e-Yantra Robotics Competition 2016

Theme and Implementation Analysis

<MT_1020>

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Theme assigned	**Model a Terrain**
Date	

Scope _ (5)

Q1. State the scope of the theme assigned to you.

The theme of the project is concerned with modelling a terrain. Modelling actual terrains can be a daunting and complicated task. Hence, we are required to model a highly abstracted terrain. The abstraction of the terrain is done as per the rules given in the theme booklet. Stating briefly about the abstraction, our terrain is a 5X5 grid. Within the 25 cells, we have objects to be detected. And there are 'shapes' on the paths which the firebird traverses. These nature of these paths should be identified as well. By traversing the terrain, we have to detect the type of objects and the obstacles in the path. It will find application in modeling an unknown terrain which is inaccessible or has harsh environmental conditions to humans to perform geographical surveys.

Building Modules_ (5)

Q2. Identify the major components required for designing the robotic system for the solution of the theme assigned to you.

Electronic Systems

*IR Sensors - We will require the use of the IR Sensors on board the Firebird V and the sharp IR sensors on it which will aid us in detecting the various objects and obstacles in the path of the Firebird V.

*Colour Sensors - The colour sensors are used in detecting the colour on the side of the objects which will help us in detecting the type of object.

*White line sensors - The white line sensor is used to detect the path along which the firebird is moving. The firebird also detects the kind of shapes by detecting the kind of patch underneath it.It will also help detect nodes and half nodes.

*Zigbee module - This low-power communication module is used to transfer the data from either firebird to the laptop or the other way round(although, we shall use it to communicate information in only one direction)

*GY87 sensor- The orientation of the robot can be determined using the GY87 sensor. This will be useful while detecting the positions of objects when the bot is on a shape.

Mechanical Systems

*Servo Motor- We will be using the servo motor for two purposes

i>To rotate the colour sensor about the object and hence detect the colour of the object.

ii>To lift the colour sensor and servo system to avoid collision with obstacles

*DC Motors- The 60 rpm DC motors are used to move the robot from one place to another.

Actuators (25)

Q3. List all the actuators present on Firebird V Robot. Besides the existing actuators, please mention any additional actuators that may be required for designing the Robot system in your theme.

(5)

Actuators on board the Firebird V

*The 2 geared motors present on the Firebird V make the robot move.

*The buzzer on the Firebird V will signal when it has finished scanning the entire terrain.

Actuators that have to be added externally

*Servo Motors- We will be using the servo motor for two purposes

i>To rotate the colour sensor about the object and hence detect the colour of the object.

ii>To move the rack and pinion onto which, the colour sensor and servo system to avoid collision with obstacles

*DC Motors- The 60 rpm DC motors are used to move the robot from one place to another.

Q4. Explain the design and working of the mechanisms and how they are mounted on the Robots.

(20)

The maximum range of the colour sensor is 4cms. This means that the robot cannot decide the type of object it is sensing when it is on the path. But, according to the rules, the robot is not allowed to move out of the path. Hence, there must exist a mechanism that moves the colour sensor closer to the object when it senses the presence of the object within the indicator. The only actuator we can make use of for this purpose is the servo motor. A rack and pinion mechanism is placed on the firebird which is made to move forward and backwards with the servo. This

servo is also mounted on the firebird. At the other end of the rack, another servo capable of rotating 360 degrees is positioned. This servo is used to rotate the colour sensor about the object as illustrated.
<Illustration 1: The entire picture goes here.>
We shall be using a 360 degree servo motor as it will help us get the colour of all four sides of the object with ease. The need to introduce a servo motor that moves the colour sensor forwards and backwards arises because of the possibility of collision of the rack and pinion with the obstacles that may be placed. The possibility of the 6cmx6cmx6cm object being placed anywhere within the 10cmx10cm indicator could create problems. The extent of the problem is minimised using the rack and pinion gear system.

The end of the pinion will have the colour sensor attached to a shaft coming out of it. This shaft should be able to support the colour sensor. The shaft rotates 360 degrees because of the servo motor attached at the end of the rigid connector as shown in the illustration. Hence, without having the firebird move around, we can read the colour on any side of the object. This reduces code complexity and most importantly saves time.
<Illustration 2: Details: The figure can illustrate the moving up and down of the colour sensor end of the stick. Two possible designs can be made for this. One for Anusha's belt drive idea/Amith's gear idea. And the other in the case where a servo is on the end of the stick.>

COMMENTS: ANSWER TO BE FINALISED. ILLUSTRATIONS TO BE INCLUDED. Besides, the motor seems to be very big. We must discuss how we will be mounting our mechanism on the firebird.

