

**e-Yantra Robotics Competition 2016**

**Theme - Navigate a Terrain**

**Theme and Implementation Analysis**

**<NT-1805>**

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| **Theme assigned** | Navigate A Terrain |
| **Date** | 26-01-2017 |

**Scope (5)**

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

**The theme assigned to us is “Navigate a Terrain”. Basically, the objective is to guide an unmanned vehicle across various terrains through a set of checkpoints from a set up camp (base station).**

**The purpose of such themes is to make an autonomous system such that the Base Station and the Rover can communicate throughout the arena to complete the task at hand. It is useful to implement such themes to establish connection between two Bots without any human interference.**

**Building Modules (5)**

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

**Base Station:**

**Mechanical Systems: Structure for the spotter.**

1. **PVC Pipe**
2. **Wooden Bases (2 levels)**

**Electrical Systems: The Actuators of the system with help of electronic system.**

1. **Servo Motor x2**
2. **Batteries**
3. **Wires**
4. **Laser Pointer**

**Electronic Systems: The connecting interface between mechanical and electrical systems.**

1. **Node MCU**

**Rover**

**Mechanical Systems: Body of the unmanned vehicle (rover)**

1. **Chassis Plates**
2. **Wheels**
3. **Castor Wheels**

**Electrical Systems: Actuators (Devices that provide mobility to the system all together)**

1. **DC Motors**
2. **Wires**

**Electronic Systems: (Interfacing devices between mechanical and electrical systems)**

1. **Raspberry Pi**
2. **Motor Driver**

**Camera (20)**

**Q3. Explain how you will detect the laser being projected on the arena using the USB Camera provided to you in the kit? (10)**

* **By using concepts in image and video processing.**
* **Finding the laser pointer on the white background in the first frame and tracking it in the following frames in the video.**
* **In continuous frames of video from the camera, the robot will move in a way such that the laser pointer light on the arena is moved to the exact centre of the frame in video.**

**This tracking of laser is done by masking for red colour point on the arena along with object tracking method with the laser point being the object to track.**

**Q4. How will you detect the colour of each Checkpoint with your Rover? (10)**

* **As the rover moves following the laser, the camera searches for a change from a dot image (laser point) on the white background.**
* **Whenever it encounters such a situation the rover and the spotter is paused till the rover identifies the colour of the checkpoint.**
* **Colour identification is done using masking concept.**
* **Masking concept --- This concept includes specifying a range of values for different colours in HSV Colour mode. Then, the colour is taken from the camera input and is then checked with the ranges specified. For the identified colour the RGB led is made to glow with the same colour identified.**

**Actuators (10)**

**Q5. How will you design the mechanism for Base Station using the actuators provided to you in the kit? Please mention any additional actuators that may be required to design the Base Station and how you will use them.**

**The base station is made using the idea and inspiration of the pan tilt system. Two servos are used to implement the base station**

* **One servo is used to control the laser pointer position on the map.**
* **The other servo motor which is placed below will move to cover the arena.**
* **The motor with the laser pointer is attached to the top of the base servo motor in a perpendicular manner.**
* **The laser motor can move through the different concentric circles in the arena.**

**Electronics and Hardware Components (5)**

**Q6. The Node\_MCU provided to you works on logic level of 3.3V. Whereas servos work at a logic level of 5V. How will you provide PWM input required to drive the servos from the Node\_MCU ?**

**Since the levels of working are different we need to manage the voltage supply. For this purpose, we use a logic level converter (LLC). This device is used to step up or step down the voltage supply. This can be done by PWM input from the nodeMCU to the LLC which is connected to the servo motors.**

**Navigation and Communication (10)**

**Q7. Consider the following scenario. Initially the Rover is following the laser and at some point it loses sight of the laser. What is the protocol to be followed in order to recover from such a situation?**

**In such a situation, we plan to follow this protocol.**

**Whenever the rover loses the sight of the laser pointer, it will send a message to the nodeMCU to pause the laser motor and backtrack till the rover camera can detect the laser. Once it detects the laser the rover sends a signal to the base station to pause the backtracking of the laser and continue the laser to move ahead in the arena along the solved map path.**

**Testing your knowledge (Based on theme and rulebook) (15)**

**Q8. How will you detect the position of Checkpoints in the Map? How will you correlate the position of Checkpoints on the Map with the angle of the spotter in the arena? (10)**

**The checkpoint position is identified using the map solving algorithm in the software terms. In case of hardware detection, the camera on the rover continuously tracks the laser red dot. Whenever a checkpoint is encountered the shape is other than the red dot. Hence, rover understands it is a checkpoint.**

**Whenever a checkpoint is encountered, there is a communication between rover and base station to glow RGB leds on both ends. At this point the nodeMCU knows the angle at which the spotter motor is. Hence using this, the correlation between the angle of spotter and checkpoint is made.**

**Q9. What will the Rover do when it encounters a Checkpoint on the Arena? (According to the algorithm used). (5)**

**Whenever the Rover encounters a Checkpoint on the arena. The Laser motor is paused till the rover identifies the colour of the checkpoint and glow the led and send the message to the base station. Using this, base station also is made to glow its RGB led to the same colour identified by the rover. Then the system is resumed to move laser along the map with rover following it.**

**Algorithm Analysis (20)**

**Q10. Draw a flowchart to explain the algorithm you propose to use to complete the given task.**

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**Challenges (10)**

**Q11. What are the major challenges that you can anticipate in addressing this theme?**

1. **Not crossing over the path lines.**
2. **Tracking of red laser point and checkpoints on the flex arena.**
3. **Movement of Rover to follow the laser point.**
4. **Communication between the base station and the rover through the use of WiFi**
5. **Handling of DC Motors for accurate movement.**