e-Yantra Robotics Competition

eYRC-PD#1909

Team leader name	Pranjal Aswani
College	Thakur College of Engineering and Technology
e-mail	aswani.pranjal@gmail.com
Theme assigned	Pizza Delivery
Date	17/12/15

Scope (5)

State the scope of the theme assigned to you.

The pizza delivery bot using the Firebird V bot will be automated, which is a proof of concept to illustrate reduction of manual labour, thus saving time and money. This can be done by allowing the bot to receive all orders and autonomously deciding the optimal path and sequence to deliver pizzas. However, we need not limit ourselves to pizzas, with the right configuration, the bot could accurately identify a variety of objects, and be able to deliver them. This has applications in postal deliveries, pickups, etc.

Building Modules (5)

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

Mechanical Systems:

1. Arm to pick up “pizzas”
2. Gears, axle, and wheels

Electrical Systems:

1. Sensors (IR proximity sensors, sharp IR proximity sensor, white line sensor, colour sensor, position encoder, etc.)
2. Actuators (DC motors, servo motors)
3. Output devices (7 segment display, LCD, LED, buzzer, etc.)
4. Microcontrollers (ATMEGA2560, ATMEGA8)
5. Battery / power source

Actuators (10)

List all the actuators present on Firebird V robot. Besides the existing actuators, please mention the additional actuators that may be required for designing the robotic system in your theme if any.

Already present:
1. DC motors

Provided:
1. Servo motors

Explain the mechanism for controlling the actuators on your robot.

1. **DC Motor:** The velocity of the DC motors are controlled using PWM (pule width modulation). The L293D IC is a dual-motor driver which provides 600mA of current to each motor. This IC can control the direction of the motors by providing the appropriate logic levels to this IC.
2. **Servo motor:** Servo motors are used for their precision, which will be required in the arm used to pick up pizza boxes. The GS-5515MG servo offers 180 degrees of movement with a step of 2.25 degrees. It is controlled using PWM.

Environment sensing (5)

Explain the functioning of environment sensing technique used by Firebird V robot in your theme.

Sensors:
1. Sharp IR proximity sensor: Required to determine the height of the pizza blocks and categorize them appropriately.
2. IR proximity sensor: Required to determine the horizontal distance of the bot from the pizza blocks.
3. Colour sensor: Required to accurately categorize the pizza block, so the bot can select the appropriate pizza for a specific order.
4. White line sensor: Required to keep the bot on the flex map's black lines in order to correctly traverse the area.
5. Position encoder: Required for the bot to maintain its position internally so that it can be aware of where it is currently, and how it can go to the next position.

Power Management (5)

Explain the power management system required for a robot in general and for Firebird V robot in particular.

Robots in general may require varied amounts of power depending on the components used and the processor used. In general, standard voltage ratings are 5V, 9.6V, and 12V.
The Firebird V has a 9.6V NiMH battery pack and an auxiliary power mode. We prefer to use the battery pack as it allows us more mobility and freedom in testing the bot, and we can make sure that the batteries are used regularly in order to keep them functioning at maximum efficiency. The robot's power is divided into 2 power rails, one for the heavy loads like the DC motors, and the second for most of the other electronic components. This power supply is also regulated for all the components to receive the correct voltages and currents according to their specifications.
The battery supplies 2A of current and 12V regulated supply.

Navigation Scheme (10)

Explain in brief the basic navigation technique for path traversal in the arena. Explain the concept and list the components required for basic navigation.

The basic idea is to use the white line sensors to follow the black path on the flex sheet. The bot will keep track of its location from the start position using the position encoders and an internal representation of the map so it can accurately move to any given node at any point in time. It will recalibrate itself on the map according to the internal map it maintains and the white line sensors, in order to reduce reliability on the readings from the position encoders. This way, the bot doesn't rely *only* on the position encoders. Turning at nodes can be handled with a combination of the internal map and the position encoders in order to find the appropriate black line on the path it should take.

The required components for basic navigation are:

- DC motors for movement
- White line sensors
- Position encoders

Testing your knowledge (related to rule-book and sensors) (15)

<u>Note:</u> *Kindly attempt these questions only after reading the Rulebook*

What do you understand by “Preorders”? Define various parameters related to Preorders.

Preorders are orders placed at the beginning of the order timeline, which can be delivered within a specific time window**.** For example, an order with a **delivery time** of 6:00pm can be delivered anywhere between 5:30pm and 6:30pm. In this example, the **time window** is between 5:30pm and 6:30pm, not before or after that. The time window is twice the guaranteed time of a pizza shop. In the example, the **guaranteed time** is 30 mins.
The parameters related to preorders are **delivery time, time window, and guaranteed time** (50s in this competition).

What do you understand by “Regular Orders”? Define various parameters related to Regular Orders.

A regular order is an order placed at a specific time in the order timeline, called the **order time**. This means that the bot is not aware of the order before it has been placed. The bot must deliver the pizza within the **deadline**, which is the **order time** + **guaranteed time**, and it must only start the delivery after the order has been placed.
The various parameters related to a regular order are **guaranteed time** (50s in this competition)**, deadline, and order time.**

Refer to Section 3.2 in the Rulebook. You need to prepare one each of the Small, Medium and Large blocks which represent the pizzas as illustrated in Figure 4 in Section 3.2 in the Rulebook.
Interface the Seven Segment Module to the robot -- refer to the “Seven Segment Tutorial” in the Resources tab on the portal. Using the sharp sensor measure the height of each of the blocks (you may measure the heights of the blocks in any order) and display the corresponding values as given below on the Seven Segment Module:

Small block – display it as 006
Medium block -- display it as 009
Large block -- display it as 012
No block -- 000

Link to the video: https://www.youtube.com/watch?v=JMjg0OjJAZ4

Challenges (5)

What are the major challenges that you anticipate in addressing this theme?

1. **Path traversal:** Controlling the bot accurately to traverse the map from node to node might be challenging due to unreliable white line sensors and position encoders. Maintaining spatial memory is key to good path traversal.
2. **Robotic arm to pick up pizza boxes:** The arm might be difficult to make, and control with dexterity in order to reliably pick up and drop boxes in the correct deposition zone.
3. **Sensor unreliability:** Given the amount of fine-tuning required to use the sensors well, we may face problems generalizing the bot to any different external conditions.
4. **Edge cases with code:** We may not anticipate edge cases and our code may be too naïve to handle unexpected scenarios gracefully. For example, in testing we may have let a memory leak go unnoticed which might be a problem when the bot is in a more realistic competitive scenario. For this, we need to ensure that we stress test the bot under various conditions and make sure that it functions as we intend.
5. **Solving the order timeline optimally:** Given a certain order timeline, we must ensure that the bot's algorithm selects the most optimal delivery plan to minimize both time and costs. It should realistically analyze the timeline with as many good permutations as possible in order to avoid selecting a local optima on a curve.