# e-Yantra Robotics Competition

# e-YRC#467-FR

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| **Theme Assigned** | **Fertilizing Robot** |
| **Date** | **05/03/2014** |

## Requirements (10)

**State the requirements for building the system of the theme assigned to you.**

**Hardware requirements:**

1. Firebird V

i) Processing Unit (Atmel ATMEGA2560, AVR architecture based Microcontroller)

ii) Sensors

- Infrared Sensor : Sharp GP2Y0A02YK IR range sensor
  To detect the plants
- White line sensors
  To follow the black line on the arena

iii) System mobility control unit

Two DC geared motors in differential drive configuration and caster wheel at front as support.

iv) Fertilizing unit

Actuators (Servo motor) to control the mechanism to drop the pellet

v) Power supply (DC battery)

9.6V Nickel Metal Hydride (NiMH) rechargeable battery pack and external Auxiliary power from battery charger.

**Software requirements:**

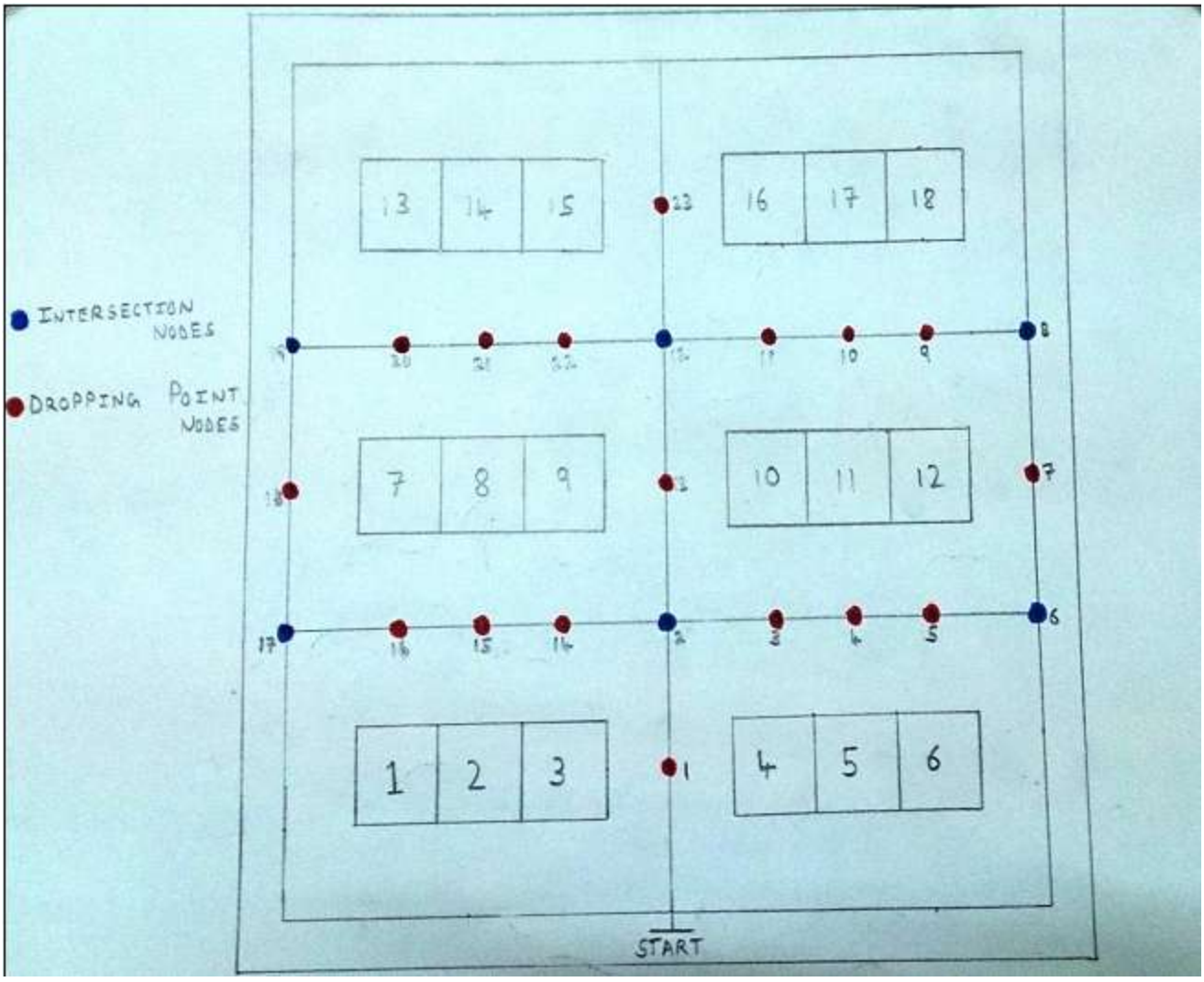
i) AVR Studio4: It used to write the code in embedded C and build.hex files.

ii) AVR Boot loader: it is used to burn the .hex file into the microcontroller.

