PIZZA DELIVERY SERVICE

1. Introduction

Everyone likes pizza, that's a fact of life. Demand for pizzas is especially high in cities and near colleges where prompt delivery is expected. It is a challenge for a pizza shop to deliver the correct order to the relevant customer on time. With increased competition amongst various fast food delivery services, in order to retain customers, delivery has to be efficiently managed.

Pizza delivery service involves: (i) Maintaining an order list that records the arrival time of an order (ii) Collecting the correct pizza from the pizza shop (iii) Remembering the appropriate house address and (iv) Delivering the pizza within a defined time.

In keeping with the importance of such an urban service, in e-Yantra Robotics Competition 2015 (eYRC-2015), one of the themes chosen is Pizza Delivery Service. In this theme the service is automated so that the orders are delivered to the intended customers within the prescribed amount of time.

In this competition, you are free to design the mechanism for detecting pizzas and delivering them to the appropriate houses. The challenge is to deliver the pizzas such that every customer's time requirement is met. The robot that performs the task best in accordance with the rules set out for this task will be declared the WINNER of the competition.

2. Theme Description

Description of the arena: The arena represents a town having 12 houses and a pizza shop.

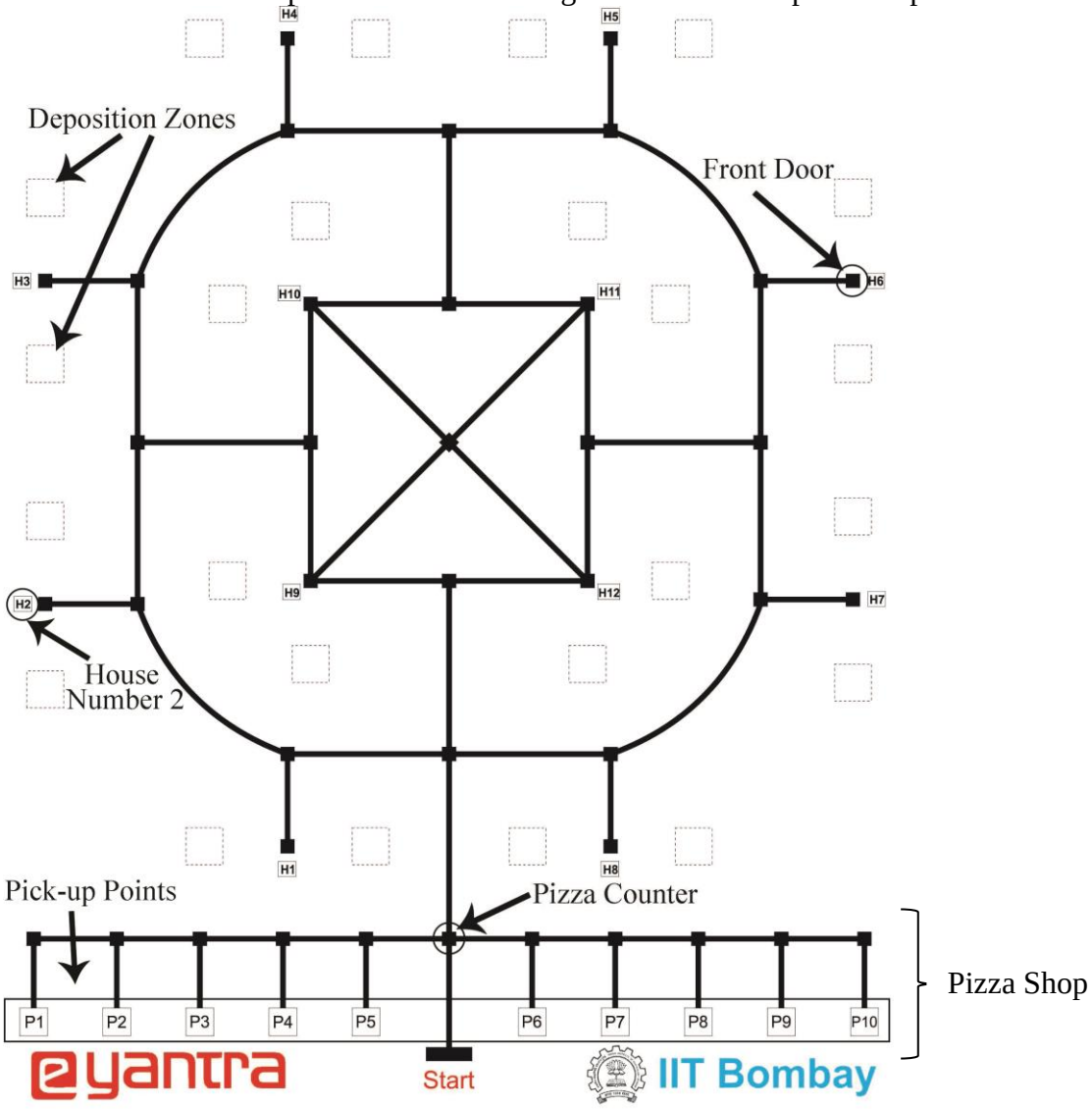

Figure 1(a): Arena

With reference to Figure 1(a):

- **House Number:** There are 12 houses numbered H1, H2,..., H12 where the pizzas have to be delivered.
- **Front Door:** Each house has a 3cm x 3cm node referred to as **Front Door**.
- **Pick-up points:** There are 10 **Pick-up points** named as P1, P2,..., P10 in the arena where the pizzas are placed.
- **Pizza counter:** A **Pizza counter** connects the **Pick-up points** to the town.
- **Deposition Zone:** Every house has two Deposition Zones. The robot may deliver the pizza at either one of the Deposition Zones associated with a house, but a Deposition Zone can have only one pizza.

