جامعة مصر للمعلوماتية
EGYPT UNIVERSITY
OF INFORMATICS

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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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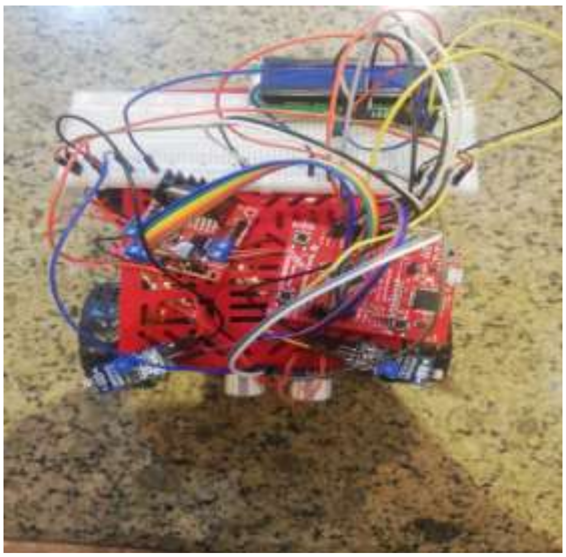
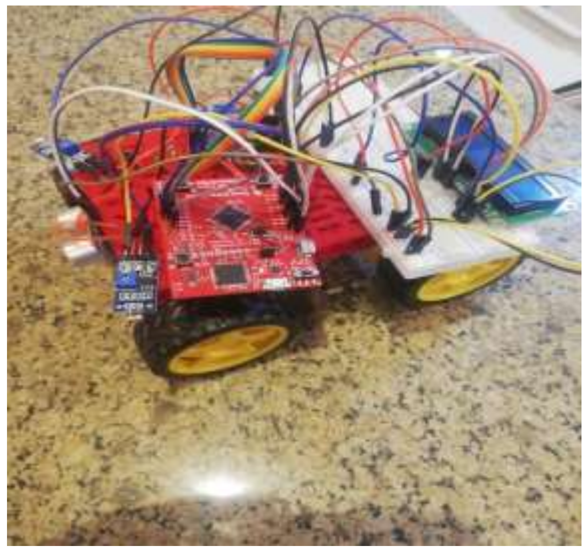
Introduction

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 switchin**g 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.

Ultrasonic Sensor Module HC-SR04

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

On-board Temperature Sensor

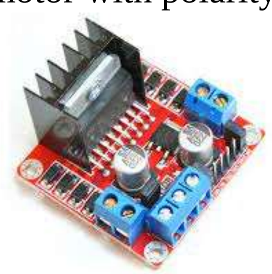
Description: The on-board temperature sensor measures the ambient temperature.

