e-Yantra Robotics Competition (eYRC 2019-20)

Task 3.1 – Supply Bot Questionnaire

SB#2183

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(to be filled)

Note: The pdf converted from this document should not exceed 5MB in size for upload.

Scope and Preparing the Arena

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

(5)

< Teams should briefly explain in their own words the theme assigned. What in your opinion is the purpose of such an application?

Answer format: Text, Word - limit: 100 words>

Recently India has witnessed a lot of natural disasters and one such natural disaster was flooding. Due to this, providing relief and rescue operations have been at the forefront of activities in the country.

Thus, our theme is Flood Disaster Management using a "Supply Bot".The idea is to build a robot to provide relief aid to the affected district or cities. The relief aid to be received by the affected areas is communicated wirelessly to the robot using a camera. Once the robot has identified the affected area, moving the relief aid as close as possible to the affected district or city is the primary task of the Supply Bot.

b. Upload the Final Arena Images. **(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: Basic Elements of the Arena" of the rulebook.

Configuration for Capital and Relief Aid are similar to that mentioned in the Test_Setup_Read_Me.pdf document in the Task 3.2 folder and as given in the table below:

Node Type	Node Number
Capital	1
Medical Aid	3
Food Supply	6

Take a single photo of the completed arena such that the entire arena along with arena components such as Capital, Relief Aids, e-Yantra logo, primary cities, and all basic elements of the Arena etc., are clearly visible in the photo.

Answer Format:The image file should be pasted in the space provided for it in this document here below [the image should be (maximum) of 256x256 in jpg format]:

Building Modules

Q2. Identify the major components required for designing the robotic system for 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.

Answer format: Bulleted form

1. Component 1
2. Component 2
3. Component ….etc. >

Electronic Components:

1. Arduino Uno board: It will act as the brain of the bot, as it will be running the software that will control all the other parts.
2. White line sensor: It is used for sensing white line on dark surface in order to ensure that the bot moves on the highway (white line).
3. STK programmer: It is used for burning sketches to the Arduino board with an external programmer.
4. L298N motor driver: It acts as an interface between the motors and the control circuits and hence provides direction to the wheels.
5. Xbee: It is used to wirelessly communicate between the supply bot and the system.
6. Buzzer module: It is used to indicate finished servicing of all three cities which need relief Aid by beeping end-of-run buzzer sequence.
7. Battery: It is used to power the supply bot.
8. Power Distribution Board: It is used to power various components of the supply bot.
9. Potentiometer: It is used to calibrate the output of the white line sensor according to the requirement.

Mechanical Components:

1. 2 DC motor: It is used to move the bot at the desired speed and stop it as and when required.
2. Servo Motor: It is used for controlling the robotic arm for precise control in terms of angular position , acceleration and velocity.
3. Wheels: It is used to move the supply bot.
4. Chassis: It acts as the backbone of the supply bot.

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)

< Teams should mention the power requirement of their system with current rating and voltage requirement. You can mention the number of batteries you think your system actually needs 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>

Efficient energy usage is a crucial issue for power management in a robot. Most of the robots used nowadays, use batteries however, for effective power management some robots use solar power.

The Supply Bot and its mechanism is powered by Li-ion battery. The Li-ion battery is connected to L298N gear motor driver which is used to drive two DC motors at up to 2A each, with a voltage between 5 and 35V DC. The L298N gives a 5V output if the input is not greater than 12V which is supplied to the arduino uno board which further powers other devices like 3.3 V to Xbee , 5V to servo motor, buzzer module and white line sensor .

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

(5)

< Support your answer.
Answer format: Text, Word - limit: 200 words >

Yes, a single power supply i.e. a 12V Li-ion battery is sufficient for our supply bot as only the L298N gear motor driver requires a power supply of 12V and rest of the components i.e. the arduino uno board, servo motor, buzzer module and Xbee module require a voltage of not greater than 5V. Thus, we provide a 12V power to the L298N gear motor driver which gives a 5V output if the input voltage is not greater than 12V which is used to power the arduino uno board which further powers other devices by making ground common.
However, to establish wireless communication between the supply bot and the system we have to provide a power supply from system to one Xbee module .

