e-Yantra Robotics Competition (eYRC 2019-20)

Task 3.1 – Supply Bot Questionnaire

2122

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Date	14/01/2020

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>

The Theme assigned to us is 'Supply Bot'. An Arena is given with concentric circle parts of varying radius and colour, each circle denoting a geographical boundary from State to Village. It also includes villages which are affected by Disaster. Theme's aim is to provide relief aid to affected villages from city by hitting a coin(relief aid) from city.

It's aim, in real time, is to serve the affected people with Relief Aid, which includes Food supply and Medical aid, when the neighbourhood is affected by any Natural or Man-made Disaster(like flood…) which makes the people trapped in some location, sometimes their very own home. This bot does disaster relief work. Hence, It can be employed in disaster management team, in addition to Trained humans, to serve the society during Disaster times. It can be employed to serve in places where humans can't go or take some time to go(like the Thai Cave Situation).

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 Systems:

- 2 x LiPo Battery for power supply to the bot
- Encoded motors
- Motor driver l298N for controlling the motion of motor
- Arduino uno to control the whole unit
- White line sensor for line following part of task
- Camera for image processing
- 2 x 50g Servo for hitting /moving mechanism
- Xbee modules for tx and rx
- Buzzer for indicating end of task
- Wires,cables,etc for connections

Mechanical systems:

- Wheels for movement of bot
- Castor wheel for flexi movement of bot
- Wood or Acrylic Sheet for chassis
- Bolts,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)

< 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>

No of batteries depends on the Load that a servo handles. For us **Two** batteries are needed as we are using a 50g servo. As our servo handles high torque in pushing against the spring force. Power consumption can be optimized by using

1. 9g servo instead of 50 g servo.
2. Use light weight and strong components for body of the Bot.
3. Draw power for servo from motor driver itself thereby reducing to one battery.
4. Make the Bot as light as possible so that motors doesn't consume much power.
5. Use thin and short wires.

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 and a No. It depends on power drawn by Servo.

If power drawn by Servo is fairly less(light load):

The li-ion battery is enough to power up the bot. Power distribution board powers up arduino using 12v dc jack and the motors. For servo(which consumes more current)power is taken from 5v pin of motor driver. Xbee, buzzer,white line sensor can be powered from arduino board. Camera can be powered from laptop USB port.

If power drawn by Servo is high(heavy load):

If power is not sufficient as 50g servo(consumes lot of current), then a 2 li-ion battery can be used with LM7805 IC to convert 12v to 5v and give this power separately to servo and other battery to power up rest of the components.

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. >

Robot traverses the arena with the help of white line sensor. Feedback to the bot is also given by camera feed. Camera feed tells the start and end position of the bot to be traversed on the arena. Also depending on the arc length(start and end positions of the bot) speed of the motors should be changed. If the bot goes out of white line, then feedback from camera should be used to make it follow the right path. PID algorithm will be very useful to make the bot follow the white line even when it deviates from it.

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>

A four or more degree of freedom robotic arm is an essential part in construction of supply bot apart from motors for movement. Robotic arm should be light,flexible and automated through image processing effectively. also there should be PIR (passive Infra red- to detect movement of any object) , proximity and a camera for navigating without getting hit by any obstacle around the vehicle.

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)>

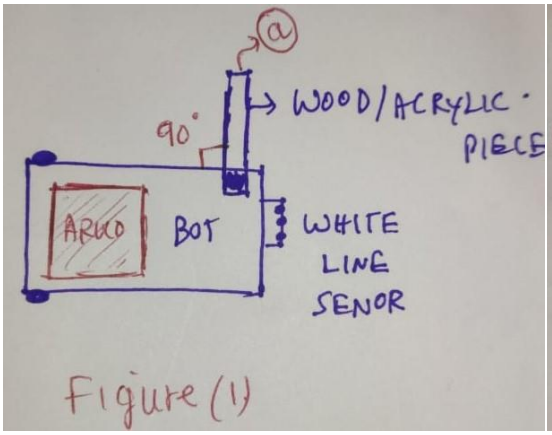
CONSTRUCTION:

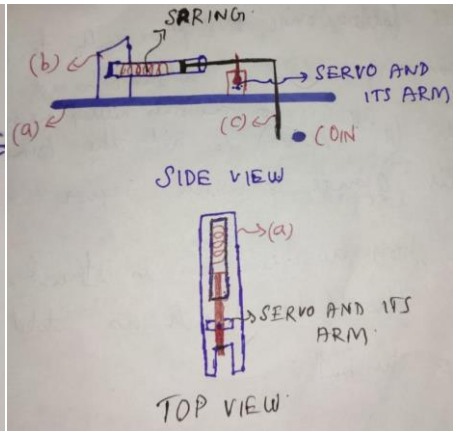
For the hitting mechanism, we need following components : 1 X 50g servo , a spring and a jacket for the same, wood or acrylic body.

