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High accuracy line following intelligent car based on infrared sensor

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Abstract

This research aims to describe the design and construction of a line-following intelligent automobile using the TM4C123GH6PZ microcontroller as the central processing unit.

The vehicle uses two MG310P20_7 motors, one motor driver circuit and a 12-gray sensor for propulsion, motor control and line detection. The sensors made the high-accuracy angler movement in tests, the vehicle is 91.85% stabile to follow the line, taking an average of 3.44 seconds to complete a 3-meter road. Therefore, this concept demonstrates how infrared sensors and sophisticated control algorithms can be used to be more stable in creating driverless vehicles.

Keywords: TM4C123GH6PZ; Motor Driver; Gray Sensor; Line Following Algorithm

1. Introduction

Transportation has transformed into autonomous vehicles over the years. Line-following automobiles are the key example of how robotics and control systems work. This project aims to create an intelligent car that follows a path by using the TM4C123GH6PZ microcontroller (MCU). The automobile's architecture consisted of an ultrasonic obstacle detection sensor, motors for drivability, a motor driver circuit and a 12-gray sensor for control and accurate line identification. Moreover, the MCU integrates these parts so that the process sensor data, run motor speed and direction can control algorithms. The goal is to navigate a predetermined path with accuracy and ease. Hence, this study aims to promote the possibilities for expanded applications of sensor-based control systems and represent how effective they are in autonomous cars.

2. Materials and Methods

To complete the project, the used components are; 12 gray sensors for line detection, two motors for movement, a power supply, a motor driver circuit for motor control and the TM4C123GH6PZ microcontroller (MCU) serving as the central processing unit.

2.1. Key Elements

- Microcontroller TM4C123GH6PZ: This MCU, which has an ARM Cortex-M4 processor and several communication interfaces (UART, SPI, and I2C), interprets sensor data and uses built-in algorithms to drive the motors.
- Gray Sensor: Comprising several infrared sensors that identify variations in brightness between the ground and the line, giving MCU information it may use to modify steering.
- Motor Driver: WEWA motor driver helps MCU to control signals that are converted to motor power.
- Motors: Based on MCU signals, two MG310P20_7 motors drive the wheels to enable forward, backward, and

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turning movements.

2.2. Connections Between the Components

TM4C123GH6PZ MCU's VCC and GND pins need to be connected to the power source. Hence, the first step will be gathering all the pins which will be needed for control and communication. Then create interfaces for communication such as SPI, I2C or UART. It must be checked whether the MCU and the motor driver's control pins are mapped correctly or not. Then, create a link to the output pins of the 12-gray sensor to the input pins of the MCU taking into account the required communication interface. The wiring and polarity should be attached right before the motor driver's output pins to the motor terminals. Therefore, establishing an essential communication link and confirming the connection of the output pins of the ultrasonic sound sensor to the input pins of the MCU is one of the vital steps. Finally, attach the power supply to each part to ensure the accuracy of the voltage and current levels.

2.3. Principles of Algorithms

- Congregate the motor driver, sensors, motors, and TM4C123GH6PZ MCU from the automobile.
- Describe variables and constants which includes turning sensitivity and speed.
- Step into the primary control loop:
  - To identify the line, interpret sensor inputs from the 12-gray sensors.
  - Handle Data: To handle data from sensors and keep the automobile in center, the 12-gray Sensor should be used to measure the location of the line and redesign the steering.
  - Manage the motors: Utilize line-following and self-balancing algorithms to calculate motor velocities.
  - Send the control signals through motor driver and adjust the direction and speed of the motor with the help of it.
  - To maintain real-time responsiveness and control, it is essential to continue repeating the control loop
- Use the authentic error-handling systems to manage errors or distinct incidents to guarantee stability and safety.
- End algorithm.

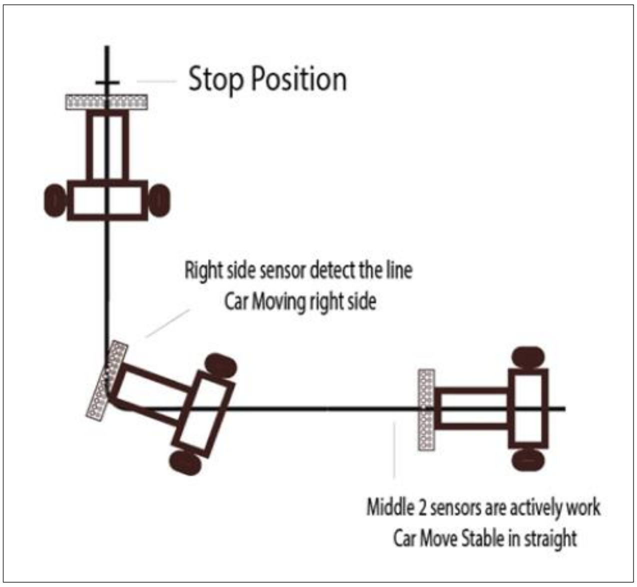

Figure 1 Diagram of the Wheels movement following the black line according to sensor's data