Design Analysis

Q4. Teams have to design a robot which traverses an arena following a given path and simulate dispatching required Relief Aid.

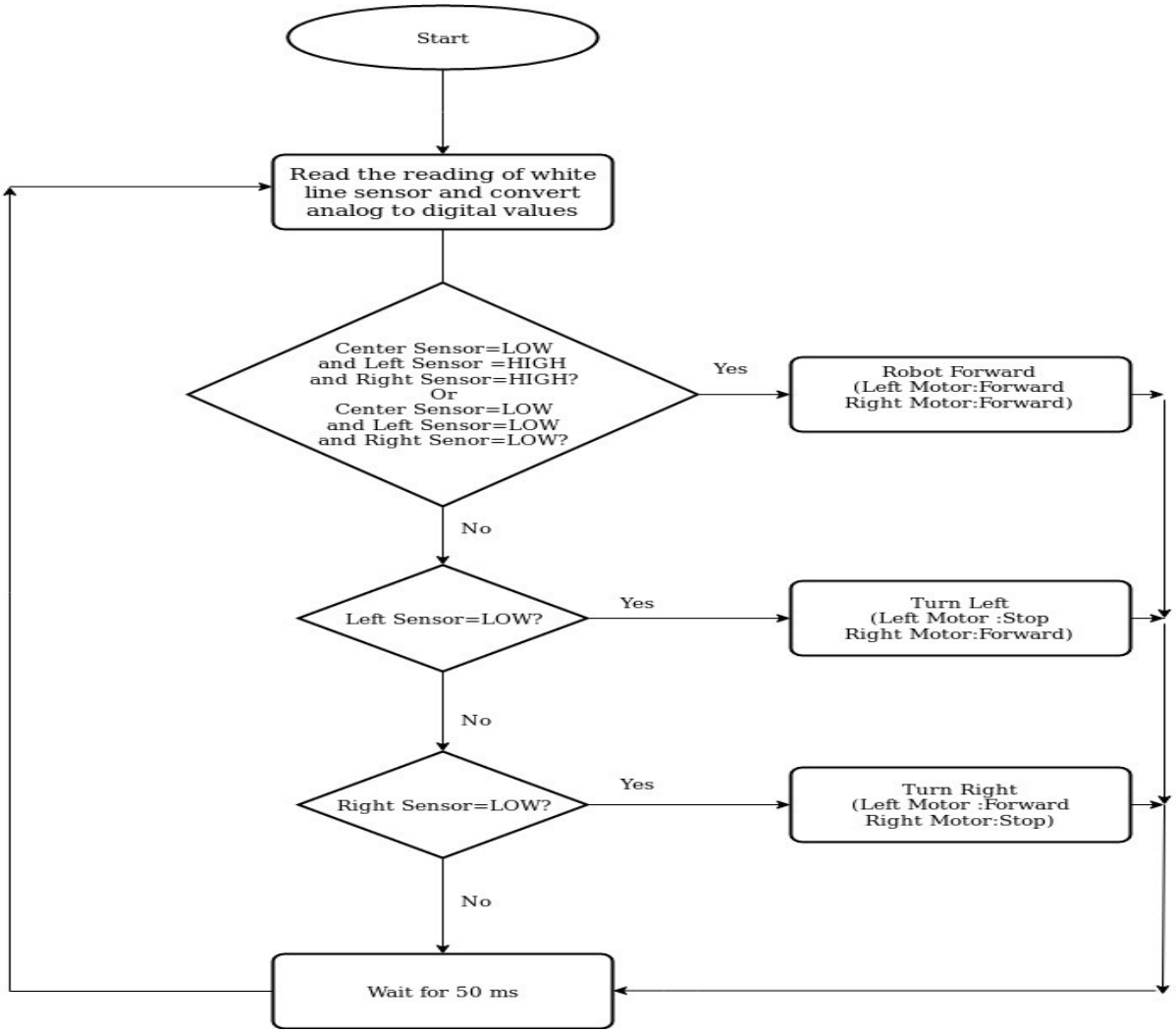
a. How will your robot traverse the state represented by the Arena given in the rulebook?