The crux of our mechanism uses spring energy to dispatch the relief aid. An wood/acrylic piece(a) with yellow color is attached to the bot as shown in Figure(1). The a spring is kept inside a covering(jacket) and attached to the upward projection(b) from center of the primary wood/acrylic piece. A 50g servo is connected as shown in FIGURE(1). The wood/acrylic piece connected spring is extended downwards as shown in FIGURE (2) SIDE VIEW . This piece will be in contact with the acrylic coin.

METHOD OF OPERATION:

Once the position of the bot is set, Then the top 50g servo compresses the spring and releases after some time. This spring force pushes the wood/acrylic piece forward which strikes the coin to the center of coin. Depending on angle made by primary servo on the spring, the distance travelled by the coin can be adjusted.





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>

USB camera is used to detect the position of different elements of the arena. One red coin,2 green coins and aruco marker (bot) position is determined using image processing technique from camera overhead. When bot reaches the target point, the fine tuning of position of bot with respect to the coins is possible only from feedback from camera overhead. Also when the bot crosses the white line feedback is given from the camera or can be implemented from the bot without help of camera.

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. >

- Color sensor - TCS3200
- Laser based distance sensor - VL53L0 (very accurate results ,cheap and small in size) .

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

On computing the given diagram we infer, their is no penalty with respect to the position of the coins. Green coin which is in between in purple and blue will be considered as correct hit and CB will not be given. But NH(no of coins hit correctly) and CD(correct detection) points will be given since the relief aid is detected and hit in the right region. Green coin in light blue region is also considered as correct hit and so CD and NH will be given. Since there is no penalty then B is also given. So P=0, NH=3, CD=3, B=200. If we assume red coin is hit first then the team will get a maximum of 2 CB(Coin bonus) or else the team gets 1 CB.

Impossible case:
Total score= (480-0)+(3*100)+(3*30)-(0*40)+(2*75)+200 = 1220

Lets assume that at best case, RT = 10:
Maximum possible score (for given situation) = 1210

This maximum total can be scored when the red coin is hit first followed by the 2 green coins.

If the red coin is not hit first, then the 2 CB's will be reduced to 1 CB and score then will be 1135

b. Name the different elements in the Arena.
(3)
<Answer format: Bulleted form
1:
2:
3:…etc. >

- Arena - State
- Outer black ring - Forest
- Inner black ring - Food supplies.
- Outer White ring - Highway
- Blue ring - Lake
- Inner violet ring - (unaffected by disaster)Village
- Orange ring - (affected by disaster)village
- Inner white circle - (Most severely affected by disaster)village
- Green sectors - Dead zones
- Nodes on outer white ring - cities
- Red acrylic coin - Medical aid
- Green acrylic coin - Food supply
- Sectors between inner white circle and inner black ring - district.

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 >
If there are 3 food supply markers a team will get a maximum of 3 CBs for a run.

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. >

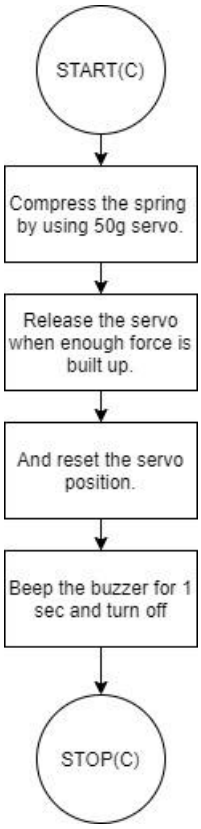
- Max time of 480 seconds is over.
- If supply bot beeps the buzzer for 5 seconds after servicing all or some relief aid.
- Supply bot goes off the white line and restart is requested.

- If restart has been exhausted and another restart has been asked ,maximum of 480 seconds is allowed.

