Bridge of Don Academy

Young Engineers Club

Aberdeen

Scotland

MATE SubSea Challenge 2008

Contents

SG.CRRAMLAJ

This is the first year Bridge of Don Academy (BODA) have competed in such an event, and as such proved challenging for the whole team, who were initially clueless as to where we should start. However, there was one thing we were sure of, our ROV/team name.

Although it looks and sounds a little weird and often gets a lot of laughs, it does have a reason and a meaning. SG.CRRAMLAJ was decided because it is a combination of the original teams' names.

Stephen Nicklas
Graham Walker
Craig Bruce
Rory Macleod
Rhys Irvine
Alan Gibson
Mike Grant
Luke Sanderson
Aaron Booth
John Murray

As you'll notice above we said the original teams' names. This is because after going through the local heats to get to the competition Luke had to drop out because of the dates, and so his place was suitably filled with the only female, Dani Brands. This caused some discussion as to whether the team name should be rearranged – this was decided against.

Throughout the process of constructing the ROV we received mentoring from two teachers from the technical department within the school, David Nicol and particularly Stephen Nicklas.

Challenges

Obviously building our own ROV, especially for the first time did not come unaccompanied by its' own challenges. Throughout the process we came across multiple challenges which we have faced and dealt with in some way or another, be it a quick fix or not.

Before the heat in Aberdeen we had not had any opportunity to test our original model, because of this we had huge buoyancy issues. This came as no surprise to us, and so we had taken with us weights and buoyancy, ready to neutralise either way. From this all important first test we took away some all important information for our re-build. For example, on the first model we filled the entirety of the ROV with expanding foam, this was obviously did not allow us flexibility in changing the overall buoyancy.

Another main challenge faced was running the Port and Starboard motors at different speeds. Throughout the build process of CRRAMLAG Mk I this was a constant battle for electricians amongst us. We tried different techniques, all to varying success. Our main method was using potentiometer, however, we could not find one which would run our motors without burning our. We even sought advice from our very own in-school electrical engineer, no success followed.

After the heats, CRRAMLAJ Mk II was created; it is identical in almost every way, but uses the information we gathered at the heats, and is now in everyway more powerful. We have added two motors which we use for the ROV to 'crab', thus, solving the need to vary motor speeds. This was a much more simple process to complete.

