Lab 9
Mobile robot control and its application

Experiment 1: Experiment on Motion of an Open Loop Mobile Robot

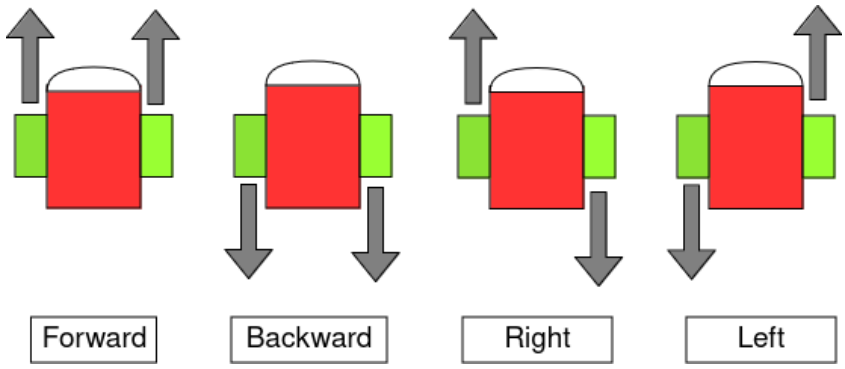
The objective of this experiment is to study and understand the motion of an open-loop two-wheel mobile robot by controlling its movements through the manipulation of the wheels. Students will gain hands-on experience in moving the robot forward, backward, left, and right, and will subsequently be tasked with navigating the robot along a predefined rectangular path.

Learning Outcomes Upon completion of this experiment, students will be able to:

- Understand the basic principles of motion in a two-wheel mobile robot.
- Manipulate the robot to achieve forward, backward, left, and right movements.
- Navigate the robot along a simple geometric path (rectangular).
- Develop insights into the challenges associated with open-loop control systems.

Part 1: Learning Basic Movements

1. **Initial Setup:**
   a. Power up the two-wheel robot.
   b. Ensure “Simple_motion.ino” is uploded in the your mobile robot
2. **Demonstration of Movements:**
   The instructor will demonstrate how different wheel rotations affect the robot's movement:
   - **Forward:** Both wheels rotate at the same speed in the same direction.
   - **Backward:** Both wheels rotate at the same speed in the opposite direction.
   - **Turn Left:** The right wheel moves forward, while the left wheel moves either backward or stays stationary.
   - **Turn Right:** The left wheel moves forward, while the right wheel moves either backward or stays stationary.



3. **Student Practice:**
   Each student will take turns controlling the robot to practice these movements. The goal is to become familiar with how each command results in robot movement.

Part 2: Navigating a Rectangular Path

1. **Setting the Path:**
   The instructor will mark a rectangular area on the floor using tape or markers.
2. **Task Explanation:**
   Students will be tasked with moving the robot around this rectangular area using only basic movements (forward, backward, left, right). The goal is to guide the robot around the perimeter of the rectangle, making approximate turns at the corners. Precision is not required —students should focus on achieving a rough rectangular trajectory.
3. **Execution:**
   a. Each student will take turns moving the robot along the rectangular path while capturing a video of the robot's movement.
   b. They will use combinations of basic motions to approximate the path:
   - **Straight lines:** Use forward or backward movement.
   - **Turns:** Use left or right turning motions to navigate corners.
     c. During the task, students must capture pictures of the robot at each corner of the rectangle and record the time taken to reach each corner.
4. **Observation and Documentation:**
   In addition to capturing video of the complete path, students will:
   - Take pictures of the robot as it reaches each corner of the rectangle.
   - Record the time it takes to reach each corner using a stopwatch.
   - Submit these pictures and times as part of their final report.

Experiment 2. Laboratory Experiment on Obstacle Avoidance in a Mobile Robot

The objective of this experiment is to study the obstacle avoidance behavior of a mobile robot. Students will observe how the robot detects and reacts to obstacles in its path. They will document the robot's movement when it encounters an obstacle and analyze how the system manages to navigate around it.

Learning Outcomes
Upon completion of this experiment, students will:

- Understand how mobile robots detect obstacles.
- Observe the robot's response when an obstacle is encountered.
- Report and analyze the robot's movement and decision-making process during obstacle avoidance.

