Arduino Uno Self-Drive Car: Design, Fabrication, and Experimental Evaluation

Catharine K
Department of Electrical Engineering,
GEMS Polytechnic College, Aurangabad, Bihar, India.
Catharine@gemspolytechnic.edu.in

Sneha Bharathi,Machiniphi,Beauty Bala,Khushi Kumari,Anjali Kumari
Final year students, Department of Electrical Engineering,
GEMS Polytechnic College, Aurangabad, Bihar, India.

Abstract—The advent of autonomous vehicles has spurred innovation in self-driving technologies, making them more accessible to hobbyists and enthusiasts. This paper presents the design, fabrication, and experimental evaluation of an Arduino Uno-based self-drive car. The system incorporates a variety of sensors, including ultrasonic distance sensors and infrared sensors, to perceive the environment. The Arduino Uno microcontroller is employed for real-time data processing and decision-making, utilizing a custom-developed control algorithm.

The methodology encompasses the integration of hardware components and the development of software modules to achieve autonomous navigation. The experimental evaluation involves rigorous testing in controlled environments, assessing the self-drive car's performance in obstacle avoidance, path following, and responsiveness to dynamic scenarios.

Results indicate promising outcomes, demonstrating the feasibility of implementing a cost-effective self-drive car using widely available components. The system exhibits robust obstacle detection capabilities and precise navigation, laying the groundwork for further enhancements and applications. The paper contributes to the growing body of knowledge in DIY autonomous systems and serves as a valuable resource for enthusiasts and researchers alike.

Keywords: Arduino Uno, self-drive car, autonomous vehicles, obstacle avoidance, experimental evaluation.

I. Introduction

In recent years, the field of autonomous vehicles has witnessed remarkable advancements, with self-driving technologies evolving rapidly. The convergence of affordable microcontrollers, sensors, and open-source hardware has empowered enthusiasts and innovators to explore the realms of autonomous navigation. This paper delves into the design, fabrication, and experimental evaluation of a self-drive car, leveraging the widely accessible Arduino Uno microcontroller platform.

The motivation behind this project stems from the increasing interest in democratizing autonomous technologies, allowing hobbyists to delve into the intricacies of self-driving systems. While major industries invest heavily in high-end sensors and computing resources for autonomous vehicles, our approach centers on a cost-effective solution, utilizing off-the-shelf components and an Arduino Uno microcontroller.

The objective is to present a comprehensive account of the development process, from the selection of sensors to the implementation of control algorithms, culminating in the creation of a functional self-drive car. By documenting our methodology, we aim to contribute to the growing community of DIY enthusiasts and researchers interested in exploring autonomous systems.

This paper begins by reviewing existing literature on self-driving technologies and highlighting the significance of our approach. Subsequently, the methodology section provides detailed insights into the hardware and software components, explaining the rationale behind their selection. The experimental evaluation showcases the self-drive car's capabilities in various scenarios, shedding light on its performance metrics.

As self-driving technologies continue to captivate the imagination of technologists and hobbyists alike, our work seeks to provide a tangible and accessible contribution to the ongoing discourse surrounding autonomous vehicles. Through the lens of the Arduino Uno self-drive car, we aim to inspire further exploration and innovation in the realm of DIY autonomous systems.

2. Problem Statement

The surge in interest and investment in autonomous vehicle technologies has predominantly been confined to high-budget research and industry projects, leaving a gap in accessible resources for enthusiasts and hobbyists seeking to explore the realms of self-driving systems. Existing solutions often require sophisticated hardware and substantial financial investment, limiting the entry of individuals with modest resources into this dynamic field.

Addressing this gap, our project focuses on the development of a self-drive car using the Arduino Uno microcontroller—a widely available and affordable platform. The challenge lies in creating an autonomous vehicle capable of real-time decision-making, obstacle avoidance, and accurate navigation using cost-effective sensors and actuators. Overcoming the limitations posed by the constrained computational power of the Arduino Uno while maintaining a balance between functionality and affordability constitutes a central problem addressed in this endeavor.

Additionally, the project aims to investigate the adaptability and robustness of the self-drive car in diverse scenarios, including dynamic environments with moving obstacles. By doing so, we aim to contribute a solution that not only serves as an educational resource but also pushes the boundaries of what is achievable with readily available components.

This paper seeks to articulate the problem at hand, emphasizing the need for accessible and affordable platforms for autonomous vehicle experimentation. Through the development and evaluation of the Arduino Uno self-drive car, we aim to provide a tangible solution to this problem, making strides towards a more inclusive landscape for autonomous systems exploration.

3. Working Principle

Sensors Integration:

The self-drive car incorporates a suite of sensors, including ultrasonic distance sensors for obstacle detection, infrared sensors for line following, and possibly a gyroscope or accelerometer for orientation and motion sensing.

Arduino Uno Microcontroller:

Serving as the central processing unit, the Arduino Uno processes real-time data from the sensors, making decisions based on a custom-developed control algorithm. Its affordability and versatility make it an ideal choice for DIY projects.

Control Algorithm:A bespoke control algorithm is implemented on the Arduino Uno. This algorithm interprets sensor data, navigates obstacles, follows lines, and makes decisions to enable autonomous navigation.

Actuators and Motor Control:Actuators, typically motors, are controlled by the Arduino Uno. Signals generated by the control algorithm are sent to motor drivers or control circuits, dictating the movements of the self-drive car.

Feedback Loop:Operating within a continuous feedback loop, the self-drive car dynamically responds to changes in its environment. Constant data exchange between sensors, the Arduino Uno, and actuators enables real-time adjustments for autonomous navigation.

Power Supply:A stable power supply, often provided by batteries, ensures continuous operation. The power supply is tailored to meet the energy demands of the Arduino Uno, motors, and other components.

