Project Name: SARRRO (Search & Rescue Reconnaissance Rover)

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Project Solutions

To meet the customers' requirements, the following solutions have been considered:

1) Buying an existing design which meets the customer requirements and is within the customers' budget.

2) Use an existing and similar project created in past HND graded unit projects and then modifying as required.

3) Use off-the-shelf components and products to build the project to the customers' specifications, using readymade circuits and hardware where possible.

4) A combined solution of Solution 3, and making use of hardware available within the college and from the customer, as well as acquiring sample (cost free) components where possible and using hardware already owned by me.

Solution 1

Solution 1 is to buy a pre-existing design that meets the customers' requirements. In the field of robotics, there is a vast array purchasing options ranging from toys through to advanced robotic systems.
The customer specifications mean that any pre-existing robotic design will have to meet the following requirements:

- Programmable hardware (Microcontroller, PLD..)
- Autonomous Operation
- Wireless connectivity – Bluetooth Ver 4.0. (With option to operate robot from Bluetooth enabled laptop)
- Ultrasonic Sensors for Navigation (minimum of one front mounted)
- 7.2V 3000mAh Battery
- Atmosphere sensors: Temperature, humidity etc...
- Minimum physical size of approx. 300mm X 300mm X 300mm.
- Four Wheels and two 5-10V motors to drive them.

While purchasing a robotic system equipped with all the above features will most likely prove to be too expensive, it will give me an idea of what the competitor products are like, how much they cost, and what their capabilities are. Below are some of the options that have been looked at.

From - www.robotshop.com
Dr. Robot Jaguar 4x4 Mobile Platform - Product code : RB-Drr-24 €7064.92

• Designed for indoor and outdoor operation requiring higher ground clearance and faster manoeuvrability
• Managing max 155mm (6") vertical step (obstacle)
• All 802.11G (optional 802.11N) wirelessly connected
• Light weight (< 20Kg) with excellent payload capacity
• Autonomous navigation with outdoor GPS and 9 DOF IMU
• Climbing up low rise stairs (up to 110mm step)
• Speed: 0 – 15Km/hr
The integrated high resolution video/audio and laser scanner (optional) provide remote operator detail information of the surrounding. Besides the ready to use control and navigation software, a full development kit including SDK, data protocol and sample codes, is also available.

The above robot comes close to meeting the customer requirements. While it boasts impressive features, it doesn't exactly meet the customers' requirements.

www.robotshop.com has a varied inventory of robots and development kits. Most are, as in the example above, beyond the customers' budget requirements and there are none present that fully match the customers' specifications.

They also sell mobile platforms. These can be built onto to create a custom designed robot. An example of these platforms is listed below.

Dagu Mr. Basic Mobile Robotic Platform Product code : RB-Dag-07 €26.90

The mobile platform is ideal for mounting custom built hardware without having to build a mobile unit from scratch. This is one of the more basic mobile platforms and one of the cheapest in terms of price. Prices for mobile platforms can reach €250+
It's clear that obtaining a pre built robot that meets the customers' requirements will prove difficult to find and will most likely vastly exceed the customers maximum budget.

Obtaining a mobile platform however may be desirable. It would account for a significant proportion of the budget, but would save a lot of development time and allow me to focus on designing and building the programmable hardware and sensors. I've therefore decided to incorporate this into solution 3. See below.

Other resources investigated for Solution 1 include:
http://www.active-robots.com/
http://robosavvy.com/site/
http://www.lynxmotion.com/
http://www.robotsdirect.co.uk/

All of the above sites specialise in robots and robot kits as well as robot components. As is the case with robotshop.com, all these sites sell robots that are out with the customer budget, and/or do not meet the customer requirements. They may however, prove to be useful for acquiring components and hardware.

Solution 2

Solution 2 makes use of previous HND Graded Unit projects. This may draw upon various projects from previous years to identify prospective circuits and designs. The starting point for this solution will be to find projects, similar in nature, and to then analyse the project.

The following projects will be analysed:

+ Line Following Robot from 2011/12 Class

I may also be able to draw upon individual projects that use similar sub systems that are going to be used in my project. This would be particularly useful for saving development time.

