Singapore Institute of Technology Information and Communication Technology

INF2004 – Embedded Systems

Final Documentation (Team 14)

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1 Introduction

1.1 Overview of Robot Car Project

This documentation provides a thorough overview of our Robot Car Project on embedded systems. The project's goal is to design and construct an autonomous car that can efficiently and precisely follow a predetermined route. The car's overall usefulness and performance are enhanced by the integration of multiple sensors and components. The core of the project is to use environmental data from sensors, make decisions based on the readings, and carry out specific tasks efficiently.

1.2 Project Scope

This project's main goal is to create a robot car that showcases the concepts in embedded system design, such as data processing, autonomous navigation, and sensor integration. The creation of comprehensive flowcharts for every component, a block diagram illustrating the system as a whole, and the integration of these components into a coherent whole are all included in the documentation. This project’s scope includes the design, implementation, and testing stages, with a robot car presentation at the end. Each of these stages is described in detail in this paper.

2 Block Diagram

This section provides the block diagram of the robot car by demonstrating the flow between components and the system's architecture. The Raspberry Pi Pico microprocessor, which is at the center of the figure, controls the car's functions by interpreting inputs from a variety of sensors, including an ultrasonic distance sensor, an infrared sensor for barcode scanning, and a magnetometer for orientation. Every sensor provides data to the microprocessor, which performs a number of functions including obstacle avoidance, barcode scanning, line following, and navigation and mapping. Afterwards, a PID controller uses the analyzed data to operate the motors, converting decisions into actual motions. The design also emphasizes the function of the WiFi module, which makes remote control and communication possible.