(5)

< Explain your path planning technique(s). Clearly specifying the hardware components, inputs and outputs for your technique. You can explain multiple techniques.
Word-limit: 300 words. >

Initially, the bot will be present on the capital ,the white line sensor in bot will be used to detect the path on which the bot has to traverse, the Xbee will be used for wireless communication between the supply bot and the system to make the bot move on the white line towards the desired location and then strike the coin in the desired direction using servo motor. Technique used for white line sensor to follow the path is as follows:

1. Read the reading of all the sensors i.e. left, center and right sensors
2. If the center reading is low continue moving on the same path as it indicates the bot is moving on the white line.
3. If the center and right readings are high and left reading is low then stop the left wheel but continue moving the right wheel which will turn the bot towards left.
4. If the center and left readings are high and the right reading is low then stop the right wheel but continue moving the left wheel which will turn the bot towards right.
5. Wait for 50 ms then repeat the same from step 1 until the bot reaches the desired city.



b. If you were to implement this theme in the real world scenario, what would be the actuators you will employ? Explain their purpose.
(3)

< Justify your answer by stating the advantage/s of the chosen actuator/s over others. Actuators that will be required for movement, planting mechanism, etc.
Answer format: Text, Word - limit: 200 words>

If we were to implement this theme in the real world scenario, then the actuators we would employ will be:

1.DC Motor: DC motors can rotate very quickly and hence, can provide very high speed to wheels which is important for fast movement of the supply bot also,it can rotate both clockwise and counter clockwise thus,the bot can move in both directions.

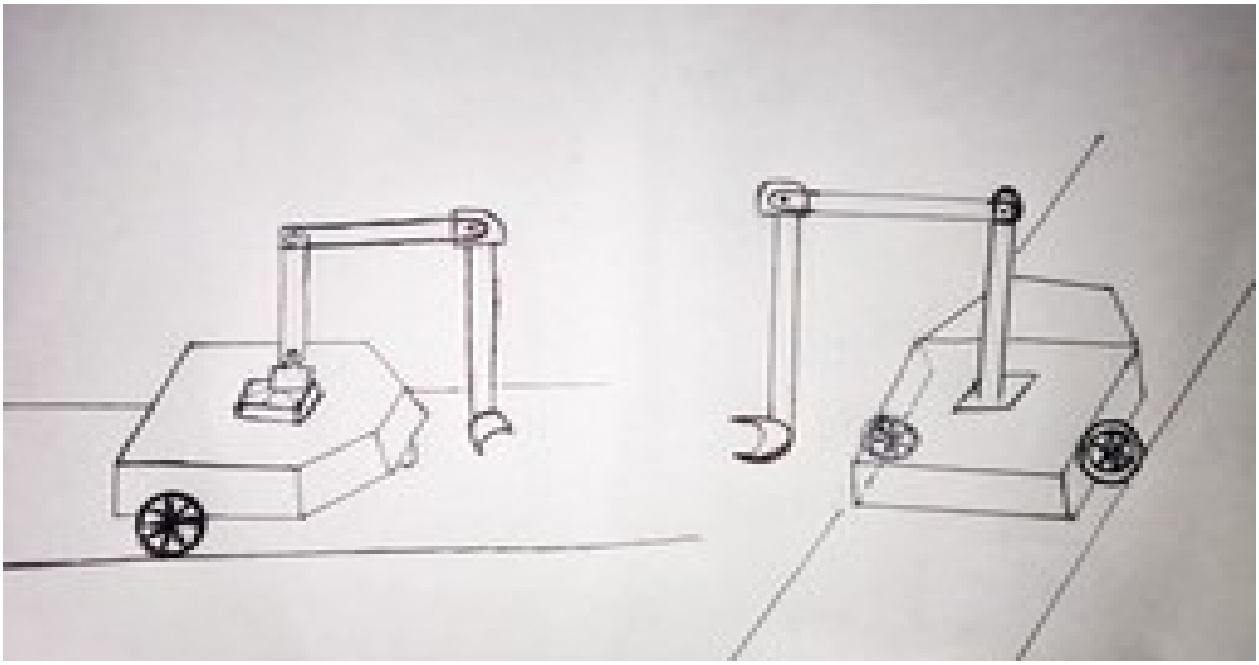
2.Servo Motor: Servo motors are types of actuators that rotate to a specific angular position and thus,can be used to rotate the robotic arm in the desired direction i.e. clockwise or counter clockwise.