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 >



Hitting Mechanism Flowchart

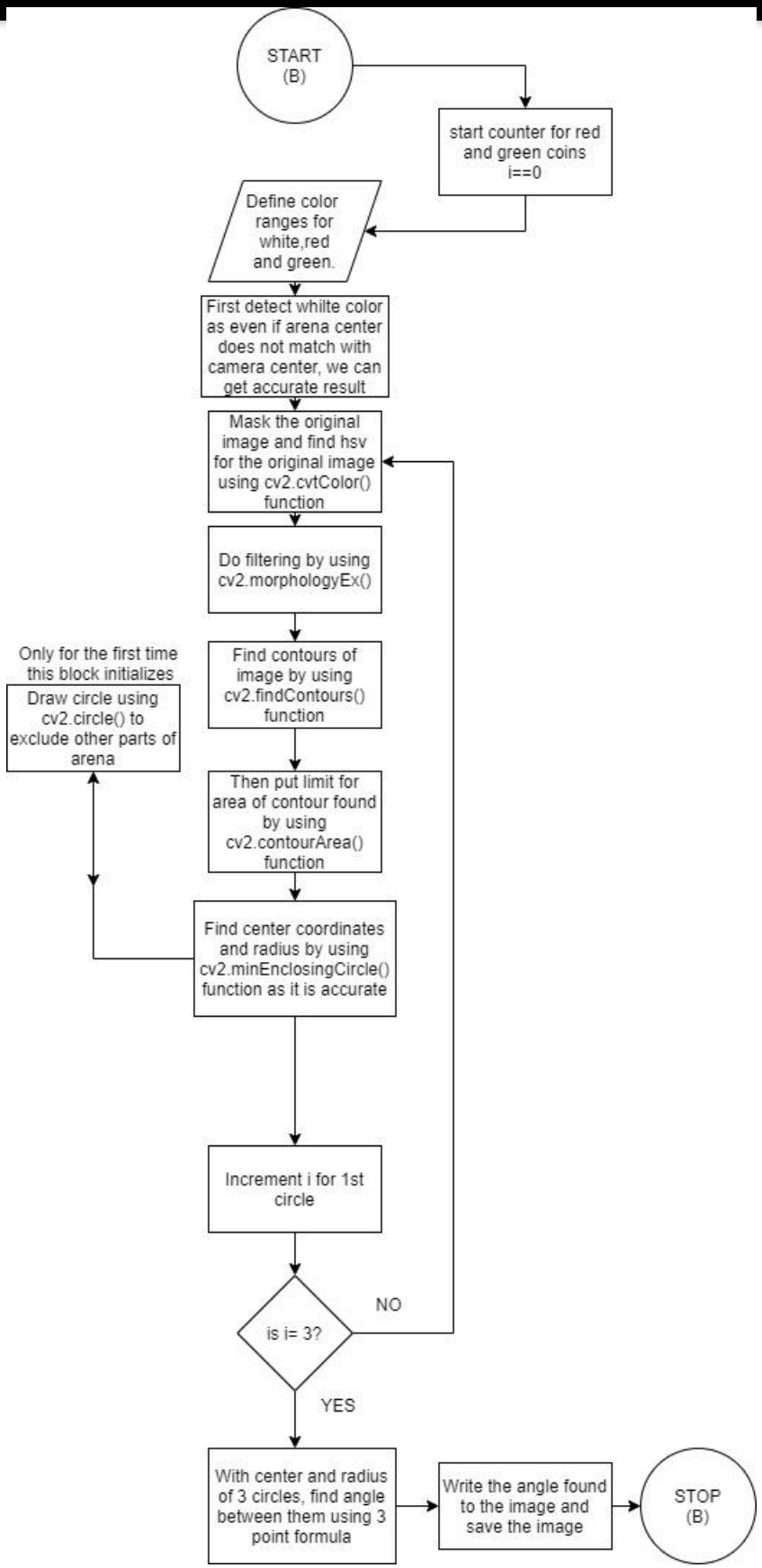
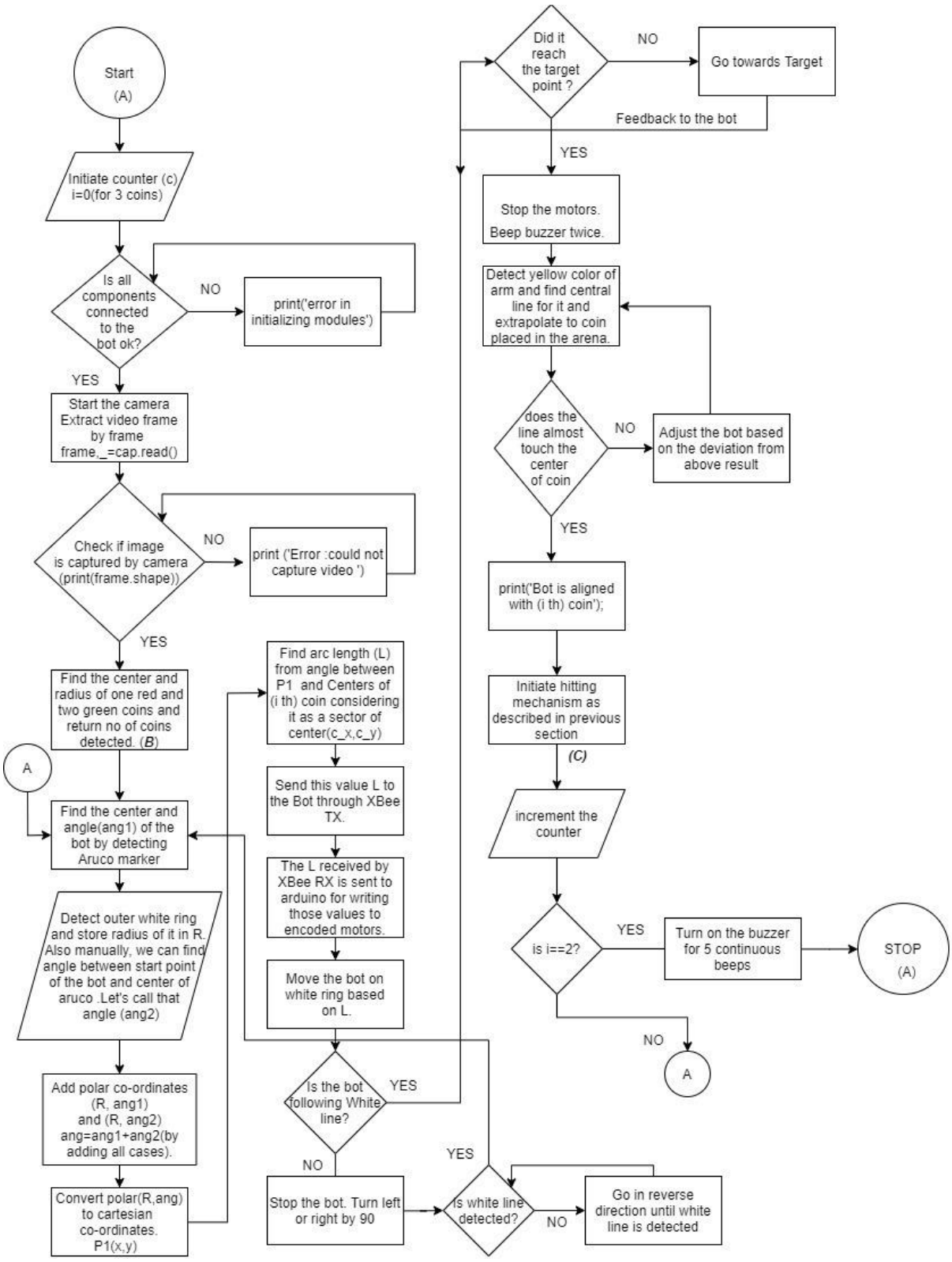