LCD Display

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

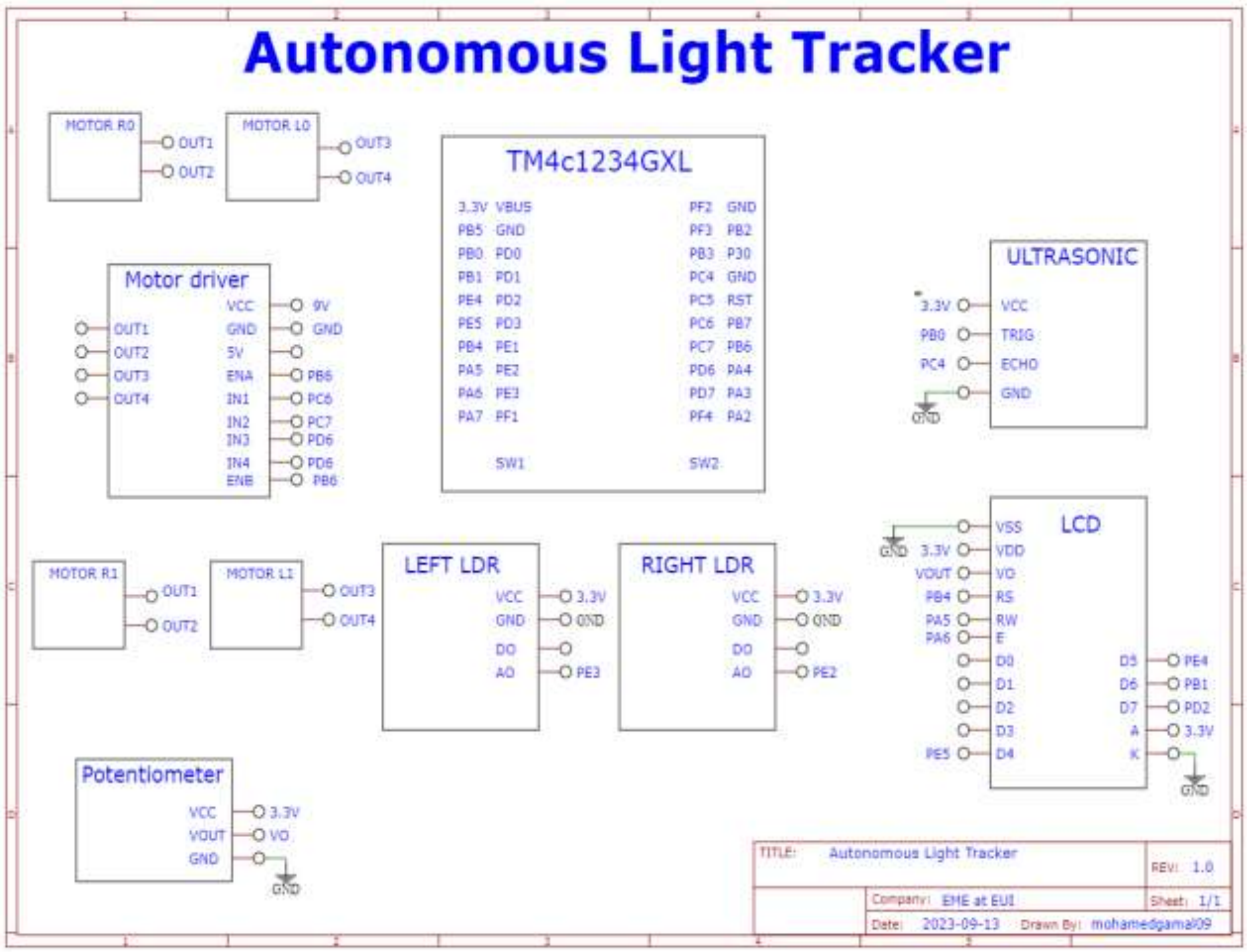
Motor Drivers

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



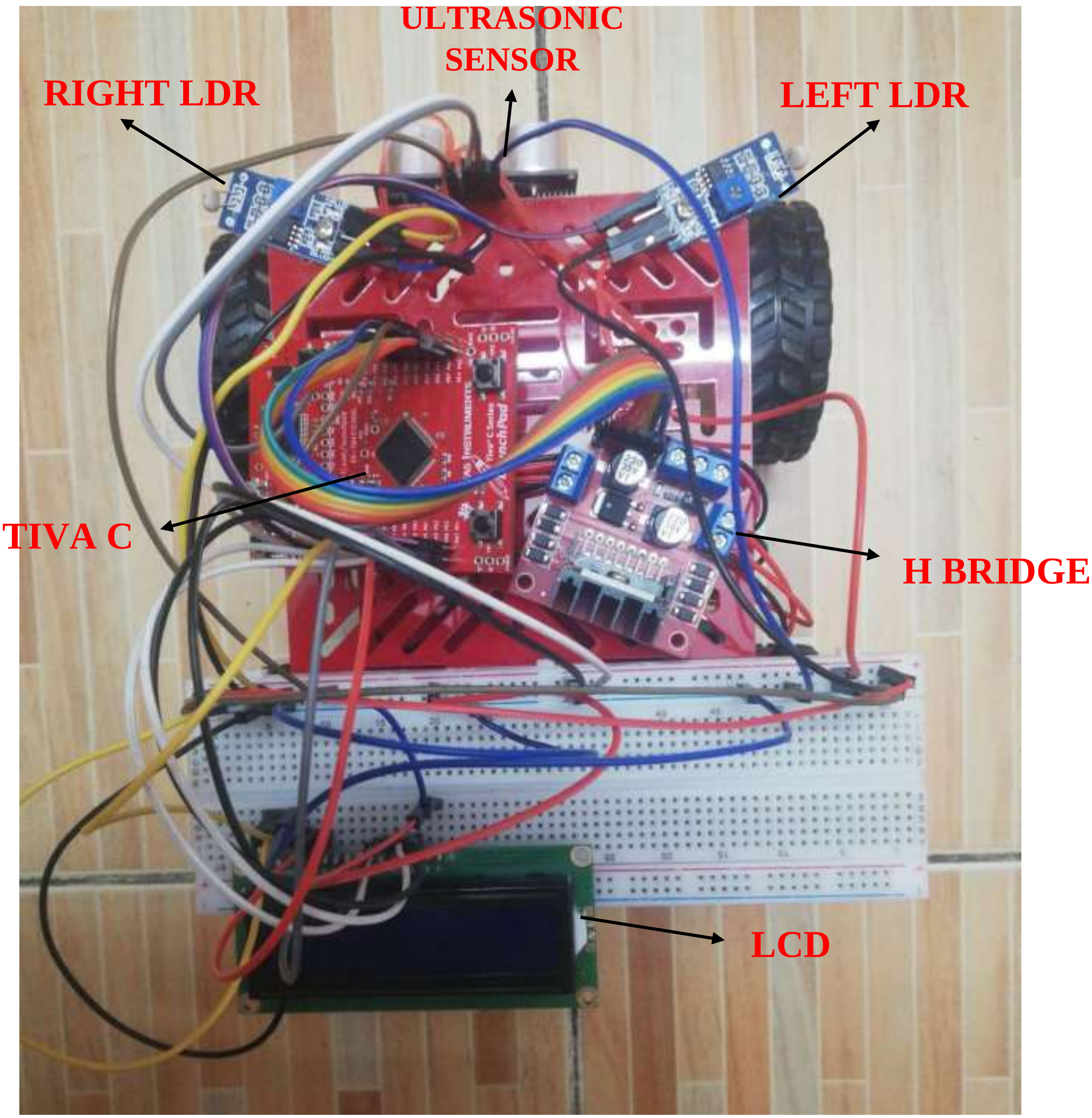
Circuit Topology

The Circuit topology indicates the Electrical signals connections and where is each pin exactly connected on a board.



Components Layout

