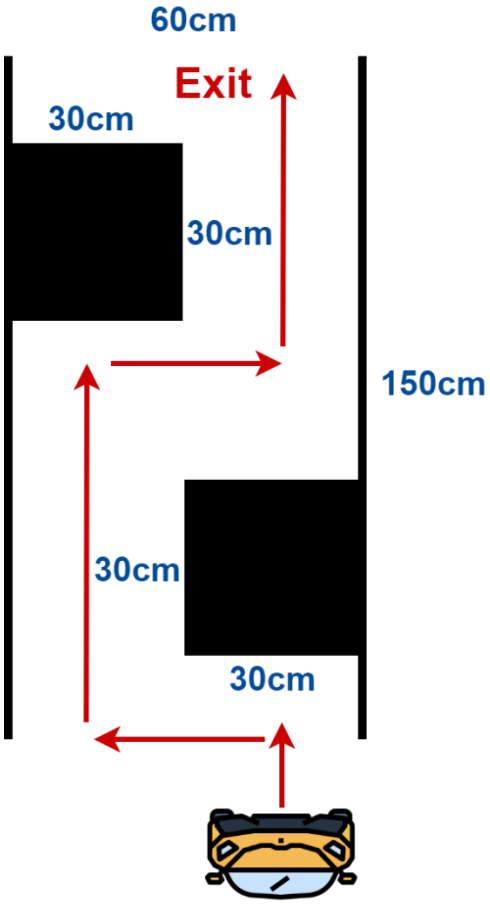
Project 1: Obstacle-Avoiding Robot

An ***obstacle-avoiding robot*** project involves designing and constructing a **robotic car** capable of automatically navigating through an environment while **avoiding obstacles in its path**. Typically, such a robot is equipped with sensors, such as **ultrasonic sensors**, to **detect obstacles** and determine their proximity. The robot's control system processes sensors data to **make real-time decisions**, **adjusting its direction or speed** to **avoid obstacles**.

In a typical obstacle-avoiding robot project, the hardware components include **motors for movement**, **wheels** for mobility, a **chassis to hold the components** together, and a **microcontroller to serve as the brain of the robot**. Key to the obstacle avoidance functionality are **distance sensors**, commonly **ultrasonic sensors**, which emit signals and measure the time it takes for the signals to bounce back after hitting an obstacle. The **microcontroller processes this data and triggers the motors** to change direction.

Programming plays a crucial role in implementing an **efficient obstacle avoidance algorithm** by enabling the robot to **interpret sensor data**, **make informed decisions in real-time**, and execute precise **control commands for motor movements**.

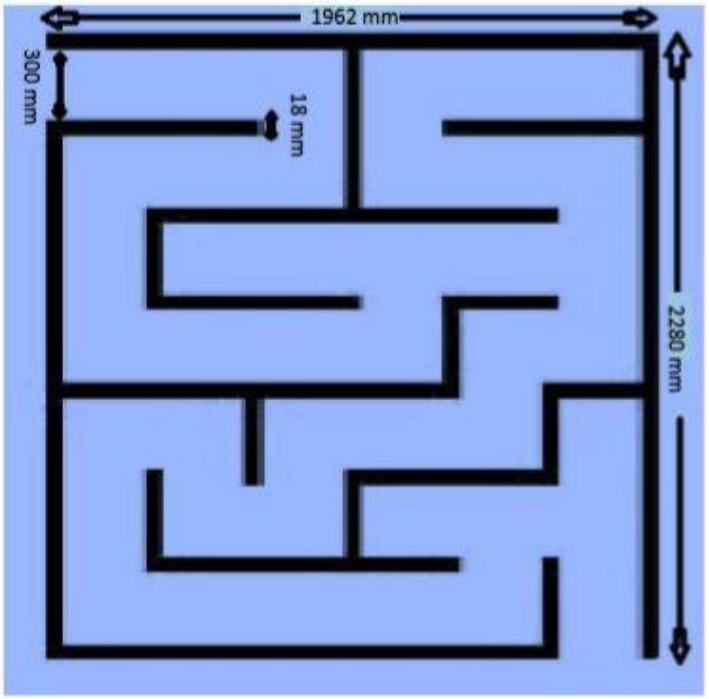


Project 2: Maze Robot

A ***maze robot*** is a robotic system designed to **navigate through a maze autonomously**. This project typically involves the integration of various hardware components to enable the robot to **explore and find its way** through a **complex maze environment**. The robot is equipped with sensors, such as **ultrasonic sensors**, to **detect walls and obstacles**. These sensors provide crucial input to the robot's control system, allowing it to **make decisions about its movements in real-time**. The programming aspect of the maze robot project involves developing a **robust algorithm** that combines **pathfinding strategies** with **obstacle avoidance techniques**.

