Autonomous light tracker mega project

A report submitted as partial fulfillment of the requirements of the Automotive embedded systems diploma by EME at EUI university

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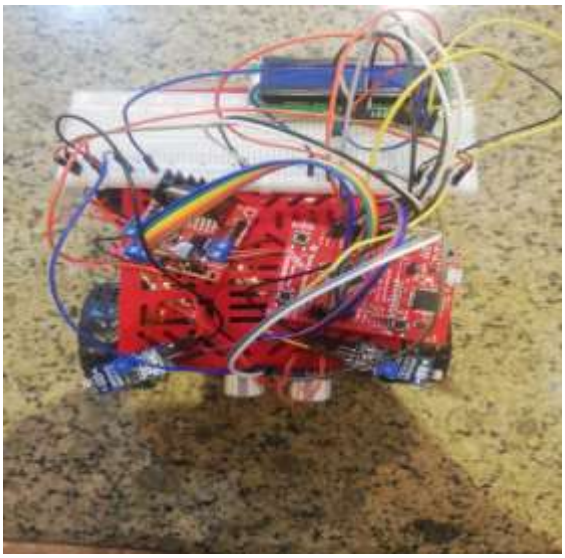
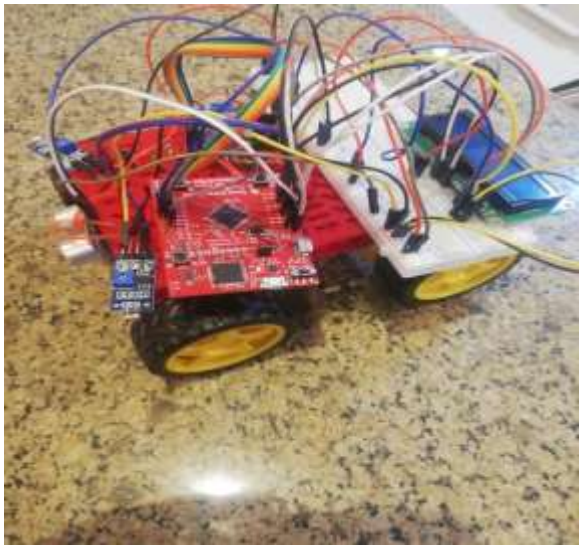
Introduction

Tasks are essential in real-time operating systems (RTOS). The goal of this project is to construct a non-preemptive scheduler, which is the RTOS's central processing unit and is in charge of switching tasks. The main goal of this project is to build a straightforward simple scheduler that manages various Tasks based on their periodicities. We created an autonomous vehicle with multiple sensors and parts to illustrate the operation of this scheduler.





Sensors Description

Photo-Resistors

Description: Photo-resistors are light sensors capable of detecting changes in light levels.

Circuit Topology: These sensors are integrated into the car's chassis, positioned strategically to monitor the surrounding light.

Ultrasonic Sensor Module HC-SR04

Description: The HC-SR04 is an ultrasonic sensor module used for distance measurement.

Circuit Topology: The sensor module is placed at the front of the car, facing forward to detect obstacles. It emits ultrasonic waves and measures their reflection to determine distances.

On-board Temperature Sensor

Description: The on-board temperature sensor measures the ambient temperature.

Circuit Topology: The sensor is integrated into the car's internal circuitry to monitor temperature levels.

LCD Display

Description: An LCD display provides real-time feedback and information.

Circuit Topology: The LCD is connected to the car's microcontroller to display temperature readings, light sensor differences, and other relevant information.

Motor Drivers

Description: An H bridge module for driving the current to motor with polarity.

Circuit Topology: Motors are connected to each of the motor drivers.

Components Layout

The components of the autonomous car are interconnected to create a functional system. Here's an overview of how these components are connected:

The car's motors are controlled using on-board switches to start the car for a minute and another one to stop the car.

The car stops either when the other switch is pressed or after one minute of operation.

When the motors start, the car moves toward the area with the highest illumination.

The LCD displays information, including temperature, LDR sensor differences, and elapsed time.

If the car approaches an obstacle within 10 centimeters, the ultrasonic sensor triggers, and the car reverses its direction and then rotates by 90 degrees.

Schedular Design

To successfully design our schedular we had to go through some design rule of thumbs.

SysTick Value > Total execution time of all tasks

Using this rule, we measured the execution time of all tasks using systick timer to be 15ms so we chose a Systick value of 20ms.

Then came the choice of tasks periodicity, we had three tasks so we tried to chose periodicities that make the hyper period large as possible to decrease CPU utilization

```
/* Chosen Periodicities of Tasks*/
#define LDR_PERIOD              100
#define LCD_PERIOD              200
#define ULTRASONIC_PERIOD       40
```

Where the hyper period can be easily calculated using the LCM of all periodicities which is 200ms

Hyperperiod (H) = LCM(Pi),
Where (Pi) is all task periodicities

We calculate the CPU utilization using the following formula

- U = R/C

- U = Utilization
- R = Requirements which in simple terms is the BUSY TIME
- C = Capacity which is simple terms is BUSY TIME + IDLE TIME

Therefore utilization is the summation of functions execution times divided by the Hyper period

U=15/200 = 7.5%

Features Validation and Verification

The features of the autonomous car were validated and verified through testing and observation:

Light Tracking: The car effectively tracks light sources when tested with a flash mobile light on both sides but one has to be careful with the threshold values between the two sensors as different lighting conditions affect them.

Obstacle Avoidance: It detects obstacles within **10 cm** as required and changes direction

Temperature Monitoring: The car accurately measures and displays temperature levels using the in board temp sensor.

Real-time Feedback: Information about the car's status and sensor readings is displayed in real-time on the LCD.

Motor Control: The motors were tested for forward, backward, turning left and right, and stopping.