The following projects will be analysed:

+ Ultrasonic Rangefinder from 2011/12 Class

While there are a couple of projects which I can examine for purposes of research, it will be more likely that I will use these previous HND projects merely as a starting point for my project. They may be able to provide useful information towards avoiding potential hardware / software technical issues.

Solution 3

Solution 3 is one of the more flexible solutions. While I will aim to build upon existing designs as much as possible, the tight budget means that I will find very little in the market place that will come in under budget in terms of pre-existing robotic solutions.
The principle behind this solution will be to use a remote control car or mobile platform as the starting point. It will provide a blank canvas around which the robots' sub systems can be mounted on to.

Where possible, and depending on cost, sub-systems such as the ultrasonic sensor array will be bought as a module rather than built from scratch.
This solution will be more cost effective than solution 1 as it will use off-the-shelf components and in-house circuit design/adaptation, but will take longer to deliver.

The pros for this solution include:

- Complete control over robot design
- Able to meet the customers' requirements
- More cost effective
- Can utilise past HND projects' designs
- Can use readily available hardware.

The cons are:

- Will take longer to complete
- May require more in-house/custom design
- Higher chance for hardware / software problems

Potential Components I have researched for use in this project:
+ Dagu Mr. Basic Mobile Robotic Platform
+ Ultrasonic Sensor Module

Figure 1 - Mobile Platform

Figure 2 - Ultrasonic Sensor

Solution 4

This is an extension of solution 3. With this solution, I'm aiming to reduce the cost of production even further by utilizing not just off-the-shelf components, but also free-of-cost components. The City of Glasgow College is stocked with basic electronic components, development boards and basic PCB manufacturing equipment. I also maintain a stock of basic electronic components which can be used for this project, further reducing the need for purchasing components.

I will also attempt to source free-of-cost (Samples) components where possible. www.microchip.com provides such a service and may be possible to acquire components as samples which will further reduce the cost. The customer has stated they will provide the hardware for the wireless requirement which again, reduces overall cost.

The starting point will again be a remote control car or mobile platform as it provides a readymade chassis and starting point for designing the robot. It can be adapted and modified to suit the project requirements. Cheap remote control cars can be easily acquired and their parts such as wheels, motors etc (if suitable) can be reused and applied to my project.

The pros for this solution include:

- Complete control over robot design
- Able to meet the customers' requirements
- Even More cost effective (Compared to solution 3)
- Can utilise past HND projects' designs
- Can use readily available hardware

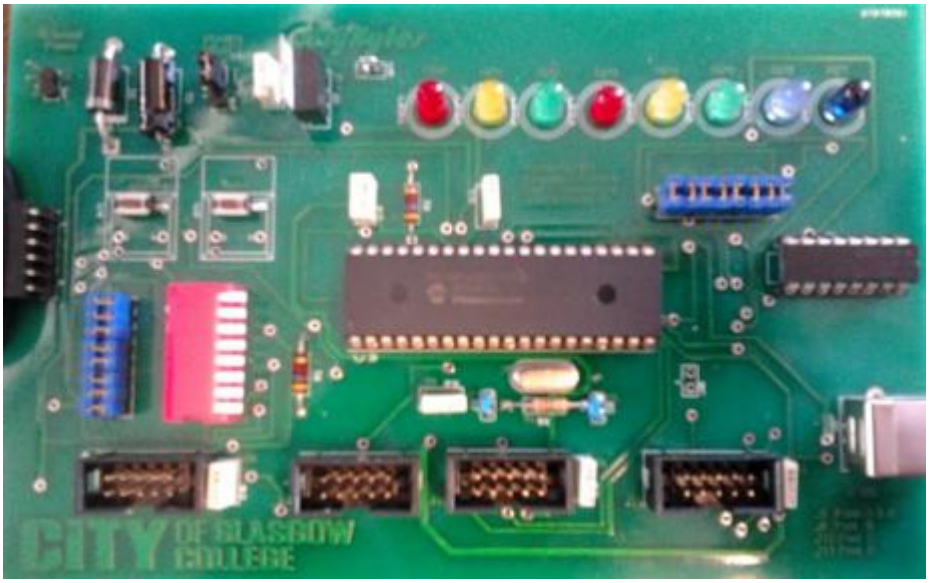

Figure 3 - City Bytes MCU development board

The cons are:

- Will take longer to complete
- Will require more in-house/custom design
- Higher chance for hardware / software problems

Each solution will be graded against each other in a matrix to identify which solution is the most economic and cost effective, and best meets the customers' requirements.

