



e-Yantra Robotics Competition - 2018

Theme Analysis and Implementation - Nutty Squirrel

<NS#5405>

Team leader name	Rashmil Panchani
College	D.J. Sanghvi College of Engineering
Email	rashmilp833@gmail.com
Date	26-12-18

Scope and Preparing the Arena

Q1. State the scope of the theme assigned to you. (5)

< Teams should briefly explain in their own words the theme assigned. What in their opinion is the purpose of such an application? You may use figures / diagrams to support your answer.

Answer format: Text - limit: 50-100 words>

The theme Nutty Squirrel is concerned with using detection of object based on its color and place it just like a squirrel which differentiates the good nut from the bad nut and places it in holes dug near its home.

The purpose of the application is that it can be used for sorting items based on their color like in small cloth industries where they produce rolls of different color cloths. The bot we are making will help differentiate the cloth based on its color and place it appropriate store.

Q2. Attach the image of final arena that you have prepared. (5)

< Prepare the arena according to the steps given in *Preparing the Arena* section in Rulebook. Please follow the arena configuration shown in Final Arena of the Rulebook.

Place the Nuts (Red, Blue and Green) in the Pick-up Area and Lift structure in lift section.

Take 3 photos of the completed arena from different angles such that the entire arena is clearly visible in the photos.

The three image files should be uploaded along with this document in zip format.>

Building Modules

Q3. Identify the major components required for designing the robotic system and lift mechanism for the solution of the theme assigned to you. (5)

< Teams should classify the components into various categories: mechanical systems, electronic systems etc. and mention how these units will be used in the theme. You may draw diagrams/figures to illustrate your answer. Team should mention the usage of individual component.

Answer format: Bulleted form, word-limit: 300 words.

Robot:

Mechanical Components

1. Acrylic Sheet
2. Motor clamps
3. Castor wheels
4. Wheels
5. Hex Spacers
6. Screws
7. Clamps for castor wheel

Electrical Components

1. Atmega2560
2. DC motors 100 RPM
3. Servo motors
4. LCD screen
5. Buzzer
6. IR Proximity sensor
7. White Line sensor
8. Color Sensor
9. RGB Led
10. Potentiometers
11. Battery
12. Resistors
13. Voltage regulators
14. Motor Driver L298

Lift Mechanism

Mechanical Components

1. Aluminum Base Plate see fig 1.
2. Channel for the base to go up and down see fig 2.
3. Pulleys
4. Strings for lifting the base up and down.

Electrical Components

1. Atmega328p
2. Motor Driver L298
3. DC motor 60 RPM
4. Voltage regulators 7809,7805
5. IR Sharp sensor
6. Battery for power supply

Q4. Can you optimize the given sensors and actuators to perform the tasks. If yes, then how? (5)

< Teams should classify the components into various categories: mechanical systems, electronic systems etc. and explain the usage.

Answer format: Bulleted form, word-limit: 300 words.

Robot:

1. White Line sensors
To calibrate the White line sensor we will place it on the flex sheet such that for the black line it gives the highest values and the sensor will have minimum possible ground clearance.
2. Color Sensor
Place the sensor in such a position that the color sensors receives sufficient amount of reflected light for accurate detection and proper tuning of the threshold values to give accurate values of pulse count of the specific color.
3. IR Proximity Sensor
Calibrate the distance between the obstacle and the robot and place the sensor in such a way that nothing comes in front of the sensor other than the obstacle.
4. DC Motors
Placing the motors such that they are perfectly aligned and adjusting the speed of motors so that they move in a straight line.
5. Servo motors
Calibrating the movement of the servos to pick and place the nut for better grip and not causing any disturbance in IR Proximity sensor.

Lift Mechanism

1. IR Sharp Sensor
Setting the triggering of movement of the lift (Up/Down) as soon as the bot enters the lift and stops.
2. DC Motor
Adjusting the delay to lift and drop the base to 12 cm height and back down.

Actuators

Q5. What are the different actuators you are planning to use in the robot and lift mechanism. Justify their use? (5)

< Team should list all types of actuators they will need for making the complete system. Teams have to mention: (i) actuators that are going to be used in building the bot and (ii) actuators that they need to interface with lift mechanism. You can also draw some diagrams/figures to illustrate your answer.

Answer format: Bulleted form

1. For the movement of the Robot we will be using the 100 RPM 2 DC Motors one motor for each wheel

2. For the Picking mechanism we are planning to use 2 servo motors 1 for picking the nut and the other to lift the whole claw with the nut and the vice versa for placing the nut in the deposit zones.

3. For the lift mechanism we will be using the 60 RPM DC motor where we will be using the motor to ascend the base of the lift when its rotated in one direction and in another direction to descend the base.