Budget

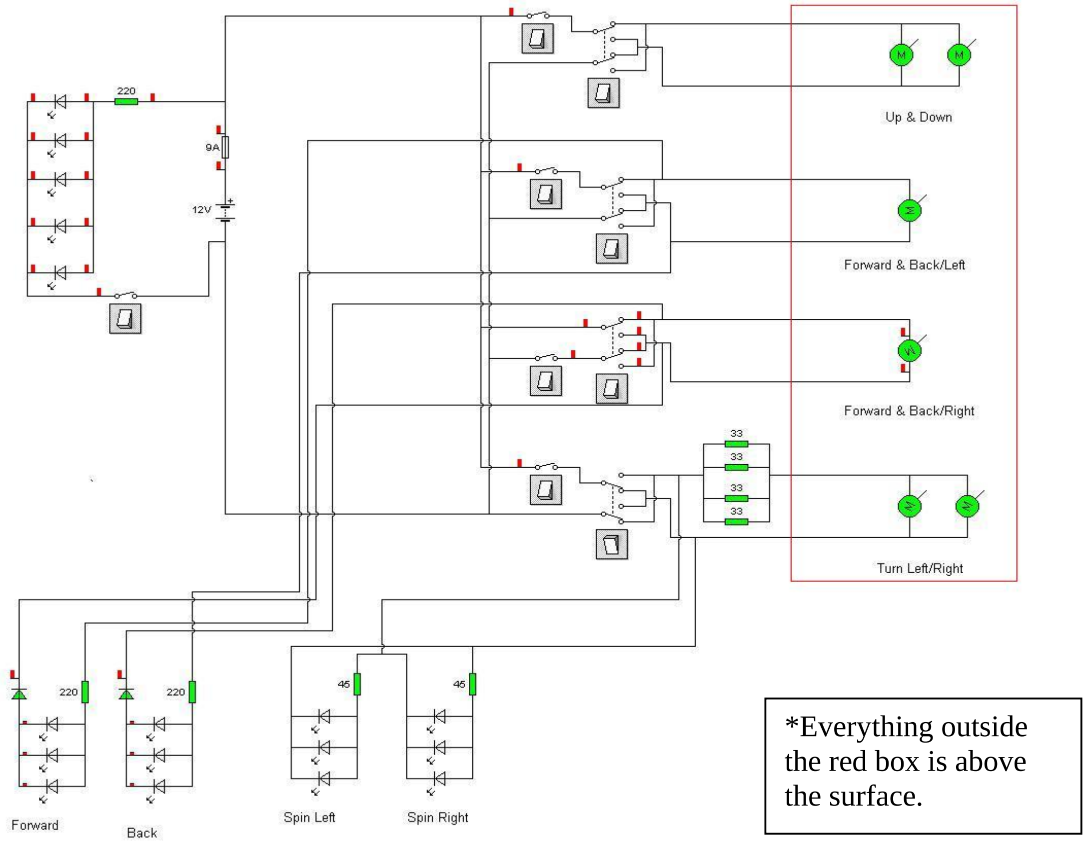
CRRAMLAJ Mk I

4x 1100GPH Rule Bilge Pumps	£80 – Buccaneer
4x Right-Turn Propellers	Donation – Buccaneer
2x Waste Pipe	£2 .96 – B&Q
10x 90º 'T'' Piece	£10 .80 – B&Q
6x 90º Bend	£5 .88 – B&Q
2x Silicon Sealant	£3 .98 - ASDA
2x 825mlExpanding Foam	£16 .96 – B&Q
2x 10m Pond Cable – 3 Core	£23 .96 – B&Q
1x Washing Line	£3 .27 – B&Q
1x 400m Waterproof Camera w/LED's	Donation – Bennex
1x Waterproof Camera Case/Lens	Donation - Buccaneer
1x Control Board	Donation - Bennex
1x Pond Net	£4 .99 – B&Q
1x Battery Powered Colour Monitor	Donation - Bennex
1x Electrical Tape	£1 .58 – B&Q
8x Lucozade Bottle	£8 - RGU Café

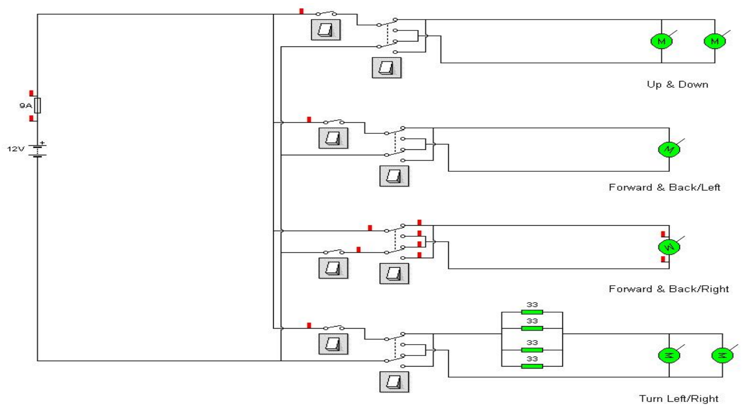
CRRAMLAJ Mk II

6x 1100GPH Rule Bilge Pumps	£120 - Buccaneer
6x Right Turn Propellers	Donation – Robert Gordon University
2x Waste Pipe	£2 .96 – B&Q
8x 90º 'T' Piece (re-used form Mk I)	£8 .64 – B&Q
8x 90º Bend	£7 .84 – B&Q
1x 30m Buoyant Cable – 14Core + Camera	Donation – Bennex
1x Washing Line	£3 .27 – B&Q
1x 400m Waterproof Camera w/LED's	Donation - Bennex
1x Thermocouple w/Display	Donation - Buccaneer
1x Dazzle	Donation - Bennex
1x Junction Box	Donation - Bennex
12x Jubilee Clips	£7 .08 – B&Q
2x Pipe Socket	£3 .98 – B&Q
2x Leave Guards	£3. 38 – B&Q
1x Laptop/Monitor	Borrowed – Team Member

