when the going gets tough. Discipline means learning how to take orders, getting them done even if you rather be relaxing. The ability to learn and adapt is one of the most important skills to have. It is evolution. For example, we learned it was hard to see everything in the front of our ROV, so we learned, then we adapted by moving the camera. Also, being a first year robotics team we have learned to adapt in the way a robotics team should be and how competitions work.

Future Improvements

For future improvements we will start earlier than we originally did which will also give us more time to fix problems or improve things. At first, we were unclear of what to do, how to build the ROV, what to put on the ROV, put the necessary paperwork together, our ideas were scattered everywhere. In the future, to improve we will be more organized. Another future improvement will be to set the motors we placed on the ROV in the center as opposed to in the back where we have them. The ROV rose diagonally upward every time we moved forward because of the motors in the back. So, placing them in the center of the ROV should take care of this problem.

The syringe also jammed during competition, to fix this next time we will use a bilge pump that empties into a platypus bag to collect the water sample. We will also add a depth gauge so we could easily measure depth.

Reflection on Experience

"During robotics I have learned so many skills and lessons, most importantly to work as a team. I do not want it to end. There is always more to do after every victory, there is always something else to research or improve." –Mario Rios, Communications Officer

"I love learning new things that revolve around science. For example one of my classes in school is physics and all the things that I learn in class are interesting. But its just not enough for me, I need to learn more. I'm in the robotics club because it gives me a chance to have a future in robotics, science, or engineering." –Rashaad Dinning, CFO

"Our team's commitment and motivation to work with one another was a success! We have come so far from people who had doubted on us to people who look up to us greatly. I hope to inspire people who are interested in mathematics and science because our world will always be in need of engineers." –Grace Mei, Communications Officer

"Going to robotics after school is the best part of the day. Even though robotics sounds like all fun and games, it is not. It takes hard work and dedication to build a robot. I am glad that our robotics team is progressing so fast, and I wish for it to get even better." –Blake Kennedy, Engineer

"The robotics club at my school has influenced me in many ways. It has allowed me to learn how to work as a team and get a well job done." –Julian Martinez, Pilot

"A single goal can unite many people. Our goal is to win." – Christopher Odor, COO

Robotics Main Theme

An explosion in one of the pipes caused the Macondo to blowout at the Mobile Offshore Drilling Unit (MODU). The MODU was set ablaze following the explosion where on which the oil rig sank. However, oil still continued to spill out of the pipe causing hundreds of thousands of barrels of oil to be lost in the gulf.

To make matters worse, millions of sea and coastal animals were either killed or injured by the oil. This, in turn, caused local fishing industries and beach resorts to either shutdown or temporarily stop production. Fishing companies became concerned with the fact that if they were to bring in seafood, that had ingested the oil, their customers might become terribly sick and even possibly die. As a result, fishing industries had to temporarily shutdown or discontinue fishing in the Gulf area at least until the crisis was over.

Beach resorts had their share of problems too. Oil clumps began to appear on the shores making the beach and the water around it dangerous to residents' health. Many beaches had to shut down because it would have been dangerous for the wildlife and hazardous for people. Before any usage of the beaches could take place, massive cleanup and repair had to be done.

Many other industries had to stop production as well. People living along the coast became worried that the drinking water could possibly be contaminated. Fortunately, this did not happen, but the oil still continued to leak out of the damaged pipe.

In order to fix the damaged pipe, several attempts were made to contain the oil spill by utilizing ROVs. They were successful after numerous attempts. The team had blocked off the damaged pipe by first drilling two relief wells near the destroyed pipe in order to relive pressure from it. Once the issue was resolved: the damaged pipe went into what is called a static mode, which means less oil was escaping from the damaged pipe. Finally, the team trying to fix the pipe began to plug up the pipe by pumping cement into it, which permanently sealed the damaged well.

The ROVs were operated by human pilots. Some ROVs were actually robotic submarines that were tethered to ships by cables that provide power, give commands, and transmit data. The pilot used these ROVs' for observation and interventions. These robots were controlled by joysticks, much like ones video game systems utilize. Some ROVs are also employed like skilled laborers: via manipulators, other interchangeable tools, and specialized equipment.

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