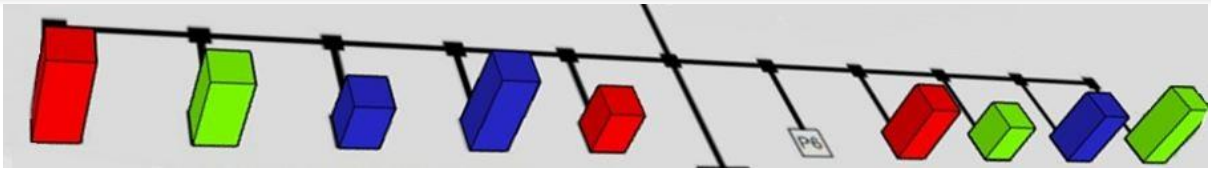

Figure 1(b): An Example Placement of Pizza

- **Pizza:** Thermocol blocks represent pizzas, which are placed on the **Pick-up points**. Note that some **Pick-up points** may be empty. Three different flavors of pizza are represented by three colors Red (R), Blue (B) and Green (G) and three different sizes of pizza namely Large (L), Medium (M) and Small (S) are represented by three different heights. An example is shown in Figure 1(b).

In this theme we abstract a real world pizza delivery service in which two types of orders are taken:

Preorders: These are the orders for a party or any other function -- these orders are placed ahead of time by the customers to be delivered within a **time window** based on the **delivery time** specified by the customers.

For example, a person orders a pizza for a birthday party that is to be held later in the evening say at 7:00 PM. The pizza delivery **MUST** happen within a time window, say between 6:30 PM - 7:30 PM. In this example, the order time is not relevant, **Delivery Time = 7:00 PM**, the **Guaranteed Time = 30 minutes** and hence the **Time Window** = 6:30 PM - 7:30 PM. Please refer below for the definitions of these terms.

Regular Orders: In this type of order, a customer orders a pizza and it has to be delivered within a certain **Guaranteed Time** from the **order time**. In other words the pizza has to be delivered on or before a **Deadline.**

For example, a person orders a pizza at 3:00 PM; it must be delivered to the customer on or before 3:30 PM. In this example, the **Order Time** = 3:00 PM, the **Guaranteed Time = 30 minutes** and hence the **Deadline** = 3:30 PM. Please refer below for the definitions of these terms.

1. **Order Timeline:** An **Order Timeline** as shown in Figure 2 represents orders received at the Pizza shop:

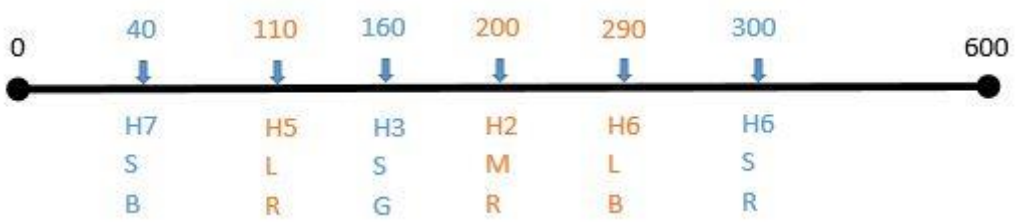

Figure 2: Order Timeline

- **Order time:** It is the time (in seconds) at which pizza is ordered by the customer. It is applicable only to the **Regular orders**. Regular orders are indicated in blue in the order timeline.