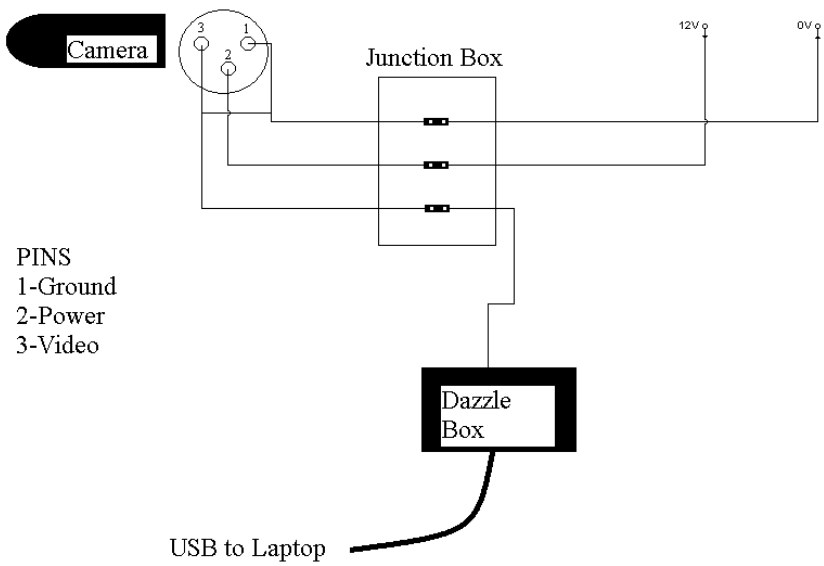
Electrical Schematic:



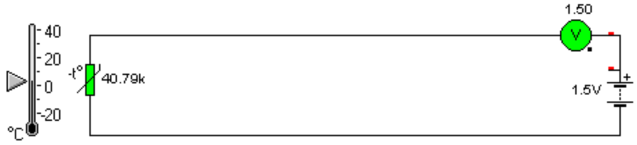
1. Wiring Diagram of motors & LED indicators



2. Wiring Diagram of motors



3. Camera wiring diagram



The voltmeter here is in place of the LCD display being used.

4. Temperature sensing system

Design Rationale:

Six 1100 gallon per hour motors are being used to move the REMOTELY OPERATED VEHICLE. Two are for forward and left/right movement, two are for up & down movement and the final two are for spinning clockwise/anti-clockwise. The forward motors have guards on them to prevent foreign debris from being caught up in the props. Also, the forward motors have been given three bladed props instead of the two on the other motors. This was done in an attempt to maximise the power coming from the motors but they have yet to be tested. The rest of the motors have been positioned so that they are facing inwards to prevent them from being damaged and have two bladed props.

The camera we will be using is a donated SST-1370 video camera with built in LED lighting. These cameras are designed to be used with DeepSea power control units. We, however, have opted to use a “Dazzle” video creator box instead. This will allow us to connect the camera to a laptop, as shown in figure3 above, and record the telemetry for easy playback. This in turn means that we can analyse the video and find ways to improve for our second turn.

The temperature sensor that has been used in the REMOTELY OPERATED VEHICLE is a commercially available system that has been modified and incorporated into the REMOTELY OPERATED VEHICLE. A pre-built system was decided upon to ensure that temperature readings will be as accurate as possible and easy to read. It has an independent power source, a 1.5v button cell, which will be on the surface in the display.

The LCD display that came with the temperature sensor will remain at the surface attached to the control box. Between the display and the thermistor, the wire has been removed and then the two components are to be reconnected through our waterproof umbilical cord giving the required length. The thermistor will be placed at the front of the REMOTELY OPERATED VEHICLE on an extended arm to measure the temperature.

To collect the crabs, our REMOTELY OPERATED VEHICLE will have basket/net in the centre and a small scoop at the front to gather them in to the net. This system was chosen above others because of its simplicity and is unlikely to go wrong or fail. For those crabs that are inaccessible to the scoop an ‘arm’ will be used to get them close enough to scoop up.

The same ‘arm’ system will also be used to collect samples from the black smoker. It will be used to poke off the samples and the scoop will then be able together them up.

Future Improvements and Lessons Learned

While building and designing our REMOTELY OPERATED VEHICLE we came across problems and implications as suspected. One of our main problems and an area we would definitely improve on in the future was timekeeping. We all knew our tasks and what we had to do to complete those tasks, the problem was getting the time and knowing when u were needed to do your part. The team as a whole had planned on doing getting the ideas and then the drawings done before we started building the REMOTELY OPERATED VEHICLE. The problem we found with this was if we designed a REMOTELY OPERATED VEHICLE we didn't have enough time to design test and make changes so to overcome this we did the draws to different parts that had been completed and put them all together at the end.