Environment Sensing (10)

Q5. List the various sensors you will need for the Robot to complete the task. Also describe the placement of these sensors on the Robot and briefly explain the reason for their placement. (10)

The sharp IR sensor which is on the firebird will be used to detect the obstacles on the path ahead. Another sharp IR sensor can be interfaced with the microcontroller to detect objects in the direction perpendicular to the movement of the robot. This sharp IR sensor will be used to detect the objects and obstacles in the cells and paths in the direction perpendicular to the movement of the robot.
Placement of sensor: The sensor is placed on the right side of the robot, below the base, by the wheels. We need it to sense the object even when the firebird is on the top of a shape.

The colour sensor will be mounted on the firebird and it can be moved up and down using a servo. Also, the colour sensor will be rotated around an object upon confirmation of its presence. In order to increase the efficiency of the robot, the colour sensor is not fixed. It is capable of moving towards the object and also rotating about it. Hence, the colour of the object is detected as soon as the object itself is detected. This saves time since the firebird itself will not have to go around the object.

The White line sensors are used to keep the firebird on the path it is programmed to take. This sensor will be very useful for shape detection as each shape has different patches with different kinds of lines on it. Traversing the curved path without this sensor would be a very hard task. There are three white line sensors located on the firebird which will help in the detection of nodes and half nodes.

The GY87 gyroscope, is essential to detect the orientation of the object with respect to the vertical direction. Hence when the firebird is on the highest point of the shape, the colour of the object present in the adjacent cell can be detected. When the firebird has climbed onto a shape and is trying to find the colour of the object beside it, it will be required to lower the colour sensor to a point much below than otherwise.

Communication (10)

Q6. Describe the exchange of information you plan to establish between the Robot and the Blender software for theme implementation. (10)

The location of the objects and obstacles will be stored in the internal memory of the firebird V and will also be transmitted to the laptop with which the zigbee is connected. The communication will be unidirectional, i.e., only the firebird will send any information to the blender interface.

STEP 1: REPRESENTING THE TERRAIN AND ENCODING THE INFORMATION: On powering the robot, it will assign certain values to represent every grid line and cell (grid line/cell will be generally referred to as "element" in this answer) uniquely. Information (namely, whether the grid line has an obstacle/shape, kind of shape, whether or not a cell has an object, kind of object) about each of these uniquely identified elements will be tied to it using appropriate data structures provided by the language. The information related to the elements will be encoded to occupy as little space as possible and for faster information transfer.

STEP 2: TRANSMISSION: When all the information fields associated with a certain element is obtained by the firebird and is updated on it's memory, the information related to the element is also transmitted by the firebird through the zigbee communication module to the laptop. The C language code will write the information using the appropriate communication protocol(UART) onto the pins to which the zigbee module is connected.

STEP 3: RECEPTION: The zigbee module connected to the laptop will receive the information transmitted by the firebird.We will use the serial module in Python to receive the the information stored in the firebird. The information that is received is used to spawn the objects in BGE.

STEP 4: BUILDING THE MODEL: The blender program places the right kind of objects/shapes/obstacles in the right places and models the terrain on decoding the information sent by the firebird.

Testing your knowledge (related to rule-book and sensors) (20)

Q7. What is the role of Blender? How is the information transmitted by the Robot used by Blender? (5)

Blender is a 3D animation tool. The role of blender in implementing the theme is that it models the objects, shapes and obstacles that will be present on our terrain by receiving the information sent through zigbee by the firebird. When the information (namely: unique path/cell identifier, object/shape/obstacle, kind of object/shape) of the object/shape/obstacle are determined, it is sent to the laptop through the zigbee communication modules. The Blender python script will import the serial module and obtain the information transmitted by the firebird and model the terrain.

Q8. Explain what sensors will be used when the Robot has to identify an Object in an adjacent Cell while traversing through a Shape? (5)

The gyro sensor as well as the colour sensor would be required here. The gyro sensor will be used to detect the z-axis reading of the firebird. Hence when the firebird is on the highest point of the shape the colour of the object can be detected. The rack and pinion system handles moving of the colour sensor to the right two dimensional coordinates. The height difference of the object the level of the rack and pinion is compensated by another separate shaft that holds the colour sensor at a lower level than the rack and pinion system. The colour of the

object can hence be determined accurately.
COMMENTS: We may have to draw another image for this answer.