Power Management

Q6. Explain the power management system required for a robot and lift mechanism in Nutty Squirrel theme implementation. What are the aspects that you should look into for designing the power management? (5)

< Teams should mention the power requirement of their system with current rating and voltage requirement. You can mention the mode (auxiliary/battery) you prefer to use in your system with necessary justification. You can also draw some diagrams/figures to illustrate your answer.

Please provide the answer in your own words. Answer format: Text

Word-limit: 100 words>

1. The Lift mechanism requires 12V supply battery which is needed to drive the 12V DC motor driver and the voltage is reduced to 5V for the arduino nano.
We will be using auxiliary battery.
2. The robot requires 12V supply the DC Motors and 5V supply for the Arduino Mega 2560 and all the other components attached to it.
We will be using auxiliary battery.

Design Analysis

Q7. How are you planning to design the robot to detect the presence of Obstacles, Nuts and Lift structure? (4)

< Teams should mention the actuator and sensor they will be using for detection purpose. Explanation of how the robot will detect the Obstacles, Nuts and Lift while going from base arena to top arena and vice-versa. You can also draw some diagrams/figures to illustrate your answer.

Please provide the answer in your own words. Answer format: Text

Word-limit: 200 words>

The detection of Obstacles will be done by IR Proximity sensor. We will set some specific value, below which if the readings of sensor fall we will trigger alert and plan the path accordingly

Detection of nuts will be done by color sensor if the threshold value of the nut is reached it will classify which color nut is there and if threshold is not reached then no nut is there and then set the deposit zone accordingly.

For the lift, whenever the lift node is detected the bot will be given command to stop for the time till the lift reaches its destination (Up/Down).

Q8. Teams have to design a mechanism for picking and placing the Nuts in Deposit zones.

a) Choose an option to position the mechanism on the robot and why? (4)

1. Front 2. Back 3. Right/Left 4. Other position

< Justify your choice for placement of the mechanism. Word-limit: 100 words. >

4. Front-Top position

Reason:

In order to avoid any disturbance in the IR sensor and the color sensor we have decided to position the picking mechanism on front-top of the Bot.

b) Explain the design of the mechanism and how it is mounted on the robot. (4)

< Explain and draw figure(s) of your mechanism and show how you are planning to mount the mechanism on/around the robot. You can also draw some diagrams/figures to illustrate your answer.>

In order to avoid any disturbance in the IR sensor and the color sensor we have decided to position the picking mechanism on front-top of the Bot. One of the servo motors will be used to move the whole mechanism of claw up and down and the other servo motor will be used to move the claws away and towards each other depicting the picking and placing mechanism.

c) What challenge/s do you expect to face while designing the picking and placing mechanism of the Nuts and how you will overcome them? (2)

< Answer format:

Challenge: The claw used for picking up the nut should be such that its length can be accommodated within the lift while depositing the nuts on raised part of arena.

Solution: making the claw mechanism to be of precise size and foldable so that it will fold and occupy less space.

Challenge: The claw should be such that after picking up nuts it should not interfere with the

sensors.

Solution: after picking the nut we can lift the nut and make 180 degree rotation so that the nut rests on the top surface of the bot etc. You can also draw some diagrams/figures to illustrate your answer.>

d) Explain the design and working of the lift mechanism. (4)

< Explain and draw figure(s) of your lift mechanism and show how you are planning to make the mechanism. You can also draw some diagrams/figures to illustrate your answer.>

The lift mechanism is an important part of the theme implementation. The lift will work based on readings of the sharp sensor powered by Arduino Nano given to us.

The design of the lift consists of a platform along with two pulleys and 60 rpm motor which will drive the pulleys to raise the platform.

The working principle is based on the changes in values of the sharp sensor. The values of the sharp sensor will change as soon as the bot comes on the platform of the lift which in turn will trigger the motor to rotate such that the platform is raised to the required height and stop and based on the count of how many times the change is detected we will decide the motion of the platform, that is, whether the platform will raise the bot to the elevation or drop it to base part of the arena.

e) What challenge/s do you expect to face while designing the lift mechanism and how you will overcome them? (2)

< Answer format:

Challenge: The main challenge is that the lift should be automated in such a way that it goes up as soon as bot is on its platform and go down next time the bot comes on its platform after deposition of nut.

Solution: We used sharp-sensors to detect presence of robot and the count of detection to decide the direction of motion of the lift.

etc. You can also draw some diagrams/figures to illustrate your answer.>

Testing your knowledge (theme analysis and rulebook-related)

Q9. Answer the following questions related to the sensors

a. What is the principle of operation for: (i) the color sensor and (ii) Sharp Sensor (iii) IR Sensor? Also, for each sensor mention the threshold value for sensing. (15)

Solution:

1.Color Sensor works on the principle of the light reflected by the object when white light is incident on it which helps in detecting the particular color. The reflected light having the maximum proportion of either red, blue, green helps us to identify color of the object.