**Input / Output operations:**

The sequence of plants to be fertilized is given in the form of tuples in the code. The algorithm determines the shortest path to be followed and is stored in an array. The .hex file generated is transferred into the bot using AVR bootloader.

The second input to the bot is the nodes as shown in the figure.




First is the intersection node (blue node) which is detected by the white line sensors of the bot. Once this node is detected the bot decides its direction of motion. Second is the node of dropping point (red node) which is sensed by the sharp infrared range sensor of the bot. Once this node is detected the bot

decides whether to initiate the dropping mechanism or not. If the bot has drop the pellets, the servo motor is moved in such a way that the pellet falls into the detected plant.

Once the sequence of a set of tupel is fertilized the buzzer is switched ON for 500 milliseconds and when the task is completed the buzzer is switched ON for 5 seconds.

## Design Constraints (10)

**Identify the major design constraints in the robotic system.**

**1. Only 3 white line sensors present:**

The three white line sensors present were not efficient enough to track the white line perfectly. The bot is stabilized using a proportional control in the code. For future use, the bot can be provided with five white line sensors and PID control mechanism for better stabilization with less settling time.

**2. Algorithm generalization:**

Algorithm used is generalized enough to find the shortest path for any input combination of 3 unit tuples and 4 unit tuples .

Algorithm stores the path i.e. nodes to be used to traverse the path in an array along with direction at each node.

Sensors need to be calibrated every time if the light sources present are not constant.

**3. Battery power:**

9.6V Nickel Metal Hydride (NiMH) rechargeable battery pack and an optional external Auxiliary power from battery charger are used to power the robot.

Current model does not have provision for using an AC power source. DC battery and voltage regulator ICs are used to power each and every blocks of system. DC battery needs recharging from time to time. Solar cells along with the DC battery can be used to reduce the recharging time and improve the overall efficiency.

**4. Parallel processing description:**

After determining the optimum sequence the bot starts to follow the black line. The white line sensors are used to detect the intersection nodes as well to follow the black line simultaneously. At the same time, the sharp IR sensors are used to detect the dropping point nodes.

## Challenges (10)

**Identify the key challenges faced during the development of the robotic system (hardware/software) and how each of those problems was solved.**

Challenges faced while making the complete system:

1. **Boot loader**:

The following error occurred when the **.hex** file had to be written into the microcontroller using AVR boot loader on Windows 7 (64 bit) operating system -

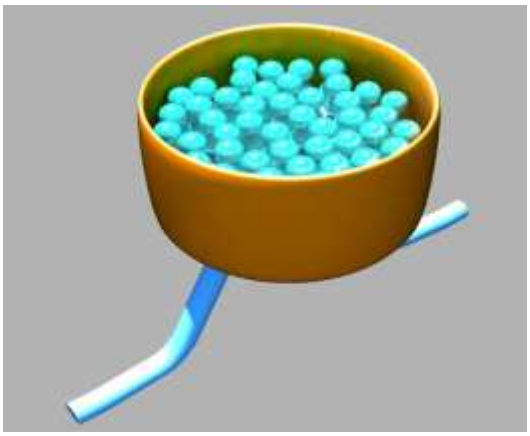
**ERROR:**
**Serial port timeout set to 5 sec.**
**An error occurred:**
**[Programmer not supported!]**

**Solution**: The operating system was changed to Windows XP (32bit).

2. **Dispenser mechanism**:

As shown in the previous report, the dispenser mechanism used a container to store the pellets. This created a problem as many pellets were getting stuck at the opening of the container, thus blocking it.

Solution: A straw system is used to tackle this problem. The pellets are stored one by one along the length of the straw such that only one pellet will fall through the opening at a time.



Old dispenser setup

new dispenser setup

3. **Line following**:
i) the three white line sensors were not efficient enough to follow the black line perfectly. This caused the bot to wobble around the black line.

**Solution**: The bot is stabilized using a proportional control in the code. For future use, the bot can be provided with five white line sensors and PID control mechanism for better stabilization.

ii) The bot faced problems while executing $90^{o}$/$180^{o}$ turns. It would not align properly with the black line after making the turn.

**Solution**: Small angle ($5^{o}$) turns are made using the encoder until the middle white line sensor comes over the black line.

4. **Plant detection**:
The plants are detected using Sharp IR range sensor. The same plant was detected twice when the bot took an $180^{o}$ turn.

**Solution**: The bot is made to move forward for a small distance after the turn while disabling the sharp IR range sensor during this distance. The bot then continues its path and the IR sensor are enabled.

5. **Encoder interrupts**:
The white line sensors freeze while taking a $90^{o}$/$180^{o}$ turn using position encoder interrupts and the code did not come out of the ISR loop.

**Solution**: All the variables used in the ISR are declared as "volatile" data type.

6. **Effect of ambient light sources**:
The changes in the ambient light affect the calibration of white line sensor. The ADC values read, changed depending upon the light present in the surroundings. This affected the line following ability of the bot.

**Solution**: Task was done under fixed light source. Sensors can be covered with black sheet to reduce the effect of ambient light.