The next section of this document will examine all of the above proposed solutions in a grading matrix. This will help me identify which solution I will employ during this project.

Solution Grading Matrix

Criteria	Solution 1	Solution 2	Solution 3	Solution 4
Autonomous operation	5	8	10	10
Bluetooth Ver 4.0	5	0	10	10
Controllable via Bluetooth	5	0	10	10
4 Wheels + 2 DC Motors	5	8	10	10
Overall Size	5	8	10	10
Programmable Hardware	5	8	10	10
Battery Specs	5	5	10	10
Ultrasonic Sensors for Anti-Collision	5	10	10	10
Atmosphere Sensors Temp, Humidity, Co2 etc...	5	0	10	10
Availability	5	8	8	10
Cost Effectiveness	0	5	6	8
Expected Time Requirements	10	8	8	6
Score	**60**	**68**	**112**	**114**

Justification

Solution 1:

This would have saved a huge amount of time which is why it scored 10 out of 10 here; however, existing robotic designs available on the internet vastly exceed the maximum budget which rules this option out altogether. It therefore scored 0 out of 10.

I only scored it 5 out of 10 across all the remaining matrix criteria. This is because while there is a huge array of robotic designs available, finding one the exactly matches the customer requirements will prove to be very difficult.

Solution 2:

There have been similar projects to this one in past HND graded units. A previous project of similarity could potentially have saved some design process time and allowed me a head start which is why it scored 8 here. It would also have been possible to meet the budget requirements with this option as I would still be required to build my project from the ground up and to the customers' budget.

There are previous HND projects which may be related to some of the sub-systems in my project and so may be of some use during development. This is why, across the matrix criteria, it scores variably. Nearly all the robot sub systems have been attempted as past individual

projects which would again, save development and design time by allowing me to, potentially, adapt and implement previous project designs.

As this is a graded unit project, I can't simply copy someone else's work. However, by analysing past projects, I can draw inspiration from others' work. So while not a viable solution, I can look to past projects for guidance during development and for avoiding potential hardware / software problems.

Solution 3 & Solution 4:

Solution 3 came close to being the winner, however was piped by solution 4, while very similar, it was important to make a clear distinction between a solution making use of cost free components and one that does not. In that regard, solution 4 emerged as the most viable option, for the reasons outlined in the solution description above.

Both solutions graded 10 across the majority of the matrix criteria for the fact that they both give me total control over the design and development of the robot, allowing me to fulfil the customers' requirements. Solution 4 scored slightly higher on cost effectiveness as it makes use of hardware that is already available as well as off the shelf components. It scored slightly less on Time requirements however as it will require more design time.

Having considered the solutions and graded each one, solution 4 presents the best option both in terms of economics and customer requirements. It is the most flexible, readily available in terms of components, and can be accomplished without exceeding the customers' budget.
It is likely that I will draw on both Solution 3 and 4 when developing this project.
Some features will be need to be developed from scratch while it will be more economical in terms of development time and cost to buy off the shelf components. The research into past HND projects may also be of benefit during development.

There are also a couple of projects that I can use to advance the development of this project. For instance, the Line Following Robot I examined contained similar features such as motors, power sources and I/O while the Ultrasonic Range Finder uses the same principles for sensing distance that this project uses.
Obviously, I cannot simply copy past work, but these projects can provide useful information about potential hardware and or software problems that I would then be able to take into consideration when developing SARRRO.

In summary, I will be utilising Solution 4 as much as possible to meet the customers ' budget requirements while at the same time I will be drawing inspiration from past HND projects. I will also attempt to use Solution 3 to strike a balance between cost and development time.