Part 1: Demonstrating Obstacle Avoidance

1. **Initial Setup:**
   a. Power up the two-wheel robot and ensure the obstacle detection sensors are functional.
   b. Upload the "Obstracle_avoidance.ino" code.
   b. Place the robot on the ground in an open space.
2. **Student Interaction:**
   a. Students will be encouraged to move in front of the robot as it moves to simulate

obstacles.
b. The robot's obstacle detection sensors will detect the students, prompting the robot to adjust its movement to avoid them.
c. The instructor will guide students in observing how the robot reacts when an obstacle (in this case, the students) is detected.

Part 2: Student Observation and Experimentation

1. **Student Task:**
   Students will take turns observing and documenting the following:
   - How the robot detects obstacles (the presence of students moving in front of it).
   - How the robot alters its motion to avoid obstacles (stopping, turning, etc.).
   - Whether the robot successfully avoids the students and continues moving.
2. **Execution:**
   a. Students will move in front of the robot at different points to trigger its obstacle avoidance response.
   b. Each student will document how the robot responds to their presence, noting the changes in speed, direction, or stopping behavior.
3. **Video and Picture Capture:**
   Students will capture video footage of the robot's behavior as it encounters obstacles. They will also take pictures documenting the robot’s movement and response at various stages of obstacle detection.

Experiment 3. Laboratory Experiment on Line Following using IR Sensors

Objective

The objective of this experiment is to learn how an IR sensor array can be used to follow a black line. Students will understand how a line-following algorithm operates by using infrared sensors to detect and follow a path. The initial demonstration will cover the basics, and students will apply this knowledge to navigate a maze with a modified sensor setup.

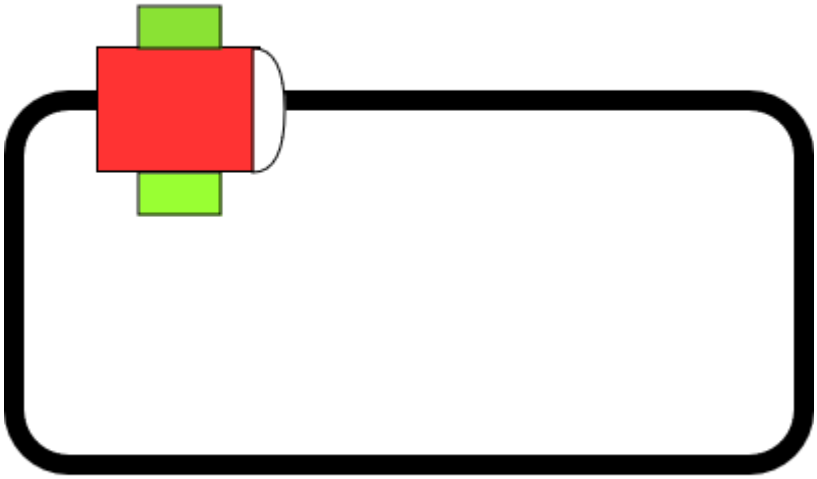
Learning Outcomes

Upon completion of this experiment, students will:

- Understand the principles of line-following using IR sensors.
- Observe the robot's response to path deviations.
- Navigate a maze using only two sensors to follow the black line

Part 1: Demonstrating Line Following with IR Sensors

1. **Initial Setup:**
   a. The instructor will configure the robot with three IR sensors, enabling the central sensor to detect the line's position and guide adjustments.
   b. The black line will be arranged in a basic rectangular path.
2. **Instructor Explanation:**
   The instructor will demonstrate how the robot follows the rectangular path by detecting and correcting its position when it deviates from the black line.



Part 2: Student Challenge – Navigating a Complex Maze

1. **Sensor Configuration:**
   For the student task, the instructor will disable the middle IR sensor, leaving only two side sensors active on the robot. This will increase the challenge by requiring students to navigate using only the left and right sensors
2. **Student Task:**
   Each student will take turns guiding the robot through the maze:
   - The robot should follow the black line using only the two active IR sensors.
   - Students will observe how the robot adjusts its path without the central sensor and strategize to stay on track.
3. **Video and Observation:**
   Students will capture video footage of their maze navigation attempt and note challenges faced in maintaining the path.
4. **Submission Requirements:**
   - Students must submit the code they developed to handle navigation with two IR sensors.
   - Include the video documentation of the robot's maze navigation and observations.