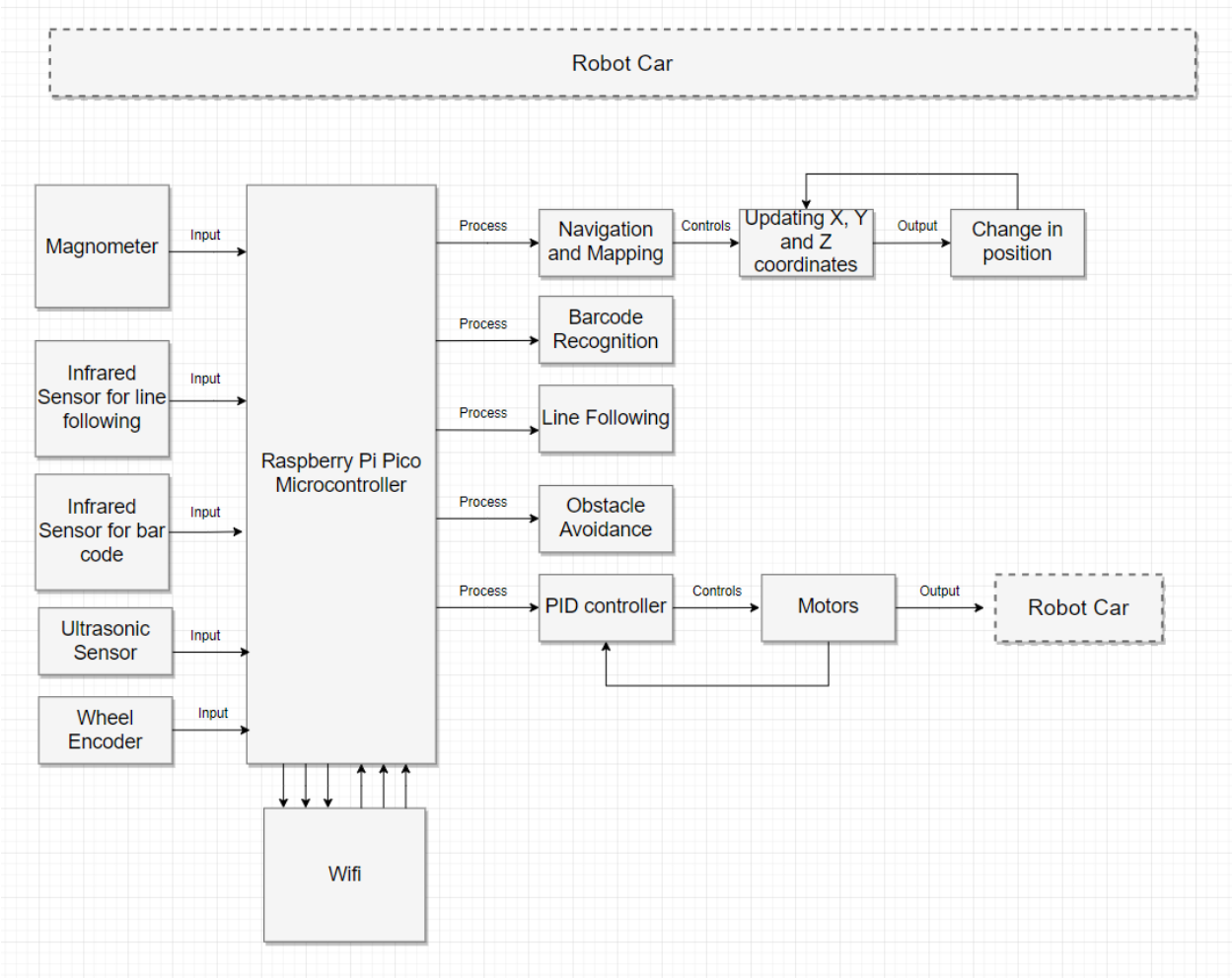


Figure 1. Block Diagram

3 Flowcharts

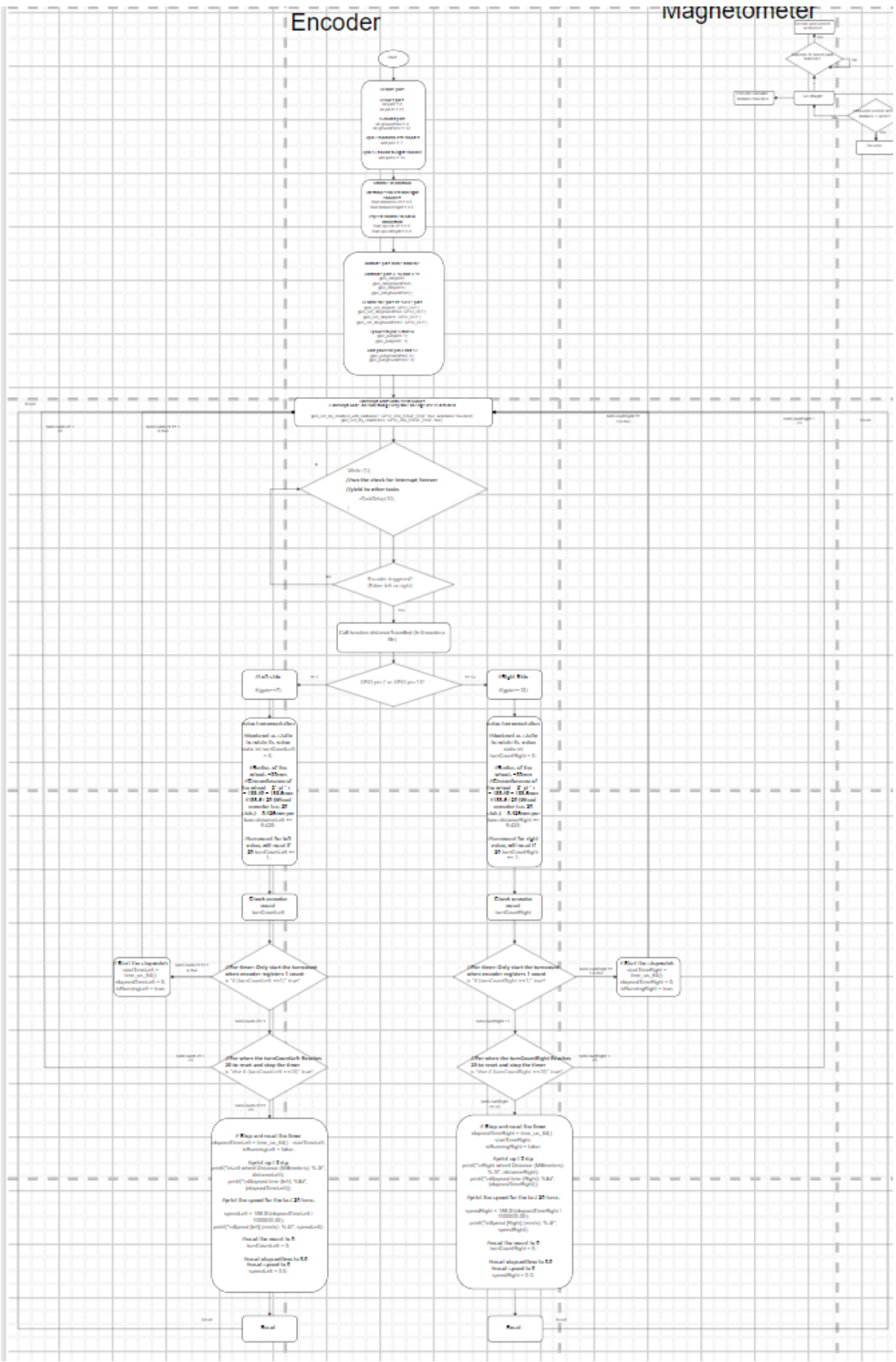
3.1 Individual Component Flowcharts

This section includes the comprehensive flowcharts for every component of the Robot Car in alignment to the partial integration tasks provided in the test. The flowcharts allowed the team to better understand the data flow and operational logic within each subsystem. They act as a manual for future improvements, troubleshooting, and programming.

3.1.1 Encoder Flowchart

The encoder flowchart displays the flow of when the encoder gathers and processes wheel rotation data.The speed and distance traveled by the car can only be determined with the use of