Threshold values:

2.IR Sensor: The emitter in the sensor is a IR LED and the detector is a IR photodiode. When the reflected IR light falls on the IR photodiode(detector) the output voltage changes in proportion to IR light incident on it.

3.Sharp Sensor: It consists of IR LED fitted with lens which emit a narrow light beam. This light falls on the position sensible photo detector and based on how the reflected light is received it is converted into voltage which in turn is converted using analog – digital converter which helps us to calculate distance.

Algorithm Analysis

Q10. Draw a flowchart illustrating the algorithm you propose to use for theme implementation. (10)

< The flowchart should elaborate on every possible function that you will be using for completing all the tasks in the assigned theme.

Follow the standard pictorial representation used to draw the flowchart. >

Added a picture of the flowchart.

Q11. What path planning algorithm you are planning to use and how it is going to affect the theme implementation? (5)

< Explain in detail the way path planning helps in attaining the best solution. Discuss the path planning algorithm). Justify your choice. What is the step by step procedure you should do for proper implementation

Answer format: Text

Word-limit: 300 words

>

The path planning algorithm we are using is A* path planning algorithm. This path planning algorithm has wide application due to its performance and accuracy. The main reason to use this algorithm is for the advantage it gives of efficiency and accuracy. The algorithm will find the shortest path for placing the nut that has been picked to the corresponding nut deposition zone which in turn will help save time to complete the task to be performed on the arena and will improve time efficiency of the bot just like the squirrel which will find the shortest path to reach the place where it has stored nuts and bring them back to the place where it lives.

We assumed the arena to be a weighted graph with nodes as the vertices of the graph. Each node has been assigned a co-ordinate and the weight is calculated by using the distance formula between two nodes. Since the heuristic can be any function, we defined the heuristic to be the distance between two nodes using the distance formula. The neighbours of the node are stored in a vector and the connections between them are initialized using an adjacency matrix such that if connection exists then the value is '1', else it is '0'. This provides to us with the path when starting and ending node has been specified. The nodes in the path are stored in a list and the current and the next node is retrieved from it and depending on the orientation of bot, right turn and left turn commands are executed. Whenever an obstacle is encountered the bot goes back to the previous node and deletes the connection between the nodes in which the obstacle is placed so that it won't traverse the same path again. On reaching the previous node, it will again follow A* algorithm to find a new path. On encountering the nuts, pick function is executed and then the bot is directed towards the dropping zone depending on the color of the nut by following A* algorithm. In this manner the bot will pick and place all the nuts and finally come back to the starting position.

Programming

Q12. How do you plan to synchronize the actions of robot and lift mechanism? (5)

< Explain the controlling, detection of the robot system and lift mechanism. You can also draw some flowcharts/figures to illustrate your answer.

Answer format: Block Diagram, Description >

The way to synchronize the actions of the robot and lift mechanism is by using the changes in the values of the sharp sensor that will be detected when the bot comes on the lift platform or leaves the lift platform.

The direction of motion of the platform is ensured with the help of count of how many times the change was detected.

If the count for change in values of the sharp-sensor is odd then the platform will move up and if it is even then the platform will move down.

Challenges

Q13. What are the major challenges that you can anticipate in addressing this theme and how do you propose to tackle them? (5)

< Answer format: Bulleted form

1. Challenge 1: Automation of the lift mechanism.

Solution:using sharp sensor to detect the change in the values of the sensor and hence triggering the up/down mechanism.

2. Challenge 2: Placement of the mechanism used for picking up nuts.

Solution: Mechanism will be placed on the front top edge so that it doesn't interfere with the bot movements and sensors.

Cost Analysis

Q14. What is the approximate cost of theme after considering individual component?

(You may include flex printing cost as well, list it separately)

< Answer in not more than 100 words>

Flex Printing -416 rupees

Voltage regulators -40 rupees

Perfboards-40 rupees

Berg strips – 300 rupees

Jumper wires- 340 rupees

Lift- 600 rupees

Acrylic sheet – 2000 rupees

Bot materials-500 rupees

Wires = 64 rupees

Total cost = 4300 rupees

Rules and Scoring

Q15. Nutty Squirrel theme consists of the following formula for scoring as mentioned in Judging and Scoring section of Rulebook:

$$\text{Total Score} = (600 - T) + (CD * 50) + (CDP * 100) - (ID * 20) - (IDP * 40) + B - P$$

What will be your strategy to earn maximum points in a run?

(10)

- We will try to improve the speed of the bot so that we can complete the task in minimum time and save the points deducted due to time taken to complete the arena but at the same time also take care of the efficiency.
- We will take care that the placement of the sensors is perfect so that the nuts are detected correctly so there is no incorrect detection which in turn may lead to incorrect deposition.
- The bot should identify the obstacle correctly and does not pick it up.
- The claw used for picking up nuts should be such that it does not interfere with the sensors after the nut has been picked up so that the bot does not keep detecting the same nut again and again.