- **Delivery time:** It is the time (in seconds) requested by the customers at which the pizza has to be delivered. It is applicable only for **Preorders.** Preorders are indicated in orange in the order timeline.
- **House number, pizza size and flavor:** These are also indicated in the order time line. For example with reference to Figure 2, at **Order time** = 40, house number 7 (H7) has ordered a Small (S) pizza of Blue (B) flavor; House number 5 (H5) has preordered a Large (L) pizza of Red (R) flavor requesting for a **Delivery time** = 110.

2. **Time (T):** It is the time of the internal clock on the microcontroller on the robot. Using crystal oscillator of the microcontroller and using the concept of timer, **T** will be programmed to increment at every one second.

3. **Seven Segment Display:** This is a circuit that can display any one of the digits **0-9**.

4. **Seven Segment Module:** It is a combination of four Seven Segment Displays – provided in your Robotic kit. This module will be used to display the time **T**. The Seven Segment Module can be in one of the following two states:
   - **Running display:** When T is continuously updated and displayed.
   - **Freeze display:** When T is frozen and the current value of T is displayed. Note that the internal timer is continuously running.

5. **Guaranteed time (X):** It is a time duration promised by the pizza shop for guaranteed delivery. In this competetion the value of X is 50 seconds which will be constant throughout the competition. This is used to determine the **Time Window** in the case of a **Preorder** and the **Deadline** in the case of a **Regular order**.

6. **Time Window:** It is applicable only for **Preorders**. **Time Window** has a Starting time and Ending time which are defined as:

   - **Starting Time of Time Window:** The robot can deliver a pizza **ONLY** after this time. It is defined by the formula:

     Starting Time of Time Window = Delivery Time – X

   - **Ending Time of Time Window:** The robot has to deliver the pizza before the ending time. It is defined by the formula:

     Ending Time of Time Window = Delivery Time + X

   Note: The robot can not deliver the pizza before **Starting Time of Time Window**

   For Example: Suppose the requested **Delivery Time** for a **Preorder** pizza is 200. **X = 50.** Hence, **Starting Time of Time Window = 150** and **Ending Time of Time Window = 250.** Since this is a **Preorder** pizza it can be picked up anytime, but it cannot be delivered before the **Starting Time of Time Window** and ideally it has to be delivered between **T = 150 Seconds** and **T = 250 Seconds.**

7. **Deadline:** It is applicable only for **Regular orders** and defined as:

   Deadline = Order time + X

   Note: The robot can not pick up the pizza before the **Order Time.**

   For example: X = 50, if a pizza is ordered at **T = 40,** then the **Order time = 40** hence from the formula given above, **Deadline = 40 + 50 = 90.** Note that the pizza **cannot be picked up** from the **Pick-up point** before **T = 40** Seconds (as the order is placed ONLY at T = 40). Ideally, it should be delivered before **T = 90** Seconds**.**

8. **Tip:** It is a counter initially set to zero. If the robot delivers the order correctly (i) within the **Time Window** for a **Preorder** or (ii) on or before the **Deadline** for a **Regular order**, **Tip** is incremented **and** points are awarded based on the Tip**.** Refer to **Judging and Scoring System** for details.

9. **Penalty(P):** Details of Penalty are discussed in **Judging and Scoring System**.

10. **RGB LED:** It is a three-colored Light Emitting Diode which is used to indicate the flavor of pizza indicated by the three colors – RED, GREEN, or BLUE.

    Note: Two RGB LEDs are provided in your robotic kit – **only one** is used for the theme and the other one is extra.

The objective of this theme is to develop an algorithm using which the robot delivers pizzas to houses in such a way that **Tip** is maximized and **Penalty** is minimized while completing the task in the fastest time:

1. The robot starts from the **START** position of the arena.
   - As the robot powers up, the internal timer of robot should start and time should be displayed on the Seven Segment Module.
2. Each **Pick-up point** can contain:
   - **No pizza** – when the **Pick-up point** is empty.
   - **Pizza** – when a pizza is available at the **Pick-up point**.

Note: For **Preorders**, pizzas ordered will always be available at the **Pick-up points** but for Regular orders pizzas may not be available. A **Pick-up point** may contain a pizza not required for the given **Order Timeline**.