this data. The method of signal processing and the integration of the encoder's output with the vehicle's control system will be explained in depth in the flowchart.


Encoder
Magnetometer

3.1.2 Motor Flowchart

The motor flowchart displays the operational logic of the robot car motor. It consists of the steps needed to start, stop, and adjust the motors' speeds in response to input from the control system. The flowchart will also demonstrate how exact speed and torque control is achieved by utilizing the motor's feedback.

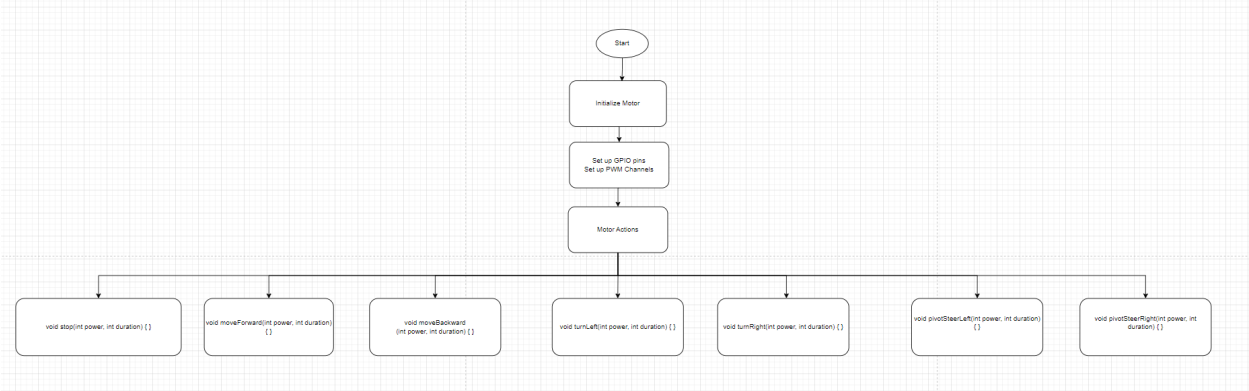


Figure 3 Motor FlowChart

3.1.3 IR Sensor (Line Detector) Flowchart

The IR sensor flow chart displays the operational logic of detecting black lines on the map. It describes how the sensor gathers environmental data and how that information is interpreted to control the vehicle's line-following steering.