Due to this being our first time competing in the M.A.T.E REMOTELY OPERATED VEHICLE challenge we didn't know how easy or hard the REMOTELY OPERATED VEHICLE would be to control in the water. Unfortunately the team did not have a test facility and also lack of time to do testing meant that we had to make sure the REMOTELY OPERATED VEHICLE was evenly balanced and had enough buoyancy that was easy to add more on or take parts off. Before going to San Diego we are planning on testing the REMOTELY OPERATED VEHICLE's stability, and its control, we are fortunate enough to given the use of a swimming poll and Robert Gordon's Sports centre. During our testing we will also be practicing the piloting of the REMOTELY OPERATED VEHICLE, tether management and last adjustments.

The actual controls for the REMOTELY OPERATED VEHICLE were a problem for the team we wanted maximum control and with this variable speed for certain motors. The circuit for the switches going to the motors was basic but the voltage going through the potentiometers kept burning them out and short-circuiting the whole control box. For the regional heat we decided to take the potentiometers out and use the switches independently. Our final

REMOTELY OPERATED VEHICLE that will be competing in San Diego has a different circuit layout that is easier to use.

From the beginning of the project one main issue was our funds and where to get funds from, we received a lot of items from Bennex that they seen as scarp but were a big help to the team and meant we could spend the little funds that we did have on items that we expensive but vitally needed such as motors. In the future we would plan on finding more funds from local oil companies or do some of our own fund raising.

Next time participating in the competition we would design the REMOTELY OPERATED VEHICLE so that it was easily transportable. Also we would make all components easily removable for changing or making repairs. We planned on designing brackets for the motors that would enable us to slip motors on and off in case there was a failure or a repair was needed.

Reflections:

The whole team has gained lots of different personal accomplishments from participating in the competition. As the whole team has gotten to know each person individually and have grown a firm friendship with one another.

As a team we have grown incredibly well as we will give help to one another, set tasks and challenges for each group to contend and accomplish by themselves. Most of us have learnt new things and gained many new skills that we didn't think we had or could gain from this experience. It has also opened our eyes to how big the industry is and how involved other countries are in this industry.

From the competition heats we also gained good ideas from other participants on how we could improve or evolve onto our REMOTELY OPERATED VEHICLE design. We have redesigned the original design to gain an idea on how to help us do the challenges quickly and more effectively. As we learnt from the heats we have to learn and test the REMOTELY OPERATED VEHICLE to get better control and to do the tasks.

The heats also opened our eyes to how hard the challenges are going to be and how much we will have to practise and learn control of the REMOTELY OPERATED VEHICLE and what would be the best way of completing the challenges quickly and effectively. With this in mind we added another two 1100gph to give more stability in turning and giving us better movement to view the surrounding area making it easier to get the challenges completed.

The team's point of view of the heats was that we did well but we will need to do better and improve the way everything was worked out, so we have to do bigger and more accurate calculations of buoyancy, weight contribution and voltage distribution.

So we will have to put in extra hours in practising and perfecting our original design. The whole team is very optimistic in complete all the tasks within the time limit with more to spare. We are hoping we will be able to be a good competitor for the rest opposition in the main competition in San Diego.

Whilst creating the REMOTELY OPERATED VEHICLE it was decided to also create it in a 3D model on the computer with software known as AutoDesk Inventor 2007 and AutoCAD Mechanical 2007. This was decided so that the REMOTELY OPERATED VEHICLE could be seen and viewed from all angles without it having to actually be made. It also meant that alterations and changes could be made to the REMOTELY OPERATED VEHICLE and the final result could be seen without any changes having to be made to the actual REMOTELY OPERATED VEHICLE. This meant that we could see the advantages and disadvantages to the changes without it permanently affecting the REMOTELY OPERATED VEHICLE. As the worst case scenario would be that a change would be made to the actual REMOTELY OPERATED VEHICLE that didn’t work and it would be irreparable after that.