3. There are twelve **Houses** in the town, numbered H1 to H12. Each house may order pizzas. A house can order a maximum of two pizzas.
4. Given an **Order Timeline**, the robot traverses the path around the town and does the following:
   - Based on the **Order Timeline** plans for deliveries by picking up appropriate pizzas from the **Pick-up points**.
   - If the pizza is available, does the following:
     - Picks up the pizza and glows the corresponding color on **RGB LED** depicting the color of pizza.

- Delivers the pizza to the appropriate house.
- After delivering the pizza turns off the **RGB LED** and sounds the **Buzzer** for one second and then **freezes display** of the Seven Segment Module for 5 seconds. (Note that the internal timer is continuously running). At the end of 5 seconds the Seven Segment Module will resume **running display.**

- If the pizza ordered is unavailable, does the following:
  - The robot travels to the **pizza counter** and beeps the buzzer twice for duration of one second each.
- Robot repeats the above protocol till it delivers all the ordered pizzas to the appropriate houses.

5. After delivering the last pizza at the appropriate house as given in the **Order Timeline**, the robot sounds the buzzer continuously for a duration of 5 seconds.
6. Sound of the continuous buzzer indicates END of task.

3. Arena preparation:

Each team prepares the arena. Preparing the arena consists of three major steps.

1. Printing the design on a flex sheet.
2. Preparing the blocks.
3. Placing the blocks on the flex sheet.

Details of these steps are given below:

3.1. Printing the design on a flex sheet

- The arena design is as shown in Figure 3.
- A Corel Draw (.cdr) file containing the flex design will be provided to the teams along with .pdf for reference. Each team shall print the arena layout design according to the instructions provided in the .cdr file.

Details of arena design:

- Dimension of arena is 210cm x 240cm.
- Dimension of the flex sheet is 220cm x 243cm. A small margin is provided on all the sides to allow for sticking the flex sheet on the ground (Refer to Figure 3).
- START is marked on the flex sheet. This is the point from where the robot starts its task.
- FINISH is NOT marked on the sheet as when the robot places the last pizza at the appropriate house, it sounds the continuous buzzer indicating that the task is complete.
- The arena consists of a grid made of black lines of 1.2 cm thickness. Square nodes of dimension 3cm x 3cm are provided at the intersection of two or more black lines.
- There are twelve houses numbered H1, H2,…, H12. This numbering will remain same throughout the competition.
- The size of each Deposition Zone is 8cm x 8cm.
- Teams are not allowed to make any change in the arena design. Any team making any modification what so ever will be disqualified from the competition.

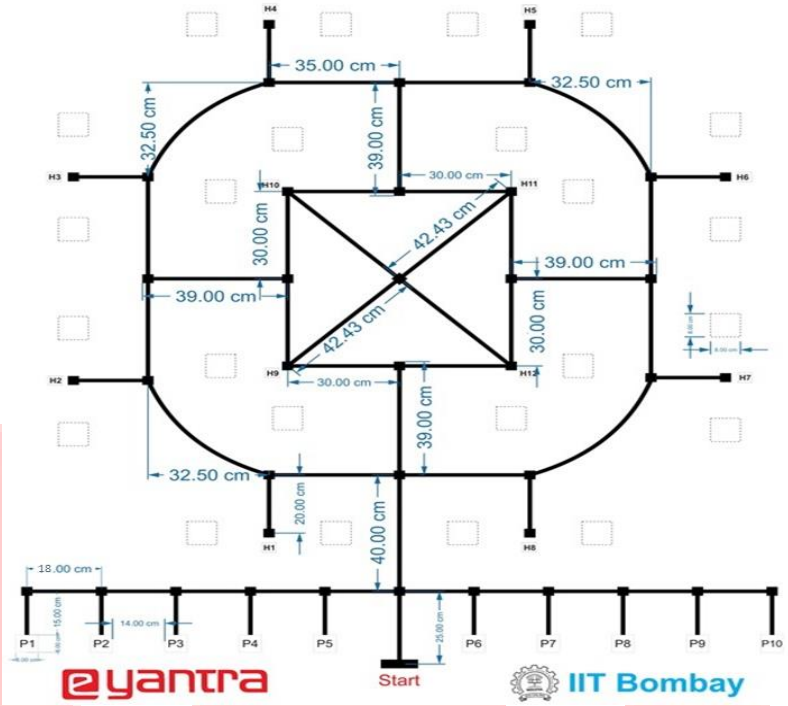

Figure 3: Flex Design

3.2. Preparing the blocks:

Materials required for preparing the blocks:

- Thermocol sheet for making the blocks.
- Red, Blue, Green and Black color chart paper for covering the blocks.
- Sample chart papers of all these colors are provided in your kit. Teams may need to purchase additional chart paper for preparing the blocks. Variation in the shades of chart paper may cause error in detection of these colors. Hence, we recommend that you take the sample chart paper and try to match these when you buy additional chart paper. All the colors given as samples have been tested for detection by the sensors provided with the robot. Note that similar chart paper as in the samples will be used in the Finals of the competition.