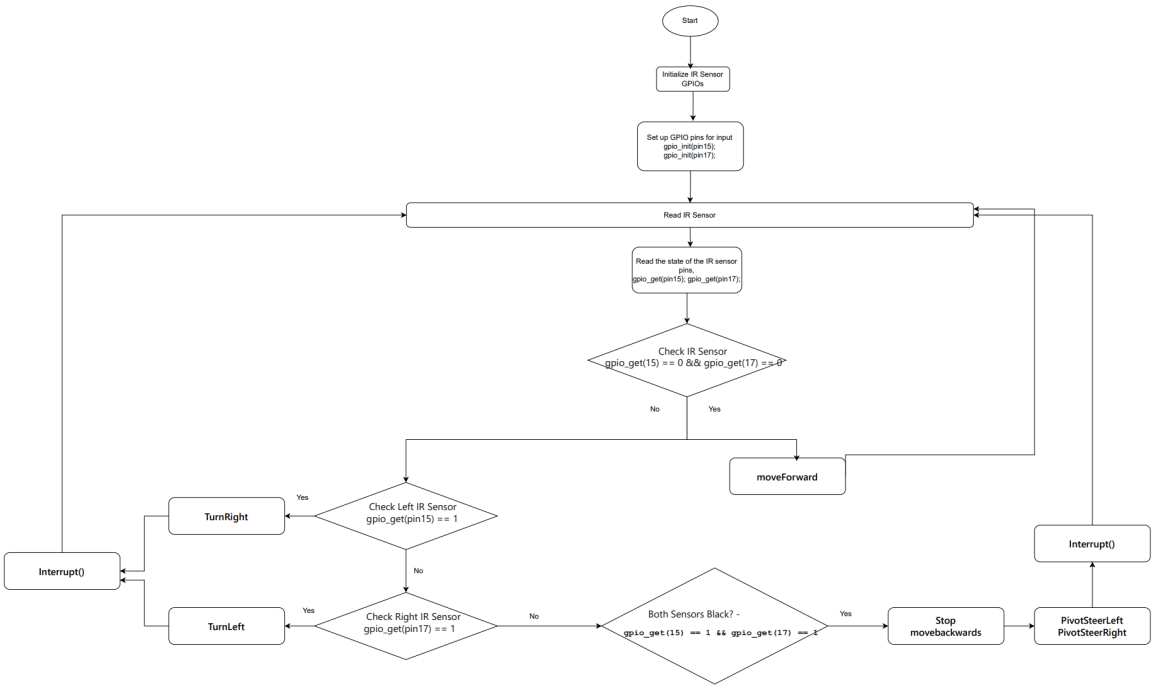


Figure 4 Line Detector Flowchart

3.1.4 IR Sensor (Barcode Scanner) Flowchart

The IR Sensor flowchart will demonstrate the procedures for scanning barcodes, deciphering the information for barcode39, and decoding the barcode into an alphabet based on the pattern