To create the frame for the REMOTELY OPERATED VEHICLE in the software, each component had to be individually created. To create the component, each part had to be measured and noted down. Once all the measurements were taken, it could then start being made on the computer. The middle joints of the frame where the first components to be created. To create this, a long cylinder with the correct measurements was created. Then another cylinder with the same measurements was created parallel to the first cylinder and they were intersected together. They were then modified and hollowed so that the final result was a joint. This was then saved and closed. Another file was then opened and another component was created inside this. This component was the outer joints of the frame and was created in the exact same way as the other joint except this joint was a corner joint. Then another file was created for all the tubes that joined the joints together and made up the rest of the REMOTELY OPERATED VEHICLE.

Once all these components were created in separate files, they then had to be assembled together. To do this, a new assembly file had to be made. All the components where then opened up and the right amount of each component was imported into the new assembly file. They then had to all be constrained together. This took along time to achieve as some components didn't constrain exactly the correct way. To overcome this a quarter of the REMOTELY OPERATED VEHICLE frame was created and then mirrored horizontally then vertically. This meant that every component was constrained correctly however mirroring the components used up a lot of memory.

Once the overall frame was created and constrained together, it then had to be rendered. To do this, a material called Black Casting was attached to each of the components. The lighting style called Cool Lighting was also attached to the REMOTELY OPERATED VEHICLE. The frame was then rendered. This gave a great effect and made the REMOTELY OPERATED VEHICLE look very realistic.

After the frame was completed, the motors had to be created alongside it. The motors were created straight within the assembly file instead of being made separately and imported in as this was the easiest way to create and save it. To create the motors, two cylinders were created with different dimensions and unioned together. These were then attached with a material called Bright Red. This was the easiest part as the next part was adding the propellers in. This was rather difficult as it had to be coiled and curved at the same time. To do this, a starting sketch had to be made in the 2D shape of propeller. Once this was done, it was then coiled. It then had to be cut so that it resembled a propeller. This was then also given the material of Black Casting so that it matched the frame.

Once all these parts were created and saved, the motor had to be attached to the REMOTELY OPERATED VEHICLE with the help of the jubilee clips. The jubilee clips were rather difficult to create. To make them however it started off as a simple sketch and extruded to the correct dimensions. However, the difficult part was getting the indents on the jubilee clip. To get these, the tool called circular pattern was used and cut into the jubilee clip. This took a long time to do and was a rather difficult effect to create. However the overall look came out great and really helped the clip to look realistic. The material called Aluminium was attached to the clips so as to give them the complete look. After all the components where together, the REMOTELY OPERATED VEHICLE was fully rendered and printed to an A3 page.

Now that the 3D model was made and created, it was decided that the REMOTELY OPERATED VEHICLE would benefit from having blueprints printed from it. This was decided so that everyone could see the dimensions of the REMOTELY OPERATED VEHICLE and how it was built. To create these drawings, all the drawings and the 3D model that was created in AutoDesk Inventor 2007 was moved to AutoCAD Mechanical 2007 where the drawings came in as 2D sketches. These were then dimensioned so that it was clearly visible how the components fitted together and the rough size of the REMOTELY OPERATED VEHICLE.

All of these print offs, including the rendered images of the REMOTELY OPERATED VEHICLE, the dimensioned 2D images and non-rendered isometric views of the REMOTELY OPERATED VEHICLE where then used in the final poster.

TEAMWORK:

Throughout this experience of the competition, a lot of teamwork has been done so as to achieve the final result – a finished, fully working REMOTELY OPERATED VEHICLE. As the tasks at hand where so big, each member of the team had to contribute so that the REMOTELY OPERATED VEHICLE would be finished in time and so that there wasn't one person doing all the work.

It was each member's responsibility to complete the task they were given within the deadline otherwise the next person couldn't do their task and the work on the REMOTELY OPERATED VEHICLE would fall behind. However, the team joined together and helped with each others tasks so that it could be completed in time.

Teamwork contributed not only in the creating of the REMOTELY OPERATED VEHICLE but in the controlling of the REMOTELY OPERATED VEHICLE itself when it was working. As the whole team has to contribute to getting the REMOTELY OPERATED VEHICLE to do the right things, either by driving it or feeding it umbilical.

