e-Yantra Robotics Competition - 2017

Theme and Implementation Analysis – Planter Bot

3819

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Scope and Preparing the Arena

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

(5)

We know that agriculture has come a long way in the past century. We need to produce more food than ever before because the world's population is rapidly increasing. Moreover people migrate from rural areas to big cities for job opportunities leaving farming as an option to others. There are several other reasons why agriculture is hindered like rapidly changing climate, health hazards, etc.

To tackle the problem of hindrance in agriculture we have been assigned the theme of planter bot. Here plantation is carried out with the help of robot which traverses entire field. Robot has been given an aid of vision with which it can understand the requirements of field i.e. which type of seedling is needed and what quantity of seedling is needed in particular zone.

Planter bot will actually make the work of planting simpler and organized. Quality of plants will improve because of less human intervention and provision of accurate amount of pesticides. It will reduce human efforts. There will be increase in production and indeed rise in GDP.

b. Upload the Final Arena Images.

Photos are attached separately.

(20)

< Prepare the arena according to the steps given in Section 3: Arena, of the Rulebook. Please follow the arena configuration shown in "Figure 1: Arena Design" and "Figure 4: Arena Design with Dimensions" of the rulebook.

Configuration for Zone Indicators and Color Markers associated with them are as per following Table:

Zone Indicator Number	Cell number for Zone Indicator	Color Marker Type	Number of Color Markers
1	N3	Red Circle	3
2	F7	Green Triangle	4
3	O11	Red Square	1
4	E16	Blue Square	2

In addition to this, place a Zone Indicator at Cell number J16. This has no Color Markers associated. Refer to Section 2: Theme Description and Section 6: Theme Rules of Rulebook for more information about this.

Take 4 photos of the completed arena from different angles such that the entire arena along with its components such as Terrains, Zone Indicators, Cells, etc., is clearly visible in the photos.

Answer Format: The four image files should be uploaded as **.jpg** along with this document as per instructions in Read Me for Task 3. >

Building Modules

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

(5)

Electronic

1. Rpi3 – used for actual processing
2. PiCam - to give aid of vision to bot
3. Memory card - to program the bot
4. Power bank - to power rpi3
5. Lithium ion battery - to power motor driver
6. DC jack socket - to connect battery and motor driver
7. Lithium ion charger - to charge battery
8. Motor driver L298N - to manage working of motors
9. Leds - to check for correct detection of colour markers

Mechanical

1. Quad motors - they will help bot to traverse
2. Motor clamps - to place motors in proper position
3. Chassis - it acts as body of the bot and consists of all major internal components of bot
4. Wheels - to help the bot traverse through the given arena
5. Shaft - to maintain the contact between motors and wheels
6. PiCam holder - to hold PiCam in the right place
7. Studs and screws - to make necessary connections for the bot
8. Caster wheels - to help in giving directions to the bot while traversing
9. Perf board - to make connections for motors, etc.

Power Management

Q3. a. Explain the power management system required for a robot in general and for the theme assigned to you in particular.

(5)

The robot is run on a dc Li-ion Battery of 11V, 2300mAh provided by the E-Yantra team. Every robot is generally run by a dc battery which needs to be charged again and again or is provided by direct power supply through auxiliary cable.
For our theme, battery mode is preferred as the requirements of power are less and the robot has to keep moving on the arena. So in this case providing power through auxiliary cable is not feasible unless we keep on moving with the robot which is inefficient.
Sometimes, the battery charges on its own while it's being used. Example: - Car battery.
Same algorithm of battery charging is employed in few of the high-rated robots.
In order to ensure the robot operating stably for a long time and make it more environment-friendly and energy-saving, an efficient power management system is designed.

b. Can there be a single power supply for your robot? - Yes/No/Don't know. Please elaborate/justify your answer choice.

(5)

Yes. The raspberry pi 3 can be turned on using only 1 power source. Also the robot can be run by the same power source. We are provided with an 11V battery. The power in it can be directed in different ports using a voltage regulator. So 5V can be given to the Raspberry Pi 3 which turns it on and also the actuators can be run by the remaining power. In this way a single dc battery source is enough to run the entire robot.

Another way can be using a single auxiliary power source. The power can be given to the motor driver directly and from the same source another wire could be used to power the Raspberry Pi 3 by plugging it in through one of the USB port available on the Raspberry Pi 3. Even though this option is available the voltage regulator option would work the best with a moving robot so that the robot remains independent of the cable through which power would've been given in the auxiliary way. This also helps the robot driver to stay in one place and steer it rather than moving with the robot continuously.

Design Analysis

Q4. Teams have to design a robot which traverses a arena following a given path and simulate planting by overlaying image in GUI.

a. How will your robot traverse a field represented by the Arena given in the rulebook?

1. The bot will start its run from nursery. The bot will use line follower technique to traverse the arena i.e. it will follow black line until inverted plains. PiCams vision is adjusted to see the Zone Indicators entirely and position of PiCam is such that it can only see a few centimetres ahead of the bot. Hence while traversing the normal path (0.59 inches) we can use the technique of line follower. It will follow the normal path of 0.59 inches until it encounters ZI. When it encounters ZI its vision will be 3 inches black. Hence the bot will be programmed such that it when it encounters the path of 0.59 inches again it will take a delay of few seconds. At this point the bot's PiCam will detect for colour markers and will blink RGB LEDs according to colour markers. Corresponding overlapping of flowers on the given field will also be done. Once the delay time is over, the bot will traverse again through the arena. Turns in the arena will be anticipated by giving proper frequencies and delay to quad motors. In this way the bot will traverse the arena up to inverted plains. In inverted plains the bot will be programmed such that if white line is detected and rest of the frame is black it will follow. The bot will end its run in shed i.e. when PiCams entire vision is black.
2. The bot will use the same technique of line following but in this technique the PiCam will be attached in such way that its vision is limited to 3 inches. So when PiCam is on normal path (0.59 inches) it follows black line. When it encounters I its vision will be entirely black and will take a delay when it again sees the normal path (so that PiCam is on colour markers). Here the bot will do the required processing i.e. blinking the LEDs and overlaying. Once the delay time is over the bot will again traverse the normal path. Turns in the arena will be anticipated by giving proper frequencies and delay to quad motors. There are going to be 5 ZI, hence there will be a loop in program from 1 up to 5. This is because when the bot will end its run into shed, it will stop at 6^{th} loop. In inverted plains the bot will be programmed such that if white line is detected and rest of the frame is black it will follow white line.

(5)

b. If you were to implement this theme in the real-world scenario, what would be the actuators you will employee? Explain their purpose.

(5)

An actuator is a motor that converts energy into torque which then moves or controls a mechanism or a system into which it has been incorporated. It can introduce motion as well as prevent it. An actuator typically runs on electric or pressure (such as hydraulic or pneumatic).
An actuator also means a mechanism by which a control system acts upon an environment. The control system can be simple (a fixed mechanical or electronic system), software-based (e.g. a printer driver, robot control system), a human, or any other input.
In real scenario, the actuators of the robot would be engine as actuators are the components responsible for the motion of the robot. Engine in real life would be powered by fuel like coal or petroleum or even electric power. The robot in the real life would then be traversing through the farms or fields and the required crops would be planted by an automated machine.

Environment Sensing

Q5. a. Explain how you will use the PiCam to decide the course of traversal.

(5)

PiCam is attached at certain height on the bot. The height is decided such that PiCams vision is adjusted to see the Zone Indicators entirely and position of PiCam is such that it can only see a few centimetres ahead of the bot. Hence while traversing the normal path (0.59 inches) we can use the technique of line follower.
The moment when PiCam arrives at the zone indicator the view will be 3 inches black then again when it sees the normal path (0.59 inches) bot will take a delay of few seconds and make the PiCam recognize colour markers and do the further process(blinking LEDs and overlaying). After the delay the bot traverses again.

b. Would the webcam be a better choice of camera over the PiCam? Explain.

(5)

1. Yes, webcam can be used instead of PiCam but it would require an extra USB port which is not actually a problem.
Let us take a look at some pros of PiCam over Webcam and vice-versa.