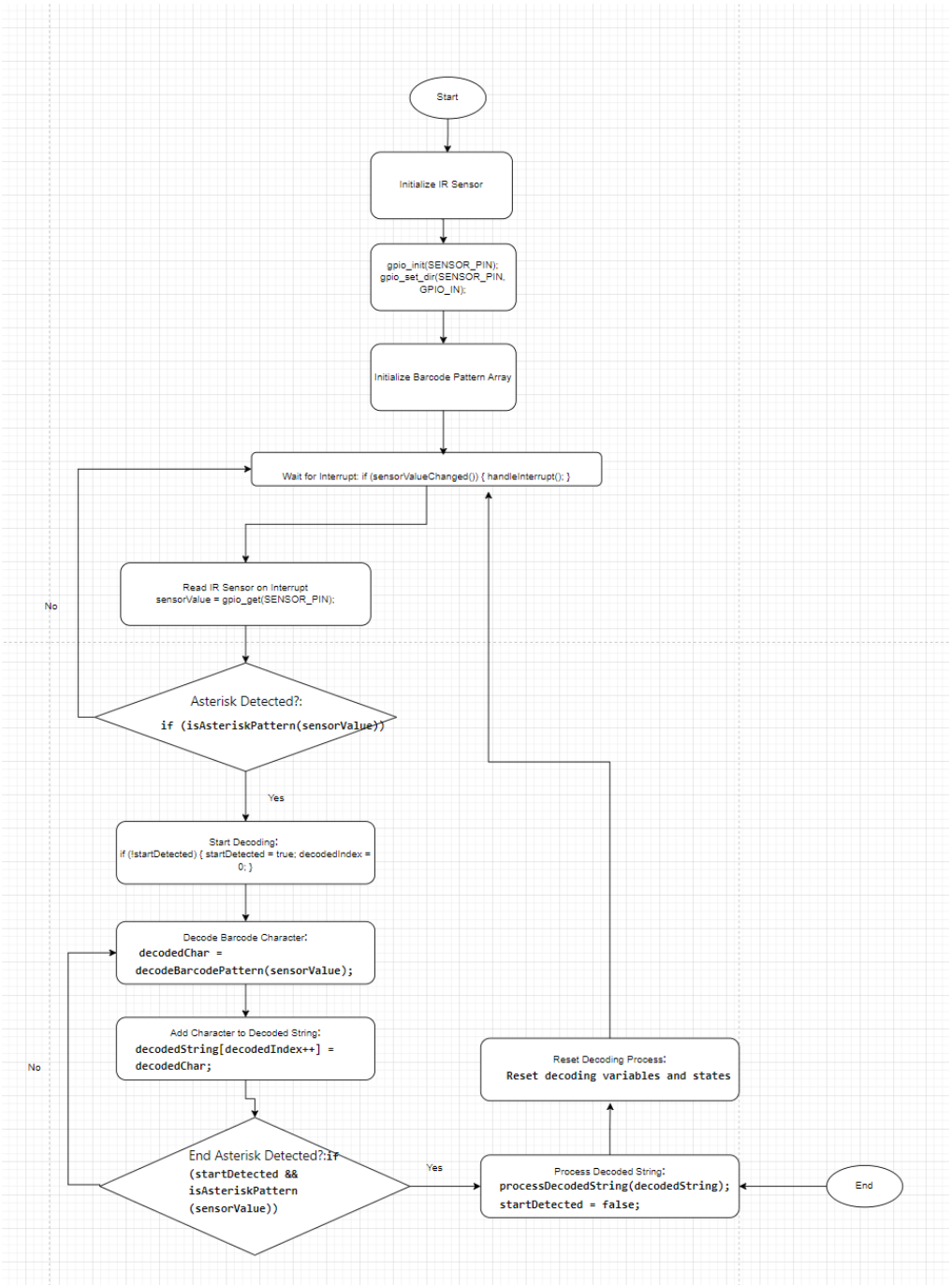


Figure 5 Barcode Scanner Flowchart

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3.1.5 Magnetometer Flowchart

The Magnetometer flowchart explains how to measure magnetic fields in order to find orientation. It describes how the vehicle makes use of these measurements for heading correction and directional guidance.

