CECS 347 Spring 2025

Project # 2

By

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Summary:

This project focuses on building a robot car that can operate in two modes. First, object following and secondly, wall following. The robot uses many components, including two DC motors, three infrared sensors, and a microcontroller (LaunchPad) to help navigate and sense the environment. The project helps us understand basic microcontroller hardware components, including GPIO, interrupts, ADC, and PWM, while building a working embedded control system. As the robot toggles between the two modes, it also reacts to sensor inputs, and performs the corresponding actions based on its surroundings.

Introduction:

The project involves creating an autonomous robot car that can detect and follow an object or a wall using infrared (IR) sensors. The robot can toggle between two primary modes: Object Follower and Wall Follower. In the object follower mode, the robot follows an object placed in front of it keeping a fixed distance of 20 cm, and adjusts its movement based on the object's position or angle. In the wall follower mode, the robot detects a nearby wall and follows it closely. The robot makes turns and sticks to the wall as it takes into account its distance from the wall.

Operation:

The robot car is powered and activated via onboard switches. When the robot is in an inactive state, we can switch between the two modes:

Object follower mode: After pressing switch 1, the robot follows an object within a 20 cm range, the car reacts to the movement of the object, adjusting its speed and direction, and with the optional feature that if the robot stops when an object is placed too close (less than 10 cm).

Wall follower mode: After pressing switch 2, the robot detects a wall on either side and follows it making sure it does not collide, and it can follow the wall to the left or right depending on which wall is detected.

In both modes, the robot stops if it detects an obstacle too close or if the object it's following leaves its range. LED indicators show the current mode of the robot (RED for inactive, BLUE for object following, and GREEN for wall following). In addition, when within a mode, when a switch is pressed in its corresponding mode, the robot exits the mode and goes to inactive mode and waits for the next switch press.

- Videos:

Video Link for Object Follower

Video Link for Left Wall Follower

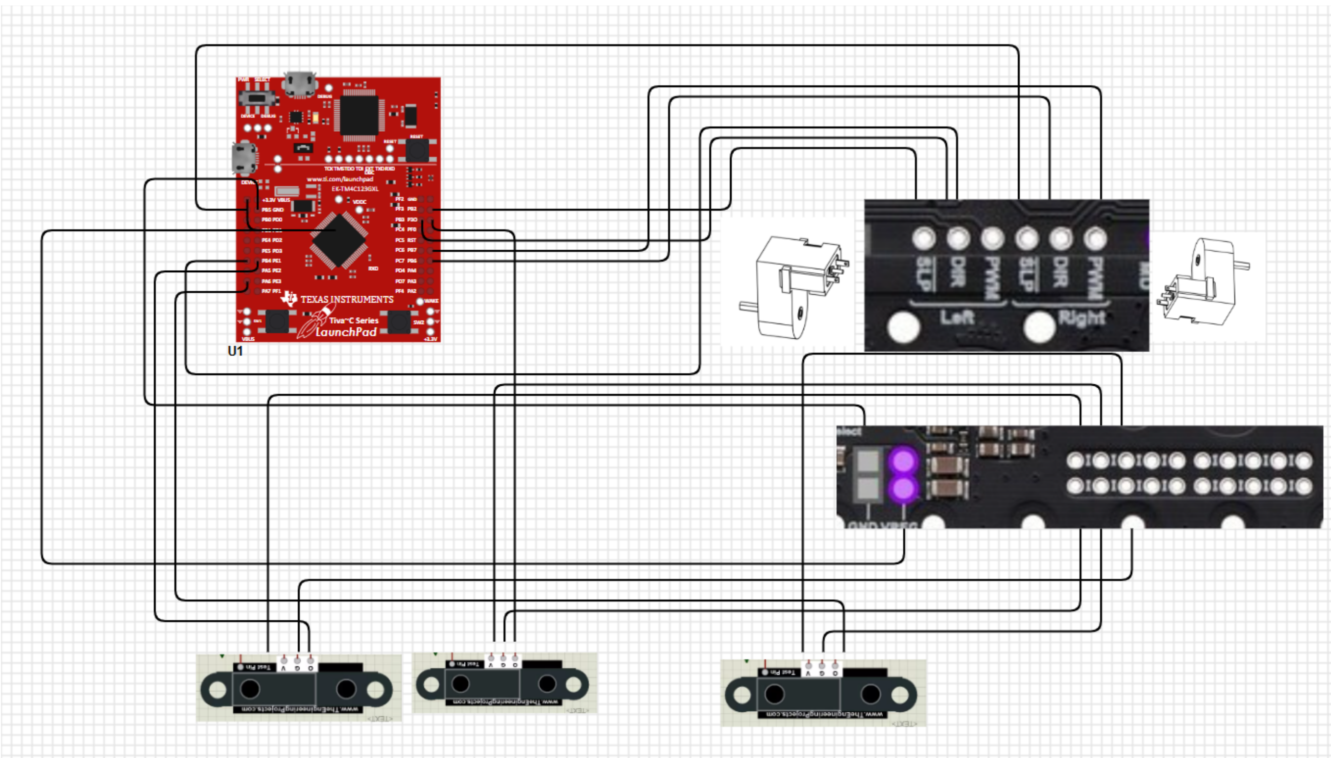
Video Link for Right Wall Follower

Theory:

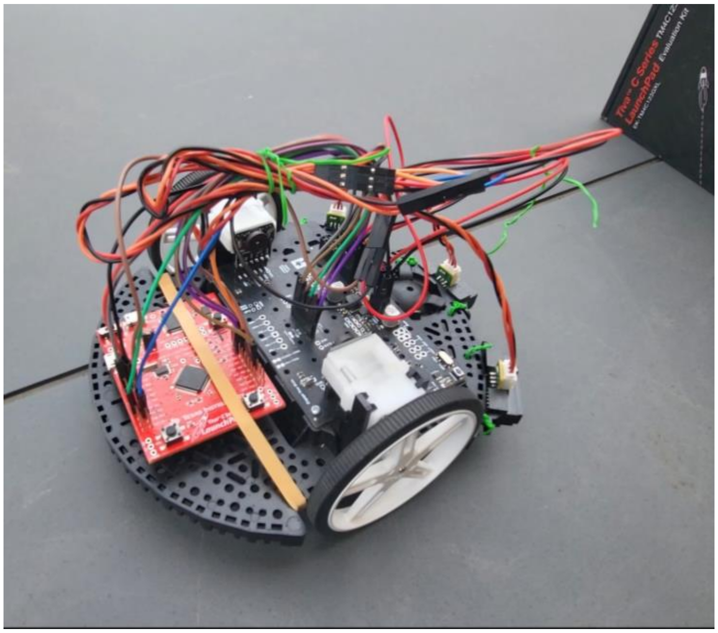
This project helped us integrate several core concepts in embedded systems like general purpose Input/Output pins that are used for interacting with the sensors, switches, ADC, PWM, and interrupts. Interrupts that are employed to detect when the robot should switch between active states or modes based on our input. Analog to digital conversion (ADC) is used to read analog values from the IR sensors, which provide distance measurements to detect objects and walls. The system uses three IR sensors to gather data, and this input guides the robot's movement decisions. PWM/Pulse Width Modulation is used to control the speed of the robot's motors. The frequency and duty cycle of the PWM signal determine how fast the motors spin, which in turn controls the robot's movement. For the control algorithms the robot must process data from the IR sensors to steer. In the object follower mode, the robot calculates the distance from the object and adjusts its movement to maintain a set distance. In wall follower mode, it adjusts its path based on the proximity to a detected wall.

Hardware Design:

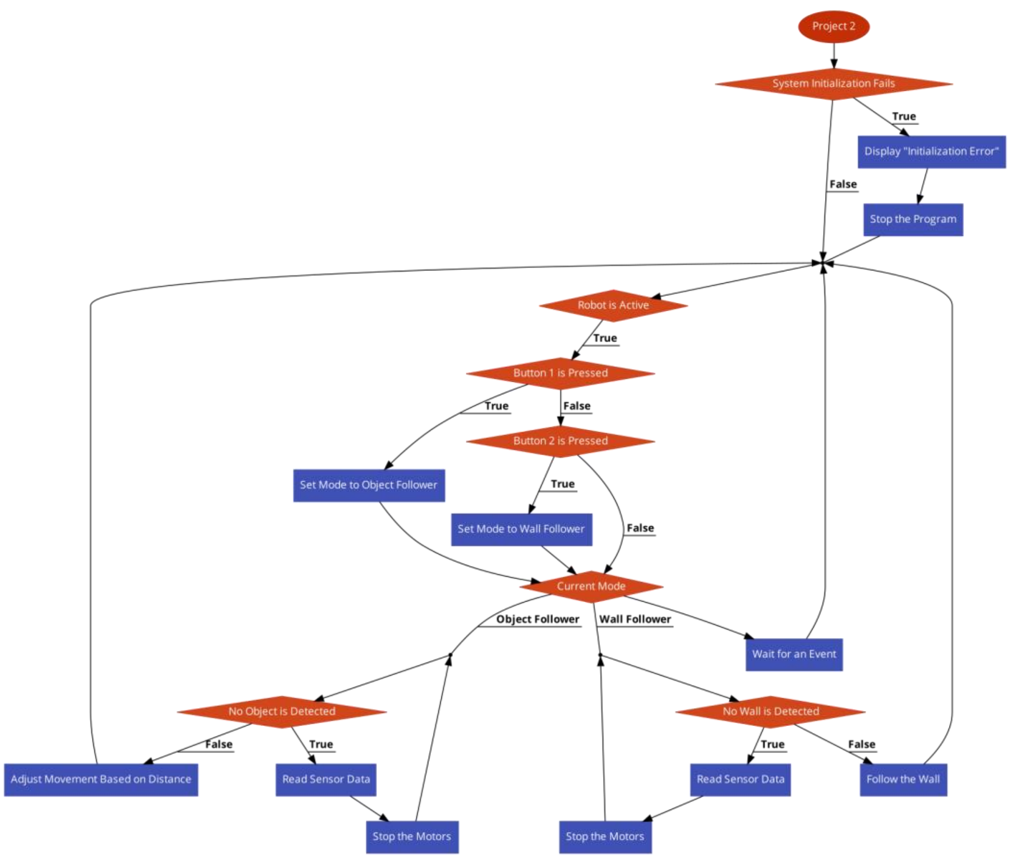
- Schematic:



- Picture of robot car:



Software Design:



Code Listing:

ZIP file attached.

Conclusion:

The Following Robot project successfully integrates key embedded systems concepts, including sensor interfacing, motor control, and real-time decision-making. By building a robot that can toggle between object following and wall following modes, the robot's ability to react to its environment and perform autonomous tasks showcases how embedded systems can be used for real-world robotic applications.

However, the project also presented some challenges. One significant issue was calibrating the IR sensors for accurate distance measurements, as varying environmental conditions like different room lighting which resulted in having to recalibrate before testing it in a different room and sensor placements affected the robot's performance. Adjusting the sensitivity of the sensors and testing them in different environments was time-consuming and required careful tuning. Another challenge was making sure that there was smooth communication between the microcontroller and the hardware components, particularly in the wall-following mode, where the robot had to maintain a consistent distance from the wall while avoiding obstacles. Additionally, the PWM control for the motors required precise adjustments to avoid erratic movement, as the motors' response to different PWM signals varied depending on the load.