Pros of PiCam over Webcam

1. PiCam is generally 5MP and standard Webcam is 2MP
2. PiCam offers faster frame rate.
3. PiCam offers better resolution.
4. PiCam is compact while webcam isn't as compact as PiCam.
5. While using RPI3 PiCam already has a slot but webcam would take additional USB port.
6. Similarly, there can be problems regarding drivers of webcam which won't occur if PiCam is used.

Pros of webcam over PiCam

1. Webcam may come with camera stand but PiCam doesn't.
2. Webcam has long wires while PiCam has short ribbon.
3. Focussing is not possible in PiCam but is possible in Webcams.

Looking at these statements it is quite clear that if RPI is being used, going for PiCam is better option than webcam.

c. What other sensors will the robot require to complete its task successfully?

(5)

1. IR sensor
Actually sensors are not needed but if needed IR sensors can be used.

Testing your knowledge (Theme Analysis and Rulebook-related)

Q6. a. If a team has an overlay similar to one shown in the Figure 1, how many points will you score for the overlay in total. Specify score for accuracy, penalty if any and total. Elaborate on penalty if any - why it will be applicable?

(5)

Note: The team has selected the correct seedling image upon detection of Color Marker and there are three such Color Markers at the Zone Indicator.

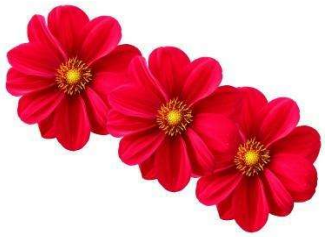

Figure 1: Overlay Example

In Figure 1, the flowers to left and right of centre flower are partially covered. That is why, penalty is applicable for 2 flowers.

Total Score = (600 - T) + (ZD*100) + (CMD*75) + (TT*100) + (IPP*200) + (O*25) + (B) - (P*50)

The team will get points for proper detection of three CMs and for one correct overlay.

However, team will be penalized for two improper overlays and team would lose 2*50=100 as penalty. Therefore, for overlays, points will be 3*75 + 1*25 - 2*50 = 150. This score is calculated using the given data. The score will also depend on other factors like time taken, zones detected, terrains travelled, etc.

b. Name the different Terrains in the Arena.

(3)

1. Hill Side Road (HR)
2. Berms (BE)
3. Cliff Roads (CR)
4. Inverted Plains (IP)

c. How many possible unique Color Markers can be made in this theme?

(3)

d. If there are 3 Blue Triangle Color Markers placed in front of a Zone Indicator, how will you indicate this via hardware only?

(3)

The bot will first stop at Zone Indicator and detect the 3 blue triangular CMs. Then the RGB LED will blink blue LED 3 times with an interval of 1 second. This is how we will come to know that there are 3 blue colour markers. Shape will be indicated by observing the overlaid image.ie observing the corresponding flower which is overlaid.

e. What are the different conditions that indicate end of a run?

(3)

Condition 1: The boot transverses the entire path and blinks the RGB LEDs according to sequence in Plantation Zone. (LEDs blinks once once for each colour, irrespective of number of CMs)
Condition 2: The maximum time allotted (600 seconds) is crossed.
Condition 3: The team wants to reposition; but they have used up both repositions.

Algorithm Analysis

Q7. Draw a flowchart illustrating the algorithm you propose to use for theme implementation.

(10)

Flowchart is attached in folder.

Challenges

Q8. What are the major challenges that you can anticipate in addressing this theme and how do you propose to tackle them?

(8)

1. Proper Overlaying – This will be a challenge as the size of overlaid image should be proper and also those images should be seen distinctly. To tackle this problem, we can adjust the parameters and coordinates between overlaying images.

2. Traversing through inverted plains – This problem can be tackled by properly coding the bot i.e. there will be a statement which would tell the bot to traverse white line.

3. Cliffside turning and Hillside turning – The bot should take proper and smooth turns. For this quad motors are required to give proper frequencies and delays.

4. Detection of Colour Markers – Detecting number of colour markers is challenging job as PiCam's vision should be properly placed. To properly detect colour markers PiCam should be placed properly and code should be accurate.