Q9. What is the principle of operation for: (i) the color sensor and (ii) GY 87 Sensor? Why do you need both the sensors to implement this theme? (5)

COLOUR SENSOR: The principle of operation of the colour sensor is as described: There are light sensitive photodiode arrays placed on the colour sensor. In this array of photodiodes, some are sensitive to red light, some to blue, some others to green and the rest to clear. When the white light falls on the object, the reflected light has different proportions of different frequencies. The photodiode array detects this light. The intensity of this light that appears as the input to the photodiode is converted into a signal whose frequency is proportional to it. The output is a PWM with 50% duty cycle.

GY87 SENSOR: When the gyro-sensor is rotated, a small resonating mass is shifted as the angular velocity changes. This movement is converted into very low-current electrical signals that can be amplified with the aid of a microcontroller. These signals that represent the angular velocity of each of the axes can be used to determine the number of degrees by which the object has deflected.
It will be used when we are traversing on a shape, as it will move differently than its usual grid path.

Both the sensors are used to implement the the theme assigned. The colour sensor is of immediate importance as we are required to detect the colour of the objects in the terrain. The gyro, however is used for subtler reasons such as, to determine when the object is present on top of a shape. If there is an object present next to the shape, to detect its colour, we must be present on top of the shape for the sake of accuracy. This is where the gyro sensor is used- to determine when the firebird is on the top-most point of a shape.

Q10. How will you determine the threshold value for a given color? (3)

Step 1: Run the code for the colour sensor.
Step 2:Place the color sensor on a black chart paper.
Step 3:Check the values for red, blue and green.
Step 4:We received three values - Red (800), Blue (750), Green (680)
We can see from the above example that the values are less than 900. So we can take the threshold value as 900.
Step 5:Once we test the code for black color we should test the code for red , blue and green colors respectively
Step 6:Note down the values for the above colours and see if the values for the non dominating colours are less than threshold value.

Q11. Did you burn the demo code given in the Resources Section on Firebird V and test the color sensor? (2)

Yes
COMMENTS: Answer closed

Please note: You have to burn the demo code on Firebird V (the Robot in your kit) to test the color sensor. If you do not test the color sensor and report any problem in this document, we will assume that your color sensor is working fine. We will not entertain any queries related to faulty color sensor later on; Teams will have to buy the color sensor on their own.

Challenges (15)

Q12. What are the major challenges that you can anticipate in addressing this theme? (10)

1.Supporting the continuous rotating servo with a rigid support that is connected to the servo which is mounted on the firebird.
2.Covering the entire terrain in 10 minutes
3.Traversing through the curved path(S1).
4.Optimisation of algorithm to cover all possible cases efficiently
5.Representation of data such that it occupies less space.

Q13. How will you implement this theme if the arena was not designed as a grid (i.e. it is a random network of paths)? (5)

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Explain what method you would use to localize the Robot and transmit the information to Blender.
Answer format: Text
Word limit: 200 words
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If the terrain is not a grid but has fixed boundaries the robot will still be able to provide a model of the terrain though it may not be fully accurate.The robot has to take zigzag path and obtain full information of an object/shape as and when it encounters them and also immediately communicate the information to blender. If an obstacle is encountered, the robot will have to find an alternate route to its immediate next destination by using the knowledge of its previous traversed routes. The robot would also have to transfer the information of the paths as and when it travels to blender. The network of paths may not be fully depicted on blender since the bot may not travel through every path.

i got bored after writing this much. what else can i add? I honestly don't know.this should suffice!! Eehh. 5 marker. How much more could they want? i donno

Algorithm (10)

Q14. Draw a flowchart illustrating the algorithm you propose to use. (10)

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The flowchart should explain how you will be using the functions defined in the main program for completing the theme assigned to you.
Follow the standard pictorial representation used to draw the flowcharts.
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Our Robot

Here is a picture of the Robot that we plan to create in Blender:

< You may create a sketch or a drawing of your imaginary Robot.....we are waiting for your cool designs. :))
Lots of work on our hands right now. We'll show this to you during the next stage of the competition. ;)