**1. Executive Summary:**

The rapid advancement of automation and embedded systems has paved the way for intelligent robotic platforms that can perform tasks with minimal human intervention. This project focuses on designing and implementing an autonomous robotic vehicle that can follow a defined path and avoid obstacles using a combination of infrared (IR), ultrasonic, and color sensors. The goal is to develop a functional prototype that simulates intelligent pathfinding and decision-making mechanisms suitable for real-world environments such as automated delivery systems or industrial navigation.

The robotic system is equipped with IR sensors to detect black lines on a contrasting surface, enabling it to follow a designated route. Ultrasonic sensors serve as proximity detectors, allowing the robot to recognize and react to obstacles within its path. A color sensor is also integrated to enhance decision-making by identifying the color characteristics of encountered objects. Based on predefined color criteria, the robot can classify objects such as `Color A` and `Color B`, influencing its navigation behavior accordingly.

A key highlight of the system is its modularity and low cost. The robot is built on a simple two-wheel chassis and powered by an Arduino Uno R4 microcontroller. Peripheral components, including an L298N motor driver, a 7.4V LiPo battery, and a power switch, provide essential control and energy management. This architecture supports expandability and makes the robot suitable for educational and research-oriented applications.

The software architecture is implemented using the Arduino IDE in embedded C++, with a focus on real-time performance. The line-following algorithm relies on digital feedback from the IR sensors, while obstacle avoidance is triggered by distance thresholds defined for the ultrasonic sensor. When an obstacle is detected, the robot either pauses or takes a detour, depending on the color of the object. For example, if the color sensor identifies a specific hue within a known RGB ratio range (Color A or B), the robot modifies its path accordingly—either rerouting, stopping, or re-centering on the line after bypassing the obstacle.

The development process was iterative, involving extensive hardware calibration and software testing under different lighting and surface conditions. The IR sensors were tuned for high contrast detection, and ultrasonic sensor readings were smoothed to minimize false positives. Color detection was verified using known samples to ensure consistent classification accuracy.

As of this report, the robot reliably demonstrates autonomous line-following behavior, detects and avoids obstacles within a 25 cm range, and reacts differently based on object color. This project serves as a practical proof-of-concept for sensor integration and autonomous decision-making in embedded systems, laying the foundation for more advanced robotics projects in the future.