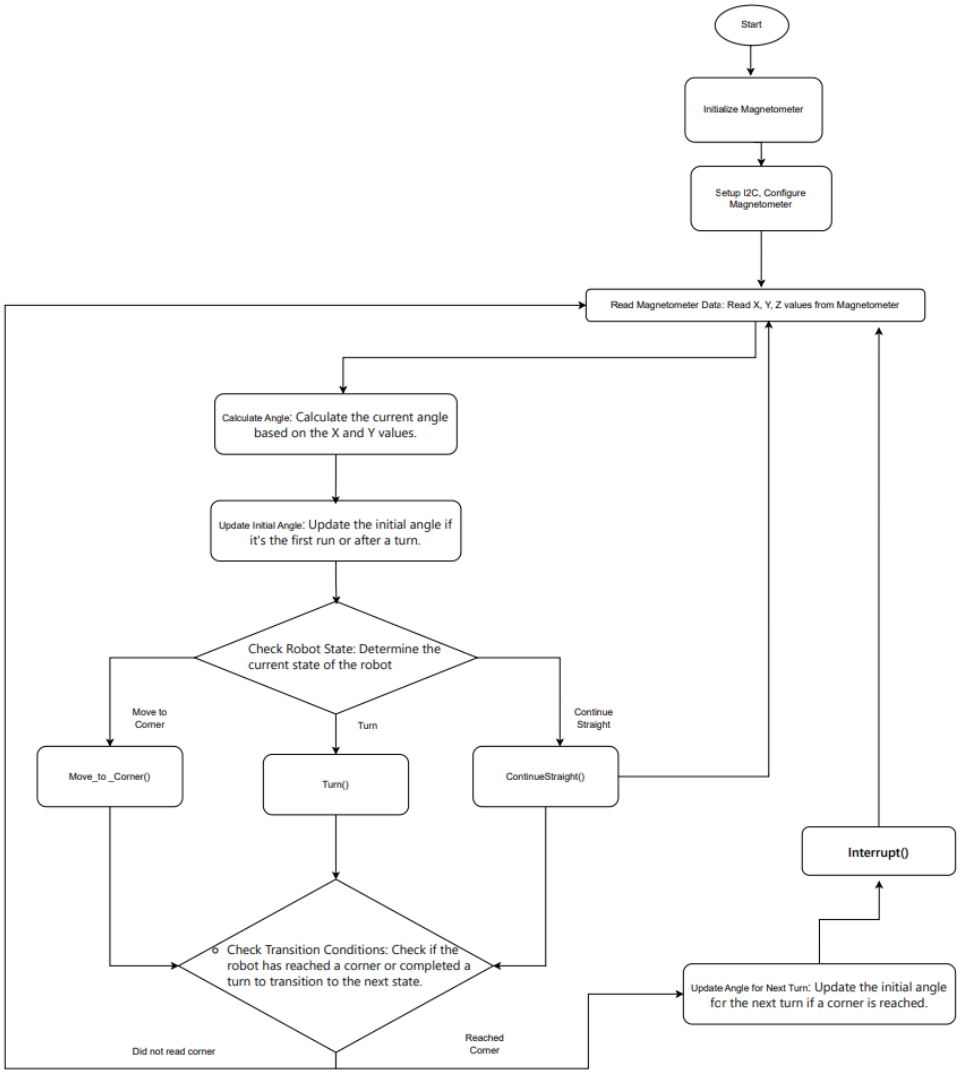

Figure 6 Magnetometer Flowchart

3.1.6 Ultrasonic Flowcharts

The Ultrasonic flow chart describes their methods for measuring distances and spotting obstacles. The car's usage of this data for obstacle avoidance and preserving safe distances.

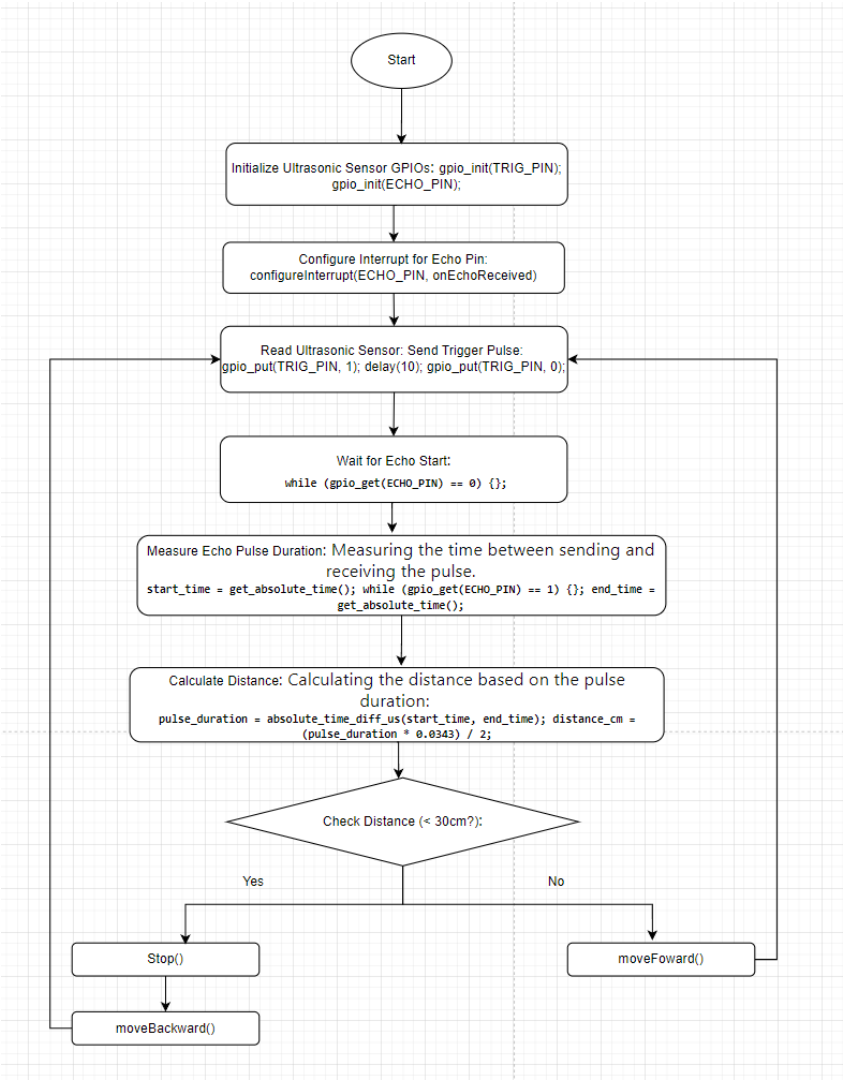

Figure 7 Ultrasonic Flowchart

3.1.7 Wifi Module Flowchart

The wifi module flowchart illustrates the method for wireless communication in automobiles. It outlines how to send and receive data, connect to networks, and integrate this connection with the vehicle's control system.

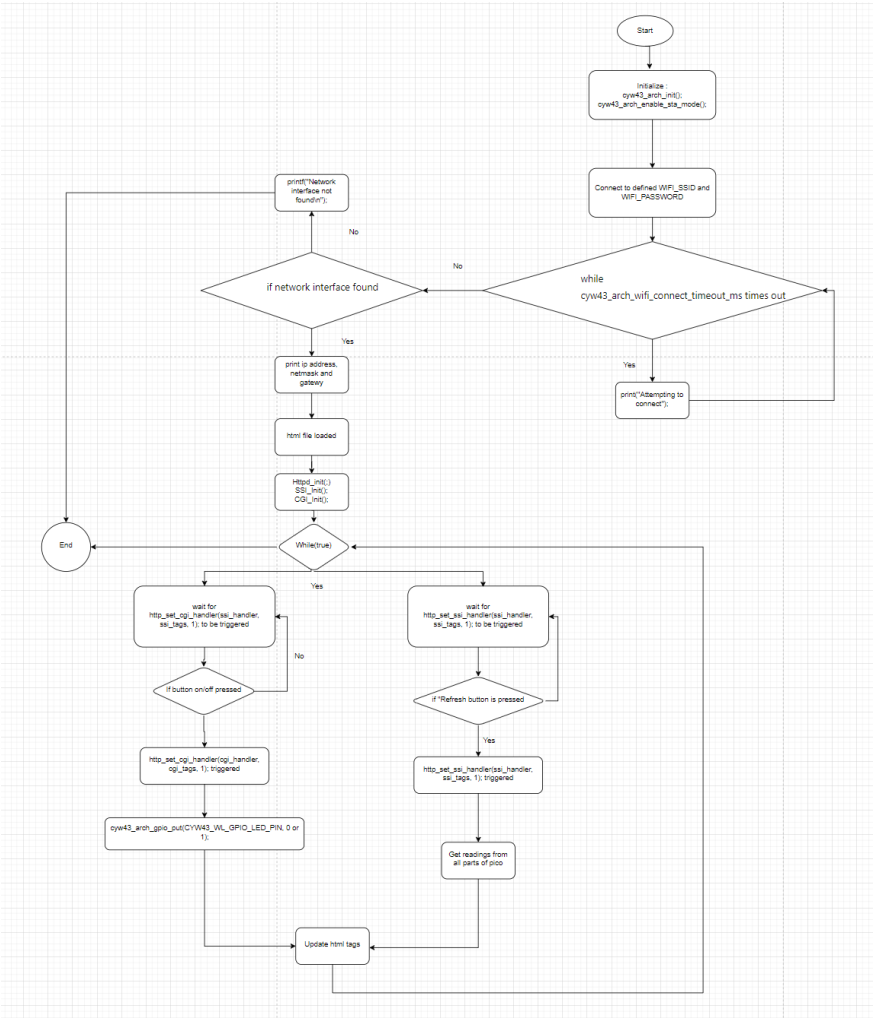

Figure 8 Wifi Flowchart

3.2 Main Flowchart

The main flowchart gives a broad overview of how the Robot Car runs on FreeRTOS. It shows how different activities and functions are called and handled, highlighting the interactions between various parts and the real-time operating system.

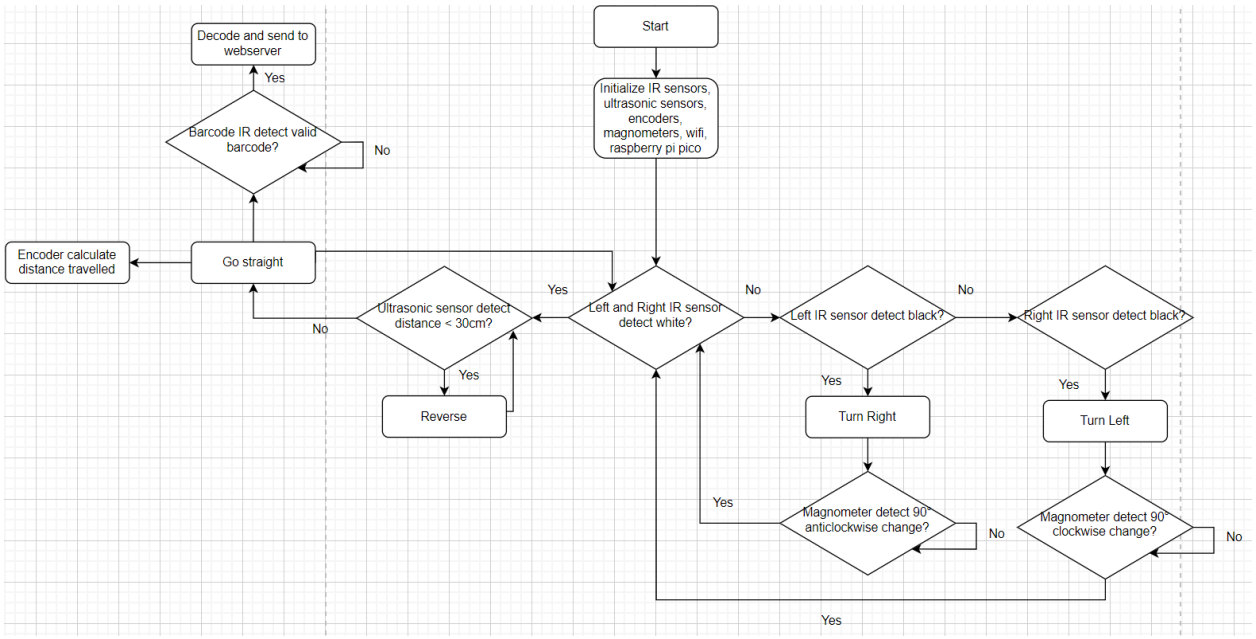

Figure 9 Main flowchart

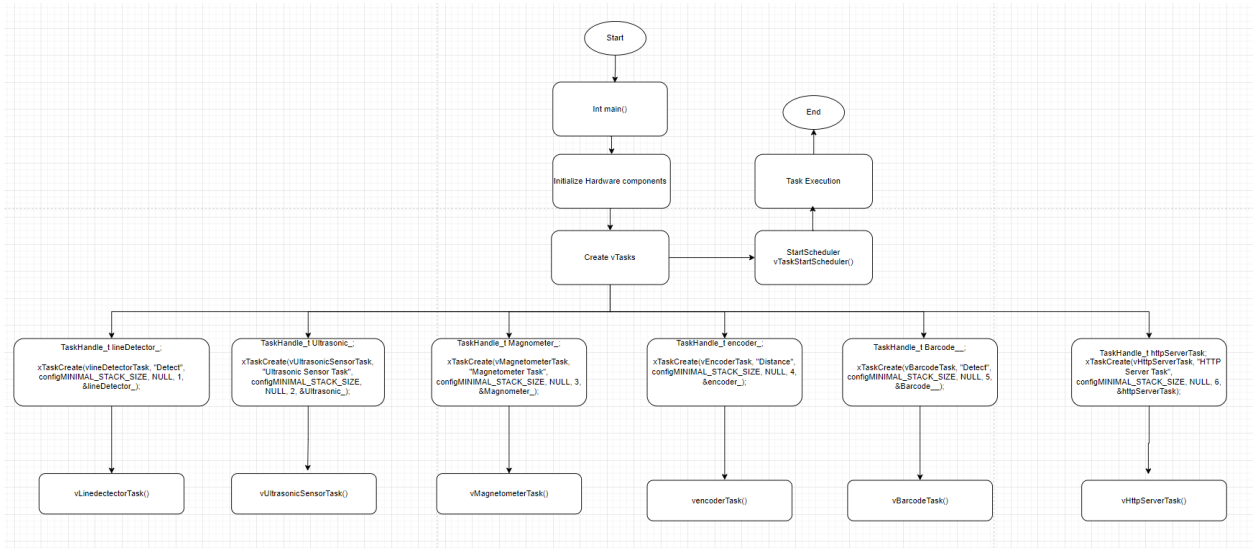

Figure 10 Freertos main flowchart