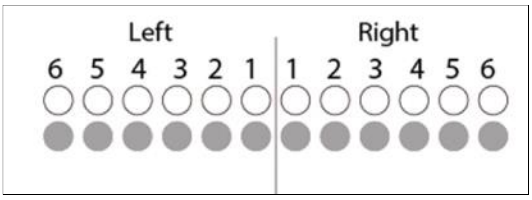

Figure 2 Diagram of right and left sensors for accuracy of movement

2.4. Program Designing for High Accuracy

- Define Libraries and Dependencies: Adding libraries for sensor integration, motor control, and TM4C123GH6PZ MCU interfacing can define dependencies.
- Set Up Variables and Constants: Assign pins to sensors and motors, adjust speed and turning sensitivity, and balance parameters.
- Initialize GPIO and Peripherals: Building the TM4C123GH6PZ MCU's GPIO pins and peripherals to operate sensors and motors will help initialize GPIO and peripherals.
- Sensor Input Functions: To retrieve data from the 12-gray sensor, creating an input function which is used for calculating line position is important.
- Motor Control Functions: Establish a feature which will allow you to steer and accelerate motors along with the communication from the motor driver to control the motors.
- Main Control Loop: For main control loop analyzing data, interpreting sensor inputs, and controlling motor function are significant. Line-following algorithms and sensor input functions also play significant role in it.
- Error Handling: Incorporating systems to deal with malfunctioning motors or sensors, halting the vehicle, or putting it in a safe mode when it is under unusual circumstances can handle error.
- Complete the program: Include any necessary timing or delay methods. Examine behavior, test the program, and make required modifications. Note down essential concerns, pin assignments, and function descriptions.
- End Program: This program design represents a base to start the car's software control. It can be expanded and altered as per different requirements, enabling the inclusion of new features and necessary code optimization.

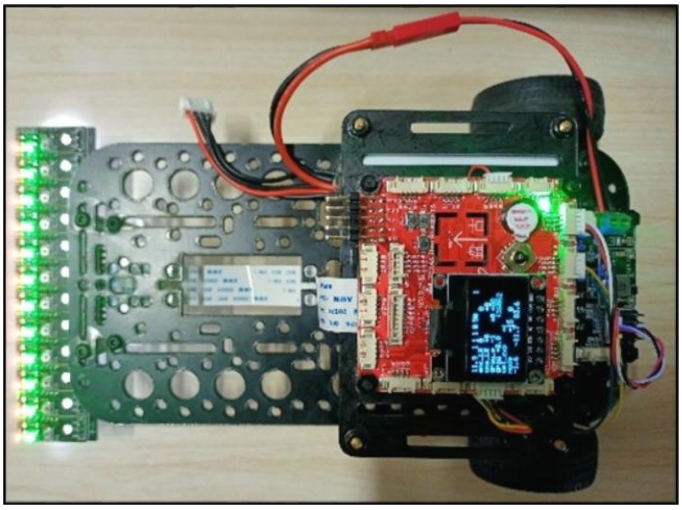

Figure 3 Full Assembled Intelligent Car Project

3. Results and Discussion

Table 1 Movement accuracy results from individual 5 tests

Test	Time Left(sec)	Stability in Right Turn	Stability in left Turn	Stability in Straight line	Stop Position Deley(sec)	Accuracy
1	34.6	87%	96.3%	97.6%	3	93.63%
2	33.7	86.2%	92.4%	96.8%	1	91.8%
3	35.2	85.9%	90%	95%	5	91.7%
4	34.3	87.6%	89.7%	97.3%	2	91.63%
5	35.4	86%	91%	94.5%	5	90.5%
Total average time = 31.44				Total Accuracy		91.85%

The TM4C123GH6PZ MCU and the car's line-following features collaborated effectively to produce the intended outcome. To ascertain the system's efficacy and utility, comprehensive testing was conducted. This study examines the outcome of the initiative. When the line-following vehicle first used the 12-Grey Sensor, it showed precise line-following capabilities. It accurately identified the route and altered its steering to maintain its position in the middle of the track. Due to the line-following algorithm's efficient functioning the line was accurate and smooth.

The result show that the total stability is 91.85% and average time left to across the 3-meter way is 3.44 second. This algorithm can be stabled the motor movement and movement to the left to right is quietly shaking between the right to left movement. This car is most stable in a straight line because the two infrared sensors are used to detect the line so the car was very stable.

4. Conclusion

The Line Following Intelligent Car uses infrared sensors, which detects the line more accurately and uses 12 sensors so that the car is quietly stable and can move the angles smoothly without trembling. This technology has the potential to be used in advanced autonomous vehicles. This technology increases the vehicle stability on the banking angle, it can be moves on smoothly any angle with driverless control system.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest to be disclosed.

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