  NOTE: Accurate calibration of the sensors is key for successful implementation of a solution to this theme. You should make the sensing as robust as possible under different lighting conditions. Also take care in the fabrication of the blocks since the proper sizing, positioning and positional stability of the blocks might make the difference between failure and success.

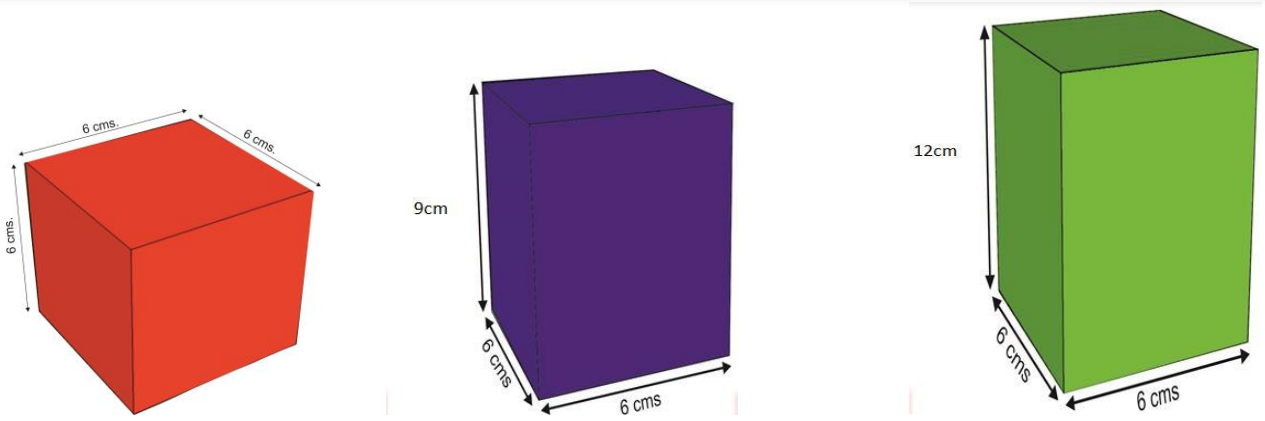

Figure 4: Examples of Blocks Representing Pizzas

- Team prepares 18 blocks using thermocol sheets.

- Dimension of Large block is 6cm x 6cm x 12cm, Medium block is 6cm x 6cm x 9cm and Small block is 6cm x 6cm x 6cm as shown in Figure 4. (If the Thermocol sheets of required dimensions are not available then the teams may cut or join the available sheets on their own).

- Team prepares a total of 6 blocks in each size, Large, Medium and Small. 2 blocks each of size Large are covered with Red, Blue and Green colored chart paper respectively. Similarly, 2 blocks each of size Medium are covered with Red, Blue and Green colored chart paper respectively and 2 blocks each of size Small are covered with Red, Blue and Green colored chart paper respectively. Sample blocks are shown in Figure 4.

3.3 Placing the blocks on the arena:

- Blocks are to be placed on the **Pick-up points**.

- Placement of the blocks for the competition will be given to the team as an image 24 hours before Task 3: Video Submission. Note that the image can represent any random placement of the blocks.

- As explained in our **theme description**, blocks are of color Red, Blue and Green. In the competition, Pizzas will be placed at the **Pick-up points**; some Pick-up points may be empty.

- We provide an example in Figure 5. If the team gets this image for placement of the blocks, they will place the colored blocks as shown in this figure and proceed with the task.