The components Layout indicates the physical positions of each sensor and their connections on the board.



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

$\boxed{\textbf{U=15/200 = 7.5\%}}$

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.

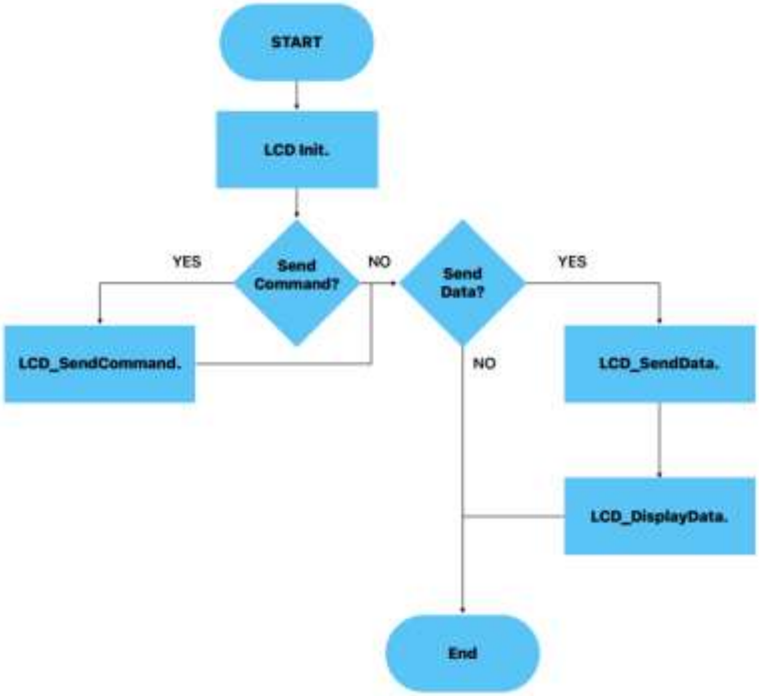
Real-time Feedback: Information about the car's status and sensor readings is displayed in real-time on the LCD.

