e-Yantra Robotics Competition

Team Id : eYRC#1004-CS

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Theme assigned	**Cargo Sorting**
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Scope (5)

State the scope of the theme assigned to you.

Ans :

Cargo sorting as the name suggests refers to arranging cargo according to the requirement. For eg. Criteria for sorting at an airport could be the destination to which the cargo is bound to, according to which a cargo unit would move to a terminal where a flight bound to that particular destination is standing.

Cargo sorting is a necessary for variety services such as cargo sorting at airports, postal services etc. Such a cargo sorting robot can be used to sort cargo which is palletized. The purpose of such a robot would be to automate the cargo sorting process. As the figure illustrates, using a robot for cargo sorting would automate and reduce cost for cargo sorting

Building Modules (5)

Identify the major components in your robotic system provided required for designing a solution to the theme assigned.

Ans :

Mechanical Systems:

- Wheels and castor wheel: Required for basic movement of the robot.
- Gripper : For picking up cargo boxes

Electrical Systems:

- Motor : For the motion of the wheels.
- Servo motor : Used for moving the gripper

Electronic Sytems and IC's:

1) L293D IC : Required for driving the motors of the wheel

2) LCD interface : Required for displaying realtime information such as color sensor values, white line sensor values, IR sharp sensor values

3) Position encoder : It helps the robot in navigation by telling how much the robot has traveled. This could be used for example to move the robot close to an object (which is to be picked up) that is at a predetermined distance.

This consists of the following:

- MOC 7811 : IT is the Optical encoder which consists of the IRLED and the Photo transistor
- Schmitt trigger: For cleaning output from the output encoder
- Encoder disk (Slotted disk) : Disk which rotates between optical encoder to give the square wave

4) White line sensors : Required for following the black line on the flex sheet

5) IR proximity sensor : To sense the presence of cargo box and to move the robot close enough that the color sensor can take a reading.

6) Sharp IR range sensor: To sense the presence of a cargo box before the robot starts moving towards it at a particular terminal (after taking a turn that is..).

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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.

Ans :

Actuators present on the firebird robot are the:

1) Two DC geared motors : The geared motors are required for rotating the wheels for the basic movement. The geared motors are run on PWM signal via the timer 5 of ATMega 2560 and through the motor driving IC L293D. This controls the velocity of motion of the robot.

Also, the position encoders help in finding out how much the robot has moved. On the basis of position encoder reading, the robot gets to know how much distance has the robot travelled.

Actuators to be interface separately are :

2) Servo motors : These are used for tightening or loosening the grip or the grip of the gripper. On the basis of whether to pick one or two cargo boxes, the grippers claws can be moved by the servo motor. The servo motor works only when the robot has moved close enough to the cargo box. This it decides by the readings of the IR proximity sensor

Explain the mechanism for controlling the actuators on your robot.

Ans :

1) DC motors :

The DC motors are interfaced using the L293D IC. A single L293D can drive two motors. Pins 3 and 6 are outputs for driving one motor and pins 11 and 14 are used for driving another motor. The input for driving the motors come from the microcontroller port A and L to pins 2 and 7 for one motor and 10 and 15 for the other. Pin 1 and 9 act as PWM inputs for the motor driving IC.

2) Servo motors:

Environment sensing (10)

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

Ans :

Environment sensing is an important part of any robot in general.

Navigation is required for each and every robot. In case of a white or black line follower, navigation can only occur if the robot is able to sense the white or black strip. Another application where environment sensing would be required is the detection of an obstacle which would require a sensor such as IR proximity sensor.

The sensors used on firebird V for our theme are as follows:

- Sharp IR range sensor : These are used to check the presence of a cargo box before the robot decides to take a turn and move towards the cargo box at a terminal.
- IR proximity sensor: Since, the sharp IR range sensor have blind spot between 0-4cm, these sensors provide readings for the presence of an obstacle for this distance.
- White line sensors : These are used by the robot to track a black or a white line strip for following.
- Position encoder : These are required by the robot to keep track of how much distance has the robot moved.

Power Management (5)

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

Ans :

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.

Ans :

After receiving light from red LED of the white line sensor reflected from a white surface, the photo transistor's leakage current increases, this drops the voltage across it. On the other hand, when the robot is above the black line, lesser amount of light gets reflected and leakage is reduced; this results in higher voltage. This forms the basis of white or black line sensing. Analog reading are converted to digital by the built in ADC of the ATmega 2560 master microcontroller and ATmega 8 slave microcontroller.

If the reading from the middle WLS(white line sensor) is lower than a threshold, it implies that the robot is moving correctly and it keeps moving forward. If reading on left WLS is above the threshold, it means that robot is going off track towards left, hence move the robot right and similarly for the right WLS.

Components required for basic navigation would be:

1) Two motors

2) White line sensors

3) IC L293D (motor driving IC)

4) Microcontroller (Master ATmega 2560 and slave ATmega 8 in case of Firebird V robot)

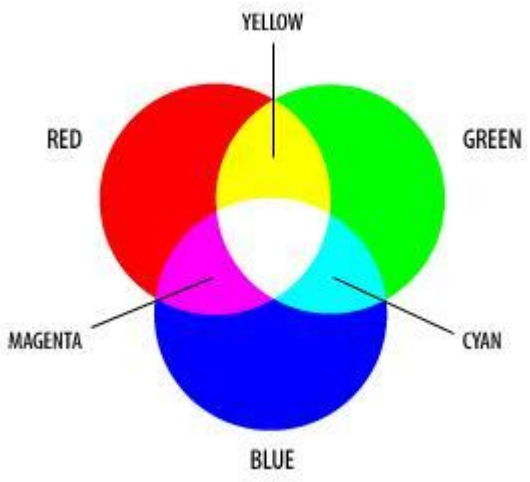
5) Built in ADC of the microcontroller’s

Testing your knowledge (Based on color sensor datasheet and tutorial) (10)

What is the principle of operation of the color sensor?

Ans :

Working principle



As we know, according to the RGB color model, a broad array colors is produced by red green and blue light added together in various ways. In other word, if we know the RGB data which constitutes different kind of color, we can get the certain color we test. With a certain color filter is selected(e.g red filter), TSC230 color sensor allows red light to get through alone and prevent other color green and blue light, so we can get the intensity of the red color. Blue and green light of intensity can be got in the same way.

S2	S3	PHOTODIODE TYPE
L	L	Red
L	H	Blue
H	L	Clear (no filter)
H	H	Green

TCS230 includes 8X8 array of photodiodes, 16 photodiodes have blue filters, 16 photodiodes have green filters, 16 photodiodes have green filters and 16 photodiodes are clear with no filters. With the different combination of S2 and S3, we can choose different type of color filter The full-scale output frequency can be scaled via two control input S0 and S1, by which we can output the different frequency coefficient (100%, 20%, 2%).

S0	S1	OUTPUT FREQUENCY SCALING (f_o)
L	L	Power down
L	H	2%
H	L	20%
H	H	100%

What are the functions of pins 1-8 of the color sensor?

Ans :

- Pin 1 : Output frequency scaling selection input (S0)
- Pin 2 : Output frequency scaling selection input (S1)

S0 and S1 are used to scale down the frequency of the output generated by the color sensor. This is done for measurement purpose.

- Pin 3 : Enable pin for output frequency f0. It is an active low signal (OE bar). It puts the output at pin 6 at high impedance state for multiple-unit sharing of the microcontroller input line.
- Pin 4 : Power supply ground
- Pin 5 : Supply Voltage (Vdd = 5V)
- Pin 6 : Output frequency f0

- Pin 7 : Photodiode Type selection input (S2)
- Pin 8 : Photodiode Type selection input (S3)

Pins 7 and 8 (S2 and S3) are used to select one type of photodiode out of a possible three.(red, green and blue)

What is frequency scaling and why is it necessary?

Ans :

Frequency scaling is done to provide a range of output frequencies such that the different frequencies can be used for optimal measurement by different measurement techniques.
Also, frequecy scaling would help in interfacing with a low cost microcontroller that has a lower frequency counter. Thus, it provides flexibiltiy in terms of the microcontroller used.(It can be of a higher frequency or a lower frequency)
Further, scaling can be used to improve resolution for a given clock.

Did you study the color sensor tutorial?

Ans : Yes

Did you burn the demo code on Firebird V and test the color sensor?

Ans : Yes

Was your color sensor working fine?

Ans : Yes

If no, please explain.

Not Applicable

Challenges (5)

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

Ans:

Ans:

Challenge 1 : As we know that given problem is of class NP-hard, there is no standard solution for the problem that will always give the best result. So, the algorithm we will design should give us the best result in most of the cases and near optimum in the rest. While addressing this problem, the algorithm complexity will increase which increases the time complexity. We have to decide a best way so that our algorithm should be time efficient and should also gives us the optimal results.

Challenge 2 : Right now, we still facing a conflict whether the cargo sorting should be done with two arm mechanism or one arm mechanism. The former approach is more complex that the latter one but it saves the travelling time to pick up the box again as we will have a spare arm to hold the box temporarily. But in some cases/configurations, the travelling time will be same as the other approach. So, more time will be wasted in the decision making , resulting in the inefficiency of the algorithm.

Challenge 3 : While the robot is moving it can get off track for eg. due to ambient light. Our approach should be intelligent enough to detect the false positives which prevents it from going off track.

Challenge 4 : The designing of the arm to lift the cargo should be done without harming the cargo while holding it.