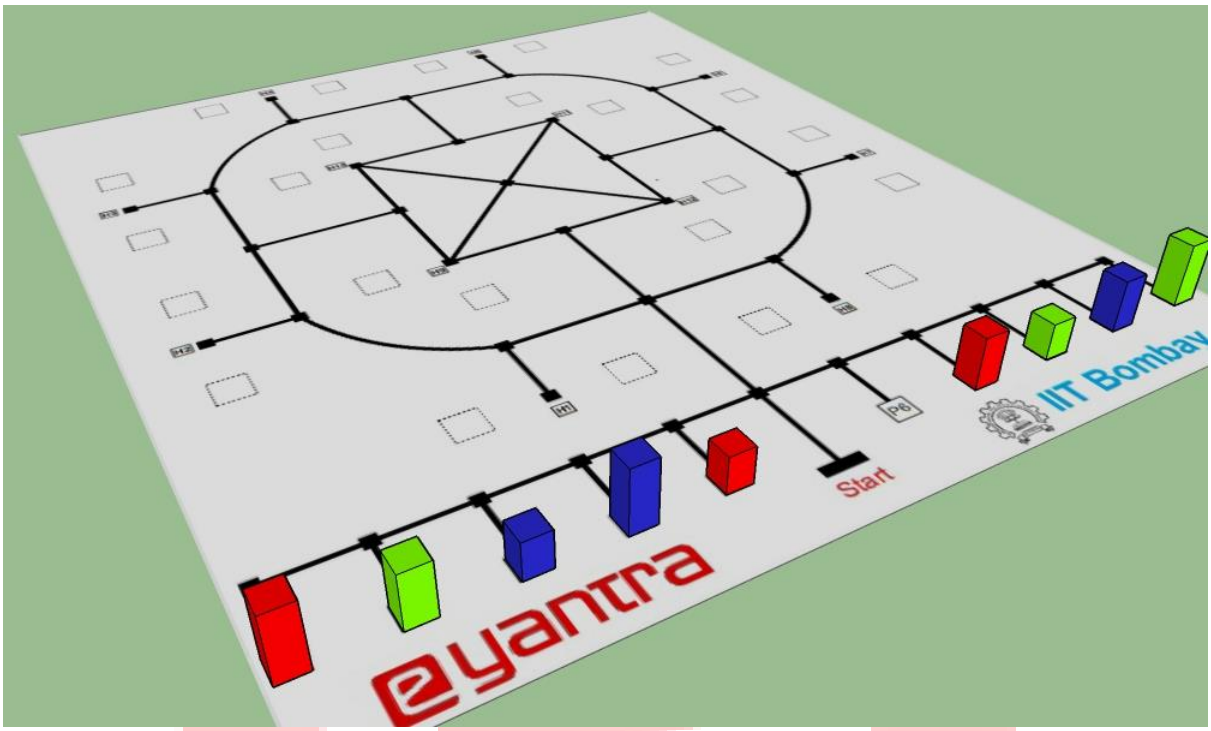

Figure 5: An Example of Placement of Pizzas on the Arena

Please maintain the arena in good condition. If the arena is found damaged or in a condition that makes evaluation process difficult, e-Yantra has the right to disqualify the team. The final decision is at the discretion of e-Yantra.

WARNING:
Please be careful while handling the flex sheet – avoid folding it at any stage as folding will result in creases which in turn will impair the movement of the robot. One way of "Flattening" flex if it has been compromised is to hang it for a few hours in the sun – it tends to straighten out. Never attempt ironing it or applying heat of any kind – it may be a fire hazard.

4. Hardware Specifications

4.1 Use of Firebird V:

- All participating teams must use **only** the Firebird V robot sent to them in the kit. **Only one** robot given in the kit is allowed per team.
- Team shall not dismantle the robot
- The robot should be **completely autonomous**. The team is not allowed to use any wireless remote or any other communication protocol or devices such as a camera while the robot is performing the task.

4.2 Use of additional components not provided in the kit:

- No other microcontroller-based board shall be attached to the Firebird-V robot.
- Teams may connect external actuators along with their driver circuits to the Firebird V robot only on the condition that the actuators must be controlled through the Firebird V robot.
- The team is not allowed to use any other sensors apart from those provided in the kit.

4.3 Power Supply:

- The robot can be charged through battery or auxiliary power supply. These are shipped with the robot.
- The team cannot use any other power source for powering the robot.
- The team can use auxiliary power during practice but the final demonstration should only be made using only battery powered robot.

5. Software Specifications

- e-Yantra has provided all teams with ATMEL STUDIO 6 – a free software programming AVR microcontroller. Participating teams are free to use any other open source Integrated Development Environment for programming AVR microcontroller.
- As per e-Yantra policy, all your code and documents is open-source and maybe published on the e-Yantra website.

6. Theme Rules

- The maximum time allotted to complete the task is 10 minutes. A maximum of **two runs** will be given to a team (the better score from the two runs will be considered as the team's score). A maximum of two **Repositions** will be allowed in each run.

  Reposition: Suppose while traversing the arena robot strays off the black line (Refer to Figure 6), a member of e-Yantra team who will be monitoring the task will place the robot on the previous node (node already traversed by the robot) in such a way that both the wheels of robot are parallel to the node and castor wheel is on the black line (Refer to Figure 7). This is termed as a **Reposition**. Note that the timer used for measuring the task completion time in the competition will be continuously running during a Reposition and robot will not be switched off.

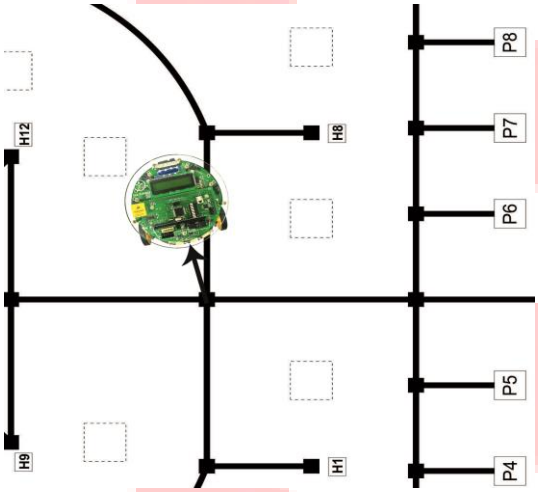

Figure 6: Robot strays off the black line

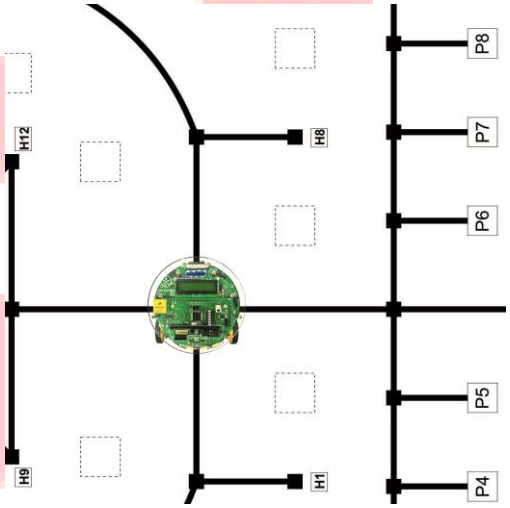

Figure 7: Placing of Robot after Repositioning

- **Deposition of Pizza:** Pizza is to be deposited in the deposition zone printed on the arena for each house.
  - **Correct depositon of Pizza:** If any part of the pizza is placed inside the Deposition Zone, it is considered as Correct deposition.
  - **Incorrect deposition of Pizza:** If no part of the pizza is inside the Deposition Zone or pizza is touching the boundaries of Deposition Zone, it is considered as Incorrect deposition.

    These are illustrated in Figure 8.

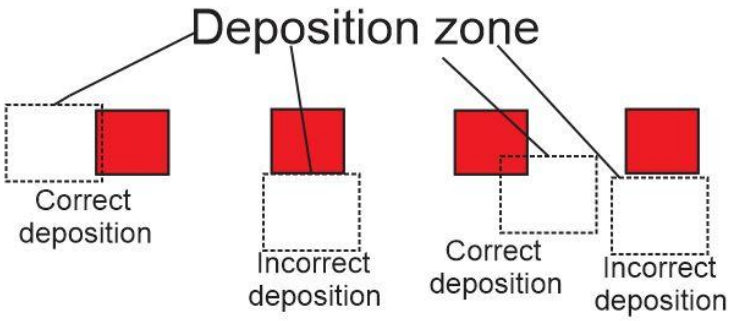

Figure 8: Placing Pizzas in Deposition Zone

- Robot should be kept at the START line with the castor wheel of the robot positioned on the line.
- The team should switch **ON** the robot when told to do so by reviewer. This is the start of a **run**. The reviewer will start the manual timer at the same time. **The robot should also start its internal timer at the start of the run. This timer measures T used for meeting the delivery requirements for each pizza.**
- Robot should be kept at the START line with the castor wheel of the robot positioned on the line.
- The robot is allowed to carry more than one pizza.
- The **Order Timeline** will be given 10 minutes before start of a run.
- Teams are given 10 minutes to initialize their robot with the given **Order Timeline**. After the prescribed 10 minutes the robot will be submitted to e-Yantra team.
- Teams are allowed to touch the robot only for keeping it at the START position to start the run.

  Note: After the first run team can only make changes to the mechanism if necessary; team will not be allowed to make any software changes.

Note:

- The robot can pick up and deliver a pizza in any order.
- Robot should visit the **Front Door** of the **House** to deliver the pizza.
- Seven Segment Module should be placed such that T displayed on it is clearly visible.
- The RGB LED should be placed such that it is visible for judging without any difficulty.
- **Important:** T displayed on the Seven Segment Module should be equal to the time measured using a manual timer. If it is found to have an error more than +2 or -2 seconds, the team will be disqualified.
- Participants are not allowed to keep anything inside the arena other than the robot.
- The time measured by the reviewer will be final and will be used for scoring the teams.
- Time measured by any participant by any other means is not acceptable for scoring.
- The robot is not allowed to make any marks while traversing the arena. Any robot found damaging the arena will be immediately stopped and the run is considered **incomplete**. The final decision is at the discretion of the e-Yantra team.
- The robot must be started with only one switch. The starting procedure of the robot should be simple and should not involve giving robot any manual force or impulse in any direction.
- A run ends and the timer is stopped when:

- The robot stops and sounds continuous buzzer or
- The maximum time limit for completing the task is reached.
- Both Repositions have been taken and Robot again strays off the line; the run is incomplete.
- The robot damages the arena and the run is incomplete.

- Buzzer sound for more than 5 seconds will be considered as end of task.
- Second run will start once again whilst resetting the score, timer and arena. The score of both runs will be recorded and best of two runs will be considered as the team's score.

Note:

- **You will be given: (i) An image for placement of the pizzas and (ii) an Order Timeline, just before the submission of Task 3: Video submission along with instructions for completing this task.**

- **After completion of all tasks, teams will be selected as finalists based on their cumulative scores across all the tasks. Complete rules and instructions for the finals at IIT Bombay will be sent to those teams that qualify for the finals.**

- **In case of any disputes/discrepancies e-Yantra's decision is final and binding. e-Yantra reserves the rights to change any or all of the rules as it deems fit. Any change in rules will be highlighted on the website and notified to the participating teams.**

7. Judging and Scoring System

- The competition time for a team starts from the moment the robot is switched ON. The timer will stop as soon as the robot finishes the task.

- The better score of the two runs for a team will be considered as the final score of the team.
- **Delivery:** When delivering pizza to the relevant house there can be following possibilities:
  - **Correct Pizza Delivery (CPD):** When appropriate pizza is delivered to the relevant house. Fifty (50) marks will be awarded if robot turns on the RGB LED depicting the color of pizza from the **Pick-up point** node of that pizza and turn off the RGB LED at **front door** of that house.
  - **Incorrect Pizza Delivery (IPD):** When wrong pizza other than what was ordered is delivered to a house.
  - **Invalid Pizza Delivery:** For Preorders, when correct pizza is delivered **before** the starting time of time window and for Regular orders, when the correct pizza is picked or delivered before the **order time**, it will be considered as Incorrect Pizza Delivery (IPD).

- **Correct Pick-up Correct Deposition(CPCD):** When the Robot correctly picks-up the pizza from the pizza shop and correctly deposits the pizza in the Deposition Zone it is termed as **Correct depositon of Pizza (**Refer theme rule section 6**).**

- The total score will be calculated by the following formula:

SCORE = (600 - T) + (CPD * 50) + (CPCD * 50) + (TIP*50) + (CD* 10)- (IPD * 20)- (P*50)

- **T** is total time taken by the robot to complete whole task.
- **CPD** is the number of **Pizzas Delivered Correctly** only after the **Order Time** or **Starting Time of Time Window**.
- **CPCD** is the number of pizzas correctly deposited.
- **TIP** is the number of times the robot delivers the correct pizza within the **Time Window** or **before the Deadline** as well as it **correctly picks up** and **deposits** the pizza.
- **Correct Detection (CD):** It is the number of times robot glows the corresponding color on RGB LED depicting the color of pizza while picking up the pizza.
- **Penalties (P):**
  - Ten (50) points will be deducted for each **Reposition**.
  - Ten (50) points will be deducted for **Damaging the Arena** (Dashing in the blocks kept on the arena).
- **IPD** is the number of incorrectly delivered pizza or Invalid Pizza Delivery.

NOTE: If the robot does not deliver a pizza then it will be considered as **IPD**.

ALL THE BEST ……!!!!!!!!!