3.Four axis robotic arm:We will create a robotic arm to strike the coin at the desired location. This will be performed with the help of a standard servo, mini servo which will be attached to a bob like structure with a flat base .Once,the arm is placed at the desired angle i.e. at 0 degree or 180 degree with the help of standard servo , mini servo is used to strike to coin by rotating it at some angle from its original position.

c. What kind of mechanism will you design to ensure dispatch of Relief Aid? (10)

<Explain your mechanism. You can put hand-made drawings/software based designs, as well (maximum 2 images/drawings of size 256x256)>

We have thought of designing a robotic arm kind of system in our bot as shown in drawing mentioned below:



First the bot will move to the appropriate city then the bot will stop there. Mechanism to ensure dispatch of relief aid is as follows:

On the top of bot will attach a servo motor that will place the arm at the desired angle. Initially the arm will be placed at 90 degrees when the bot is moving. When it stops at the desired city it will rotate its arm at an angle of 0 degree or 180 degrees according to the position of the coin. Now the mini servo will rotate at some desired predefined angle to strike the coin to its appropriate position with a certain force in perpendicular direction and then the mini servo will rotate back to its original position. Now standard servo will rotate back to its position of 90 degrees and bot will start moving towards other cities which require the aid.

Environment Sensing

Q5. a. Explain how you will use the given USB camera to decide the course of traversal. (5)

< Team should explain in detail how they will use the mounted USB camera to sense the environment associated with the theme. Explain the role of Camera in providing important feedback during the Run.

Answer format: Text, Word - limit: 300 words>

The USB camera will be used as a sensor to identify the ArUco marker to identify the position of the supply bot. It will also be used to identify the position of red and green coins and thus help us in detecting the districts which require aids. This will help in identifying the node numbers which require the medical aid or food supply. Then the algorithm will first detect the angle between the aid requiring cities (if there is a city requiring medical aid then it will be considered first) and the distance of bot from the aid both in clockwise and anticlockwise directions. Then the bot will start moving towards the city in direction from which the angle is minimum. After reaching the required cities and completing its tasks it will then look for the angle between its current position and position of other coins in both directions as mentioned above and then will move towards the required city along the minimum distance path. Thus, this will help to direct the bot about direction of motion i.e. clockwise or anti-clockwise and of the places of stoppage i.e. the places which requires medical aid or food supply.

b. What other sensors will the team use to aid their robot to complete its task successfully? (5)

< Answer format: Bulleted form

1. Sensor 1
2. Sensor 2
3. Sensor 3 ….etc. >

If we were to implement the theme in real life scenario then the sensors we would use will be:

1. Distance sensor:To calculate the distance between the affected region and the relief aid.

2. Temperature sensor: To calculate temperature and humidity of the surrounding environment for safe movement of bot in affected areas.
3. Light sensor:For precise information about the location of affected regions.
4. Gas sensor: To detect the presence or concentration of gases in the atmosphere.
5. Positioning Sensors:These are used to approximate the position of a robot, indoor positioning and outdoor positioning.
6. Tilt sensor: Due to disaster there might be obstacles in the path of robot so to ensure safe movement of bot in flood affected region tilt sensor will be required in real life scenario.

The sensors that we would use in out theme are:

1. White line sensor
2. ArUco marker

Testing your knowledge (Theme Analysis and Rulebook-related)

Q6. a. If a team has a condition such as that shown in figure 1 below compute the possible bonus, penalty if any and the maximum marks the team can score. Elaborate on bonuses or penalty if any - why it will be applicable? Also elaborate the conditions in which the team will score a maximum in this situation (5)

Figure 1: Overlay Example

< Analyse the formula provided in the rulebook and explain how it will affect the score.
Answer format: Text/Bulleted form >

Note: disregard the unequal shape of the coins, there are 2 green and 1 red coins in the Arena

It is assumed that the bot will complete the run in 400 seconds ,the red coin was hit first, the bot had stopped as and when required and there was no restart.