Image Processing Flowchart



Complete Flowchart

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. **Making the bot with properly working Hitting mechanism.** This in our view will be done if we spend some time in reconstructing it.

2. **Calibrating the force of Hitting mechanism in order to make the relief aid(acrylic coin) reach the centre white circle.** This will be tedious work, if we are not wrong. But we will do it. This problem can be solved by Trail and Error method.

3. **Making the white line follower algorithm work correctly as it is the very basic thing for the bot to do all other work. Fixing the PID value is tedious as well.** The remedy for this is the time we spend on this section of bot.

4. **Maintaining the CG(centre of gravity) of the bot might be a main aspect as well.** Improper CG of bot may lead the bot out of white line even when the line following algorithm is perfect. This can be of no problem when we design the bot precisely.

5. **Integrating the image processing from live feed with the bot movement may arise some problem in our view.** We are not specific about the problem but are sure about facing some problem there.

6. **Hitting the coin at the correct spot.** This is the most difficult job to do in the whole task. If the bot strikes the coin in a slightly varying angle than required, then the relief aid may reach the neighbouring instead of the one in need of it. This we are planning to address by pasting a colour paper at the striking end and calibrating the strike with image procssing techniques.

7. **Making the bot work under varying lighting conditions.** Detection of colours at different lighting conditions may not be perfect. We are going to check the arena with different lighting conditions and fix the most efficient detection range and also note the colour range values for different lighting conditions for easy initial setup in case of emergency.

8. **Malfunctioning of components used.** We are planning to have a spare for every component we use.

9. **Troubleshooting.** Finding the source mistakes, if any, in our code and source of error in our bot(like loose connection) is going to be a hefty work for us.