e-Yantra Robotics Competition

Theme Report: Kolkata Robosome

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Theme assigned	**LINE FOLLOWER**
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Requirements (10)

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

The basic requirement of an autonomous line follower robot is a white line sensor module which uses a high intensity red LED for illumination and directional photo transistor for line sensing. No other external accessories as such is required as input. The number of sensors that can be installed in the white line sensor module depends on the arena. If the arena has sharp turns, then more white line sensors in a module is necessary to efficiently track the path, for example, detect intersections in a grid, etc. However, too many sensors would lead to problems regarding tracking adjacent lines if the lines are too close. So an optimum number of sensors must be used. It is recommended that the sensors have a sufficiently high range of ADC values so that the white and the black regions can be clearly distinguished from each other by a threshold value. The sensors should then be calibrated in a generalized way so that it is immune to the fluctuations in the ambient light conditions as far as possible.

For output, provision can be made for a LCD display and a buzzer to indicate the sensor values and other necessary parameters. The DC motors, which move the robot, should be free from electrical noise and offset values so that they are in perfect synchronization with each other. Positional encoders can be used to quantify the locomotion of the robot.

FIREBIRD – V satisfies almost all these requirements and therefore it can be configured to be an intelligent line follower robot.

Design Constraints (10)

Identify the major design constraints in the robotic system.

FIREBIRD – V is a very versatile robot which can be programmed to perform various kinds of tasks. The hardware of the system is robust and well-protected from external faults such as charging errors. However, a major constraint is that the sensitivity of the white line sensor module is different under different ambient conditions. During the daytime, the threshold value of the sensors drop drastically while at night, they rise. So the sensors have to be calibrated each time they are used alternately in day and night. This issue can prove to be a major concern if we intend to use automated line following transit systems in future. Better white line sensor technology has to be used to make the sensors immune to their environment and function with consistency.

The algorithm used for line following has essentially 2 parts:-

a) The **fine control** for the minor bends in the line where the proportional control algorithm is used. Here the error of calculated average sensor value from the desired value is used to generate a control variable for varying the velocity of the left and right motors accordingly to regain the track.
b) The **coarse control** for the sharp bends like a U-turn, V-bend, etc where the robot suddenly loses the line (all the white line sensors go off-track). In such a case, the history of sensor values, i.e, the previous sensor values are important in deciding which side to turn. Note that here, the velocity of the 2 motors remains the same and they just make the robot rotate on its own axis till it regains the line.

A limitation of the above algorithm is that it cannot detect intersections in a grid or traverse a loop efficiently.

Power utilization in the FIREBIRD is satisfactory. The parallel processing technique employed between the master ATmega2560 and slave ATmega8 is necessary as the master cannot handle so many operations at the same time. So there are no constraints regarding processing and power utilization.

Challenges (10)

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

The key challenges faced during the development of the robotic system are:-

a) The soldering of the 4 extra potentiometers for the 7x white line sensor module had to be done with much care since the delicate PCB had many wires closely placed in the vicinity of the soldering region.
b) The sharp V-bends in the track were one of the most challenging points in the entire arena. Here, the robot had to take almost 170 degree turns. So the previous sensor values were used to initiate the coarse control (as mentioned before) to make the robot turn in the direction of the line.
c) Traversing the grid via the shortest path, avoiding the black spots is a tough job. We could not solve this problem efficiently since our algorithm is only specific to this arena. Due to shortage of time, we could not incorporate a more general maze exploration algorithm to traverse the grid but we will keep working on it.
d) The change in logic of line following from white line to black line is a tricky one. Here we use the condition that if the next state of the sensors is just the complement of the previous state (i.e, 0 and 1 interchanged), we change the logic of line following from white to black.
e) The loop traversal is also a challenge as the robot tends to keep moving in the loop repeatedly due to two tracks diverging from one at the end of the loop. An efficient solution has to be found out for this problem.
f) The bonus point for stopping the robot at the end point is difficult to be done because here all the sensor values are active (on black line) but such a similar case has already occurred before during the start of the circular loop. So the program cannot distinguish these two cases uniquely.

Feedback

I) Three things I liked about this competition:
   1) The e-yantra competition provides the robotic platform free of cost to the participants. So teams get time for the coding without having to bother much about the hardware.
   2) The themes allotted are very pertinent and relevant for modern day scenario which can be implemented for making our lives easier.
   3) The doubt clearing on the online forum was good.

II) Three things that can be improved:
   1) The scoring criteria for task3 – demonstration specifies that the full marks will be above 500 but for task1 and task2, the full marks are 25 and 75 respectively. So there should be a scaling down of task-3 marks to 100 so that all the tasks are assigned equal importance and weightage.
   2) More resources and sample programs can be supplied to the participants.
   3) The competition should be popularized more, especially in the eastern part of the country.