1. There will be 3 NHs since all the coin landed in either of the Villages (light blue/purple/orange/white region)
2. A maximum of 3 CDs will be awarded as all the cities have been detected correctly.
3. The medical aid(red coin) will earn 2 CBs if the medical aid was hit first and landed in the white circle.
4. Since,both the food supplies(green coins) have landed in the lake so there will be 1 penalty.
5. There is no overall run bonus since,all dispatches were not successfully deposited in the inner most villages depicted by orange or white concentric rings on the Arena.

TT=480

RT=400

NH=3

CD=3

P=1

CB=2

B=0

Thus,according to the formula, the total score will be:

(480-400)+(3*100)+(3*30)-(1*40)+(2*75)+0=580

b. Name the different elements in the Arena.

(3)

<Answer format: Bulleted form
1:
2:
3:…etc. >

State

1. City
2. Districts
3. Forest
4. Villages
5. Dead zones
6. Lakes

7. Highway
8. Capital

c. If there are all 3 Food Supply (Green Color) Markers placed on the Arena, how many CBs can you have maximum for a run?
(3)
< Answer format: Text
Word-limit: 200 words >
A CB is the bonus given if one or more than one coin lands in the innermost village i.e. the white circle. Since,a single CB will be awarded for food supply(Green coin) thus, we can have a maximum of 3 CBs.

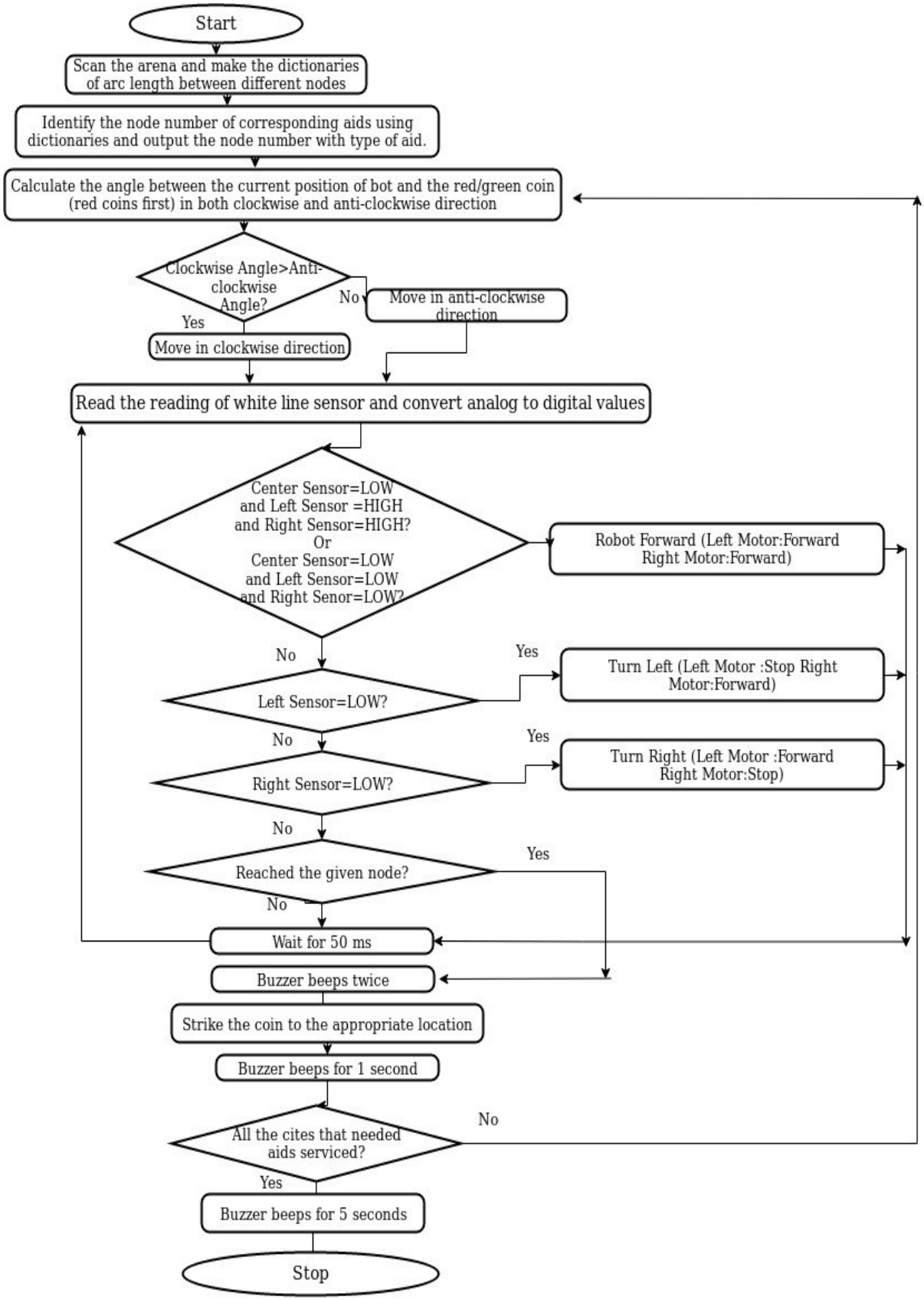
d. What are the different conditions that indicate the end of a run?
(3)
< Explain in your own words. Answer format: Bulleted form, word-limit: 300 words
Condition 1:
Condition 2:
Condition 3:…etc. >
The end of run section occurs when:

1. Time lapses i.e. 480 seconds of run is over.
2. The Supply Bot buzzer beeps for 5 seconds after servicing all or some of the requirements.
3. The Supply Bot goes off the white line and requests for the restart in one given run.
4. If the team has already exhausted its available restart.

Algorithm Analysis

Q7. 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.
Answer format: Text, Word-limit: 1000 words >

The algorithm for our theme implementation is as follows:


Start
Scan the arena and make the dictionaries of arc length between different nodes
Identify the node number of corresponding aids using dictionaries and output the node number with type of aid.
Calculate the angle between the current position of bot and the red/green coin (red coins first) in both clockwise and anti-clockwise direction
Clockwise Angle>Anti-clockwise Angle?
No
Move in anti-clockwise direction
Yes
Move in clockwise direction
Read the reading of white line sensor and convert analog to digital values
Center Sensor=LOW and Left Sensor =HIGH and Right Sensor=HIGH? Or Center Sensor=LOW and Left Sensor=LOW and Right Senor=LOW?
Robot Forward (Left Motor:Forward Right Motor:Forward)
No
Yes
Left Sensor=LOW?
Turn Left (Left Motor :Stop Right Motor:Forward)
No
Yes
Right Sensor=LOW?
Turn Right (Left Motor :Forward Right Motor:Stop)
No
Yes
Reached the given node?
No
Wait for 50 ms
Buzzer beeps twice
Strike the coin to the appropriate location
Buzzer beeps for 1 second
All the cites that needed aids serviced?
No
Yes
Buzzer beeps for 5 seconds
Stop

Challenges

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

(8)

< Answer format: Bulleted form
1. Challenge 1
2. Challenge 2
3. Challenge 3, etc. >

1. To complete the run in the minimum time: The speed of the bot should be fast enough that it is able to complete the run in the desired time but not too fast that it is not able to stop it at the desired location.

2. The node(city) corresponding to the aid might not be detected correctly: We will make sure that the algorithm includes all possible cases and we will test the bot in different situations.

3. The bot might not be able to detect the white line: We will place the white line sensor at appropriate height from the arena i.e. neither too close nor too far.

4. The aid might not reach the desired position: We will take care of the amount of momentum transferred to the coin while striking so that it reaches at the appropriate location.

5. Speed synchronization of wheels: We will make sure that algorithm is such that one wheel stops and starts at the right time with respect to the second wheel.

6. Xbee communication setup:We will make sure that the Xbees are at appropriate distance and are configured properly so that they communicate well with each other.

7. Extra power source: If all our battery is used up while working of robot then it will halt in between the task thus, we will attach a power bank to the bot for regular charging of the bot.

8. Condition of flex sheet: There might be wrinkles on the arena which may act as obstacles for the bot and can also make image processing difficult. So we will ensure that flex is be printed properly as per dimensions and also kept properly.