REMOTELY OPERATED VEHICLE exploration in North East Scotland

Historical aspects of REMOTELY OPERATED VEHICLES

Aberdeen is a thriving, cosmopolitan port in the North-east of Scotland and the country's third largest city after Glasgow and Edinburgh. Aberdeen is fuelled by the oil industry. It was the coming of offshore oil that bestowed the title of "Oil Capital of Europe" upon the city and led to the latest boom in the city's fortunes starting in the 1970s. It is because of this that REMOTELY OPERATED VEHICLES have had such an important roll in North East Scotland. REMOTELY OPERATED VEHICLES have been used in North East since commercial firms developed them from the military.

People don't know who actually invented REMOTELY OPERATED VEHICLE but there are two who deserve credit for it. The Programmed Underwater Vehicle was a torpedo developed by Luppis-Whitehead Automobile in Austria in 1864, but, the first tethered REMOTELY OPERATED VEHICLE, named POODLE, was developed by Dimitri Rebikoff in 1953. From this developments were done by the United states navy. The next step in advancing the technology was performed by commercial firms that saw the future in REMOTELY OPERATED VEHICLE support of offshore oil operations. The transition from military use to the commercial world was rather rapid. Once at the work site, the operators were happy if they got the vehicle back, and were really happy if they got more than 4 hours of productive time per 24-hour day. But now they can be left in the water 24/7 as long as it has a supply of electricity.

First type of commonly used REMOTELY OPERATED VEHICLE was an "Eye Ball" REMOTELY OPERATED VEHICLE. At this time it could not manage any tasks like repairing pipes but it could still inspect them and feed back information to the surface. This has greatly changed with the improvement of technology. Now you get many classes of REMOTELY OPERATED VEHICLES that can do many different jobs.

Cultural and Social aspects of REMOTELY OPERATED VEHICLE

Offshore drilling is changing as there are deeper waters that need to be explored that are in even more remote locations. The further we go into the sea the more harsh environments that are found. All of which could be very dangerous and expensive if you used a team of divers to do this. REMOTELY OPERATED VEHICLES can perform underwater inspections without exposing humans to these dangerous situations. Trying to locate a fault or breakage in equipment hundreds of feet below the surface can be very time consuming with a conventional diving team. This is another advantage of using a REMOTELY OPERATED VEHICLE. REMOTELY OPERATED VEHICLES are now widely used because of how practical they are. You can easily be sitting on the Oilrig with a computer checking the supports and pipes thousands of feet below you without any hassle.

REMOTELY OPERATED VEHICLES can vary in size from small vehicles fitted with one TV camera, up to complex work systems that can have several dexterous manipulators, video cameras, mechanical tools and other equipment. They are generally free flying, but some are bottom-founded on tracks. Towed bodies, such as those used to deploy side scan sonar, are not considered REMOTELY OPERATED VEHICLES. Lifting and rock dumping devices employing thrusters for lateral motion only are also not normally included in listings of REMOTELY OPERATED VEHICLE systems.

The main purpose of a REMOTELY OPERATED VEHICLE is exploration but it not the only operation it has. There are many different types of REMOTELY OPERATED VEHICLE to do different jobs. There are High Capability Electric REMOTELY OPERATED VEHICLESs that can go down to a depth of 20000 ft and manage many small tasks. You also get work class vehicles that carries seven function rate manipulator and a five function grabber and can carry up to 1000lbs. Typical tasks for this class are drilling support, light construction support, pipeline inspection and general "call out" work. The Heavy work class REMOTELY OPERATED VEHICLE can go down to a depth of 10000ft . With new requirements to perform sub-sea operations on deepwater installations and to carry very large diver-less intervention systems, this class of REMOTELY OPERATED VEHICLE is becoming increasingly large, powerful and capable of carrying and lifting large loads. Easily managing tasks that divers could not. REMOTELY OPERATED VEHICLES are not cheap and or normally hired instead of bought by companies. There is about 435 work and heavy work class REMOTELY OPERATED VEHICLES costing about $1.5 billion. If they were not worth it so much money would not be put in to buying them. Improvements are always getting made so that they can go deeper and manage more difficult tasks.

The REMOTELY OPERATED VEHICLE has massively changed offshore drilling and has probably saved many lives of divers that could have died doing the same operations and tasks. North East Scotland needs this to keep on top and to keep there name of “Oil Capital of Europe”.