The hardware setup includes **motors for controlling the robot's motion**, **wheels** for mobility, and a **chassis to house the components**. The **brain of the maze robot is a microcontroller** which **processes sensor data** and **executes the algorithm for maze navigation**. The algorithm is a key component and is **responsible for determining the optimal path**, making decisions and **avoiding dead ends**.

The maze consists of a **series of blocks** as shown in the figure below. The robot must **complete autonomous ride with just one switch** to start and one to reset it. You are **not allowed to touch the robot** after the start. The idea of the project is to **solve the maze in the shortest time**.

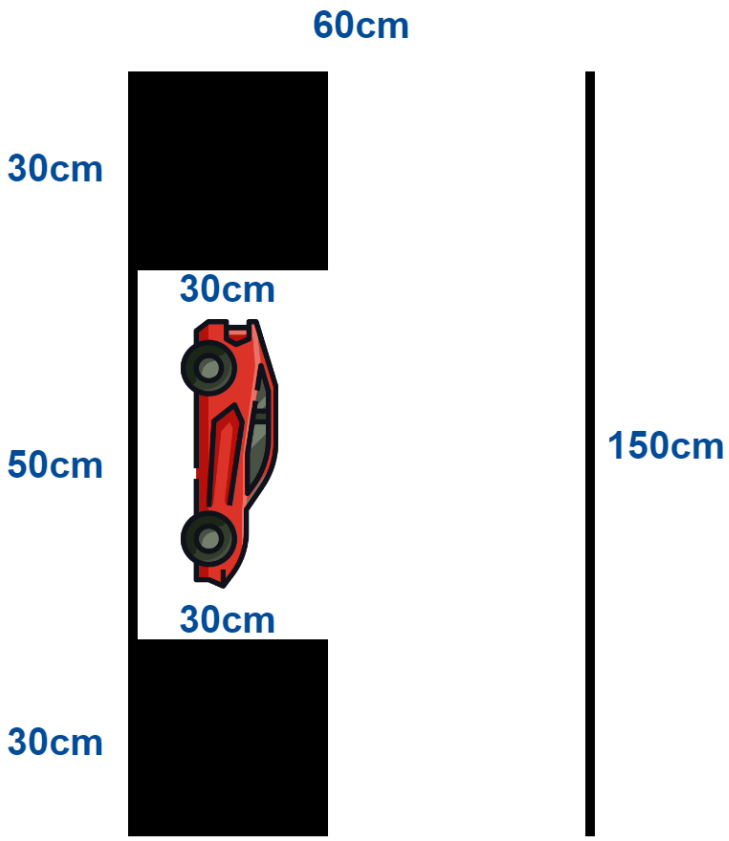


Project 3: Self-Parking Car

A ***self-parking car*** project involves creating an autonomous car system that can **park itself without direct human involvement**. This project integrates **sensors**, **actuators**, and **control systems**, to enable a vehicle to **autonomously handle parking tasks**.

At the core of the self-parking system is an **advanced control algorithm**. This algorithm **processes the data collected by the sensors**, interprets the environment, and **makes decisions regarding the car's movements**. The self-parking car algorithm usually involves several stages, including **identifying available parking spaces**, **planning an optimal parking**, **avoiding obstacles**, and **executing the parking** effectively.

This **microcontroller** serves as the **central control unit** for the car to **process data collected from the sensors**, **make real-time decisions** based on a parking algorithm, and **control the actuators**. The ultrasonic sensors **assess the surroundings**, i**dentifying available parking spaces**, while the algorithm determines the **optimal path for parking**, considering the dimensions of the car and **avoiding obstacles**.



Requirements

Deliver a ***report*** that includes the below requirements.

a) Define your **project goals**, and **identify its objectives**.

b) In a table, **identify the inputs and outputs** and briefly **describe their meaning**.

c) Provide a short description of the **hardware components** used in the project such as **microcontroller**, **DC motors**, **motor driver**, **sensors**, etc. For organization, in a table, list the **sensors** you used in the project and **their functions**.

d) Explain the **used algorithm** in your project.

e) Design the software code by providing the **flowchart** and the required functions.

f) Develop the **Ultrasonic code in C language** for the **AVR microcontroller**.

g) Propose a **test strategy to verify the operation of your project**.
Carefully select an **appropriate set of test cases**.

Bonus

- Develop the **entire project code in pure C language** for **AVR microcontroller**.
- Copied code to get a bonus leads to **ZEROS for all team members**.

Important Notes

- If you will implement another idea, you have to discuss it and get approval from ***Dr. Ahmed Shalaby*** before you start implementation.
- Cheating leads to **ZEROS for all team members**, just **do your best**.

GOOD LUCK,
Embedded Systems Team