Project Proposal – Summary

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Overall Strategy

The robot is required to perform following task according to the requirements:

1. Line Following
2. Wall segment avoidance
3. Climbing the ramp, opening the middle tunnel
4. Picking the box up and following the coloured path
5. Move in a specified segment and freeze when a sound is played
6. Avoid a moving guard robot

And the following strategies would be used to complete the above given tasks.

Line Following

For this task, a Pololu QTR-8RC IR Sensor Array would be used to identify the line. The input from the sensor will be fed into the microcontroller, and using the input from few of the sensors, robot aligns itself so that the line is constantly kept in the centre. This is done by repeatedly checking if the line is at the centre, and turning if it is not.

Wall Segment/Obstacle Avoidance

For this task, two HC-SR04 Ultrasonic sensors placed in the front, facing each side at angle is used. During the subtask 02, The line following code will run while quickly checking if an obstacle nearby is detected. As soon as an obstacle is detected, the robot will align itself to have a fixed distance from it, and traverse parallel to the object while keeping this fixed distance. The distance from the obstacle is constantly fed into the controller, while correcting its direction with the error of above feedback. This part is done using a PID algorithm.

Climbing the Ramp, Opening the Tunnel

While climbing the ramp, to identify the pitch of the robot's heading, a SW520D tilt sensor will be used. This will be used to identify the ramp to provide extra support during the climbing down by a manoeuvre similar to automatic breaking: by stopping the motion ever turn so the robot does not slip.

For opening the tunnel, an Ultrasonic Sensor facing front will be used to detect the box, and the robot grippers will be used to hold the box while pushing it to open the tunnel.

Picking Up the Box, Following the Coloured Path

The above-mentioned Ultrasonic Sensor will be used to detect this box, and then its colour will be detected using a TSC230 Colour Sensor attached to a Servo. Then the Servo is flipped 90° and will be used to identify the colour of the path. Then the box will be picked up using the gripper, and the IR Sensor Array will be used to follow the line.

Freezing When a Sound is Played

For this task, a MAX4466 Electret Microphone Amplifier will be used to pick up the sound. After feeding the output from this into the ADC of the Microcontroller, the robot will be made

to stop its motion if the output is greater than a certain threshold. During this segment, the robot will travel slower than in the other segments to assist sudden stopping.

Avoiding the Moving Guard Robot

The above mentioned 3 Ultrasonic Sensors can be reused in this task. Since the 2 side Ultrasonic Sensors in the front are at an angle, they can be used to identify the direction of which the guard robot is in, without crossing its path. At the same time by using all the Ultrasonic sensors, the robot can measure the speed of the guard robot. By having the information on speed, and the position, the robot can predict the speed it needs to travel the path, and it will start going at the optimal position, which is just after the robot had passed the centre point of the line.

Mechanical Design of the Robot

The current design of the robot contains 4 wheels, with a 2-wheel drive. Hence it has its weight distributed across a rectangular support polygon, which would in retum give a better weight distribution, and a greater traction which would be beneficial in traversing the ramp section.

The robot would have the approach angle and the departure angle greater than 25°, and the breakover angle less than 165°. This would ensure that the chassis does not contact the ramp. Semi-Pneumatic wheels with appropriate size to achieve above specifications would be used.

As of the current design, we will be using multilayered plexiglass for the design, as it is both lightweight, and durable enough to hold the load of the modules being used.

Robot Gripper

Also, the robot would have a gripper, to grip onto the boxes in subtasks 3 and 4. The robot gripper consists of two arms which are moved using a stepper motor, that would hold on to the object from the two sides. In the task 4, it is required to pick up the box from the floor level. To do this a servo motor would be used.

Actuators

For the motors, we will be using 34:1 Metal Gearmotor 25Dx64L mm HP 12V with a built-in CPR Encoder. The CPR encoder will be used to calculate the amount by which the motor turned, to turn more accurately. As of now, the motors will be supplied power with a L298N Motor Driver.

Also, 2 SG90 Micro Servo motors will be used: one in turning the colour sensor from front facing to down facing, and one in ‘picking up’ a box using the gripper. A small Stepper Motor with sufficient holding torque will be used in the robot gripper to move the two arms.

Power

For this robot, we will be using a 12V 5200mAh Li Polymer battery as its power source. As the voltage levels required for most of the sensors are between 3.3V - 5V, this would be obtained by the onboard voltage regulators of the microcontroller development board. This would be sufficient to drive the sensors, as it can give a maximum current of 800mA.