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

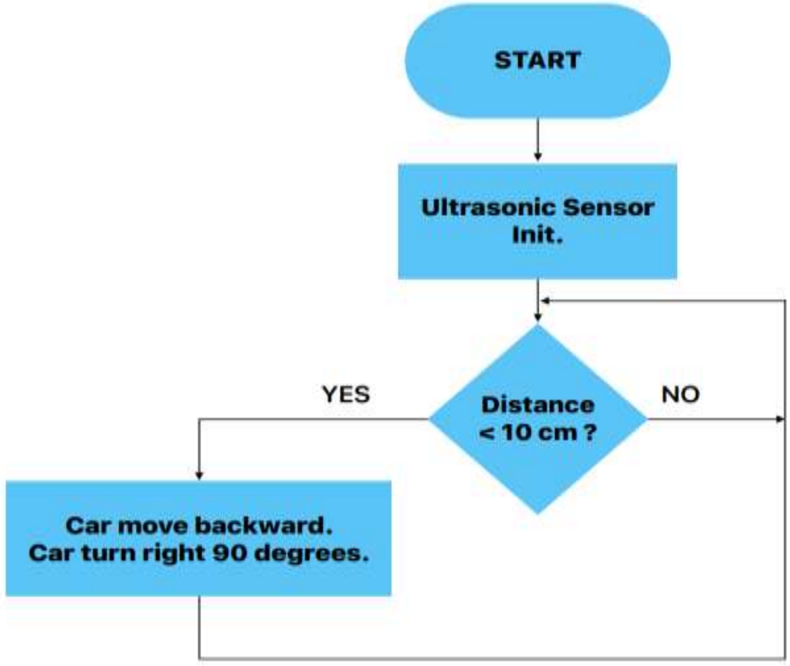
FLOWCHARTS

Modules:

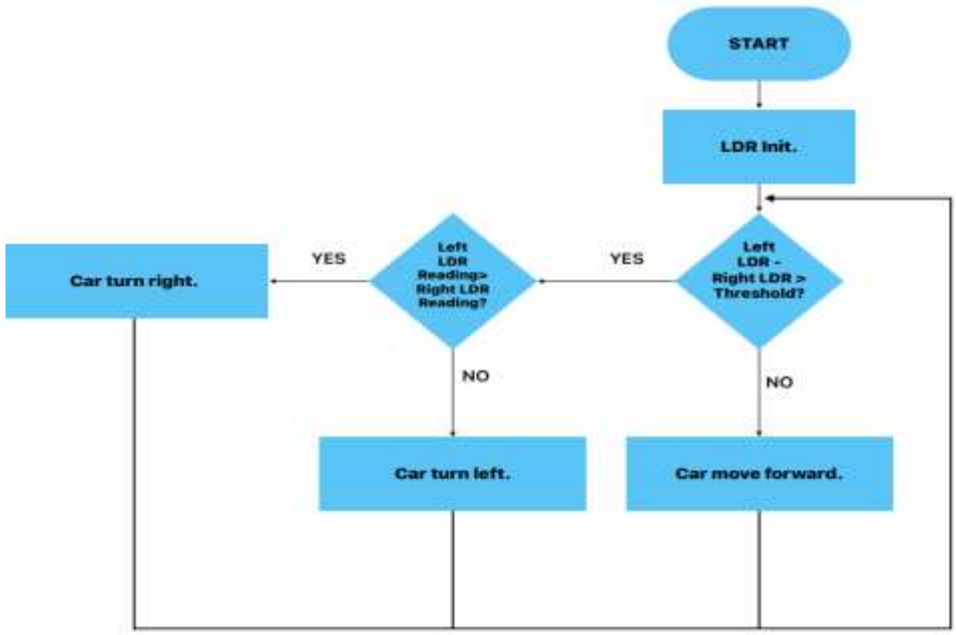
LCD



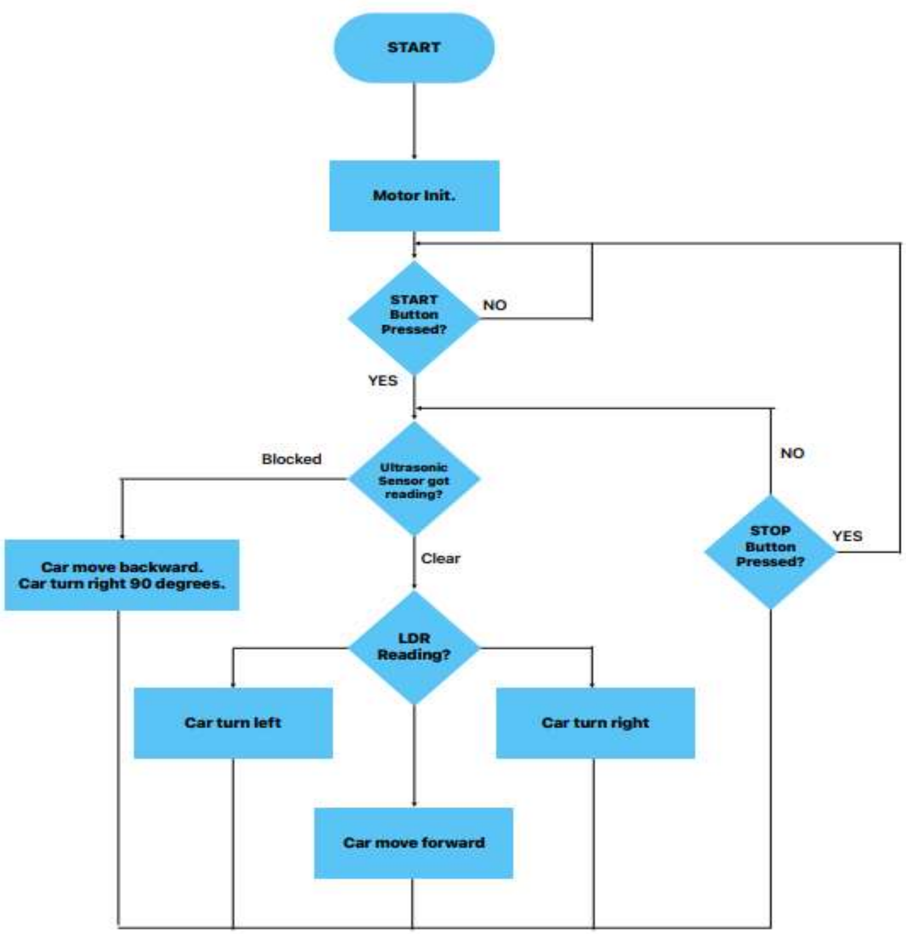
ULTRASONIC



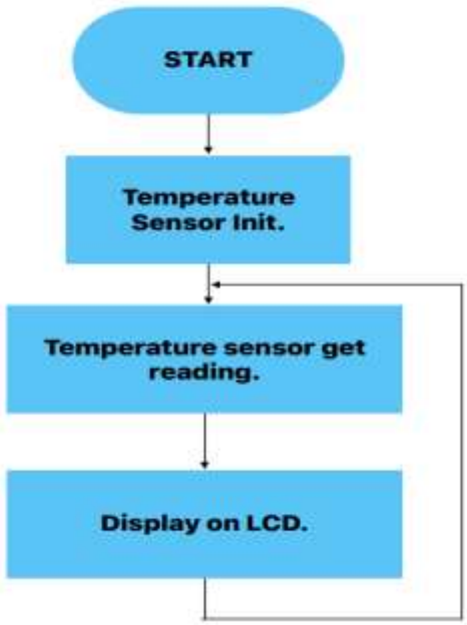
LDR


START
LDR Init.
Left LDR - Right LDR > Threshold?
YES
NO
Left LDR Reading> Right LDR Reading?
YES
NO
Car turn right.
Car turn left.
Car move forward.

MOTOR


START
Motor Init.
START Button Pressed?
NO
YES
Ultrasonic Sensor got reading?
Blocked
Clear
NO
STOP Button Pressed?
YES
Car move backward.
Car turn right 90 degrees.
LDR Reading?
Car turn left
Car turn right
Car move forward

TEMPRATURE SENSOR



CAR APPLICATION: