Robot Design & Competition
Strategy & Design Summary

Team Savitars

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September 28, 2024

1 Overall strategy

Initially the coin would be positioned on a electromagnet (KK P20/15 lifting solenoid) that is placed on the center of the robot. This will stay on until the coin drop.

The robot will employ array of five TCS34725 colour sensors for all the coloured & black,white line following tasks. Encoder readings will be used to maintain constant speed & detect the distances robot travel thus will be employed for task 1 for reading the white line code.

3 ToF sensors will be employed. 1 will be mounted facing front, on the gripper that is vertically moving and other 2 will be mounted on the sides of the robot. The front faced ToF will be used to detect the black, blocking wall in front of the coloured squares.

Colour sensor array will detect the tangled coloured lines withing 50ms each loop (24ms in the other regions as accuracy of the colours is crucial in this task).

In the task 5, white line segments following,after losing the white line, robot will move straight for some certain distance.In that period if the robot didn't come across an line,robot will rotate and come back by small decrements of distances.

Robot will stop after detecting the white square, near the gate. Front ToF will be employed detecting the gate. The robot will keep the vertically movable front ToF at a constant height for 8 seconds. If the ToF isn't blocked for atleast 1.5 seconds, then robot will move the ToF by 2cm vertically. This will be done until the gate is detected. After detecting the gate and making it confirmed by checking whether the reading is blocked for 5 seconds robot will move ahead as soon as it results in a unblocked ToF reading. (Distances, Periods are subjected to change)

The ToF sensor mounted on the gripper is also used to identify the heights of the box. The robot stops in front of each box at a constant distance, and the ToF sensor reads this distance.We then move the gripper upwards until the distance measurement changes.By noting the distance that the gripper have travelled when this change occurs, robot will determine height of each box For example, if the box is 10 cm, ToF distance reading will be blocked value, until we reach height of 10cm from the ground. The gripper has a vertical range of motion from 2.5 to 12.5cm. So this is feasible.

We use our front ToF sensor and parallel gripper to identify the distances and grab and lift the box. The same combination will be used to place the 5cm box in the chamber. The gripper is designed in a way that it can place the 5cm box in the 7x7 opening. After only grabbing the box inside half the length of the arms, robot will move forward until the box is completely inside the chamber and release the box.

After detecting the black stripes using the colour sensor array, the robot will enter the uneven terrain and will employ the side mounted and front faced ToFs to navigate without hitting the walls.Colour sensor array will be used to detect the black cross. As this sensor is cable of identifying colours accurately at a distance above 1cm, this sensor array will be placed in such a way that the robot has enough ground clearance. The robot will go to the center of that area following a rectangular spiral path using the distances to the walls obtained through the ToFs. Encoder readings would not be employed here as slipping can occur. This way the robot will cover the entire area and won't miss the cross. After arriving at the cross, the robot will de-energize the solenoid and release the coin.

2 Robot mechanical design

2.1 Actuators

The **MG90 servo motor** will be used to drive the gripper across the vertical rack.**SG90 servo** will be used to open and close robot's parallel gripper arms. **4 JGA 25-370 brushed DC motors with encoders**will be used to drive the robot. KK P20/15 solenoid will be used to grap and drop the coin.

2.2 Mechanisms

In our 2nd design iteration, robot employs 4 wheel design that let addressing and controlling each motor separately via 4 attached encoders and 2 dual motor controllers. The robot will utilize rack and pinion mechanism for its parallel gripper.The gripper arms has a very small thickness of only 4mm, enabling it to navigate tight spaces.With a maximum opening of 6.9cm, the gripper can grasp the 5cm box. Even while holding the box the combined width of the gripper arm (4mm) and the grasped box (5cm) adds up to 5.8cm, leaving enough space to pass through the 7cm x 7cm chamber opening.The gripper has a vertical range of 2.5cm to 12.5cm.

3 Sensors

We mainly use **5 x TCS34725 color sensor, 3 x VL530L0X Time-of-Flight sensors** and will use an I2C multiplexer to address each of the TCS34725 sensor module as it doesn't contain an XSHUT pin. Colour sensor array will be mounted on the front of the robot about 1.2cm from the ground. ToFs are mounted at sides and on the gripper. Applications of each sensor is mentioned in the overall strategy section.

4 Algorithms

- PD controller will be used to maintain constant speed and for line following.

- Rectangular spiral search will be used to navigate the uneven terrain. The robot will first turn 90 degrees and perform wall following until it can no longer proceed. It will then turn 90 degrees again and resume wall following. After completing one round of wall following at a certain distance, the distance threshold for wall following will be incremented by the robot's wheel gap.The robot will then follow the walls at a greater distance, creating a rectangular spiral path to cover the entire area. This process will allow the robot to locate the black cross in the terrain.

- For maze navigation, the robot will first identify the unblocked colored cell. If the unblocked colored square aligns with the position of the box, the robot will navigate directly to that position from the second 120cm line, reverse back to the colored cell, and drop the box. If they don't align, the robot will return to the position in the shortest path and pickup and reverse or go forward and drop the box at the aligned position with unblocked coloured squre. Then it will go to the 2nd 120cm line again and reverse back to the coloured cell and drop the box there.