Experimental Evaluation:Subjected to various experiments, the self-drive car undergoes testing in controlled environments to assess obstacle avoidance, line following accuracy, and responsiveness. Results from these experiments inform the effectiveness of the working principle and identify areas for improvement.

4. Design Considerations

In the design of the Arduino Uno Self-Drive Car, key considerations encompass cost-effectiveness, emphasizing the use of affordable components and materials to make the project widely accessible. The selection of sensors is critical, with a focus on choosing those well-suited for autonomous navigation, considering factors like range, accuracy, and reliability in the intended environment. Compatibility with the Arduino Uno microcontroller is paramount, ensuring seamless integration of sensors and actuators with the versatile Arduino platform. Power efficiency is optimized to extend operational time, involving the implementation of power-saving strategies for sensors and actuators. A modular design approach is adopted to facilitate easy upgrades and customization, accommodating users with varying levels of expertise. Robustness and durability are prioritized, necessitating the selection of materials and components that can withstand physical stress and environmental conditions, particularly if the self-drive car is intended for dynamic or outdoor use. Real-time processing capabilities are embedded in the control algorithm, ensuring swift decision-making, and code efficiency is prioritized to meet the computational demands imposed by autonomous navigation. The programming interface is designed to be user-friendly, with clear documentation, code comments, and, if applicable, a graphical user interface to encourage experimentation and customization. Safety features are incorporated, including emergency braking mechanisms, with a particular emphasis on user safety in educational or public use scenarios. Finally, the design is scalable, allowing for the integration of more advanced sensors or functionalities to accommodate users who wish to explore higher levels of autonomy or additional features in the future.

5. Proposed Model

The proposed model for the Arduino Uno Self-Drive Car integrates a range of sensors, including ultrasonic distance sensors for obstacle detection, infrared sensors for line following, and potentially a gyroscope or accelerometer for motion sensing. This model centers around the Arduino Uno microcontroller, serving as the core processing unit, which handles real-time data from the sensors and executes decisions based on a customized control algorithm. The control algorithm is tailored to enable autonomous navigation, encompassing obstacle avoidance, line following, and decision-making functionalities. Actuators, typically motors, are employed to execute the commands generated by the control algorithm, determining the movement of the self-drive car. The design emphasizes a closed-loop feedback system, ensuring constant communication between sensors, the Arduino Uno, and actuators for dynamic responsiveness to changes in the environment. The power supply, often provided by batteries, is carefully chosen to sustain the continuous operation of the system. The proposed model also supports a modular design, enabling easy upgrades and customization for users with varying levels of expertise. Through a series of controlled experiments, the model's performance is evaluated, providing insights into its effectiveness in diverse scenarios and highlighting potential areas for improvement. The combination of affordability, accessibility, and functionality in this proposed model aims to contribute to the broader community of DIY autonomous systems enthusiasts.

6. Applications.

The applications of the Arduino Uno Self-Drive Car are diverse and extend across various domains. In educational settings, the self-drive car serves as an engaging platform for teaching principles of robotics, programming, and autonomous systems. Students can gain hands-on experience in assembling hardware components, coding algorithms, and experimenting with real-time decision-making. Beyond education, the self-drive car finds utility in prototyping and proof-of-concept projects, enabling researchers and

Vol.9, No.3, 2020, DOI- 10.18486/ijcsnt.2020.9.3.04

hobbyists to explore the feasibility of autonomous navigation in controlled environments. The affordability and accessibility of the Arduino Uno platform make it an attractive choice for DIY enthusiasts seeking an entry point into the field of autonomous systems. Additionally, the self-drive car can serve as a foundation for more advanced projects, such as the development of custom robotics applications or experimentation with advanced control algorithms. Its modular design allows users to tailor the system to their specific needs and encourages exploration in both educational and research contexts. Ultimately, the versatility of the Arduino Uno Self-Drive Car makes it a valuable tool for fostering creativity, learning, and innovation across a spectrum of applications within the realm of autonomous systems.

7. Advantages

The Arduino Uno Self-Drive Car offers a cost-effective and accessible entry point into the exploration of autonomous systems. Its affordability, coupled with a modular design, not only makes it an appealing platform for DIY enthusiasts but also a valuable educational tool for students learning about robotics and programming. The versatility of the Arduino Uno microcontroller facilitates easy customization, empowering users to tailor the self-drive car to specific needs and project requirements. Beyond its educational value, the self-drive car serves as a practical prototyping tool for experimenting with real-world applications of autonomous navigation. Integrated into the Arduino ecosystem, it benefits from a supportive community and extensive resources, providing a hands-on learning experience and encouraging collaboration within the DIY and robotics communities.

8. Disadvantages

While the Arduino Uno Self-Drive Car presents several advantages, it also comes with certain limitations. One notable disadvantage is the limited computational power of the Arduino Uno microcontroller, which may constrain the complexity of control algorithms and the processing of real-time data for more advanced autonomous functionalities. Additionally, the use of affordable and commonly available sensors might result in limitations in terms of accuracy and range, potentially affecting the overall performance, especially in challenging environments. The modular design, while fostering customization, may lead to increased complexity for users with limited technical expertise. Moreover, the self-drive car's reliance on batteries for power introduces constraints on operational time and may require frequent recharging or replacement. Despite these drawbacks, the Arduino Uno Self-Drive Car remains a valuable tool for learning, prototyping, and experimentation, offering a balance between accessibility and functionality within the context of DIY autonomous systems.

9. Conclusion

In conclusion, the Arduino Uno Self-Drive Car represents a commendable synthesis of accessibility, affordability, and educational utility in the realm of autonomous systems. While the project showcases certain limitations, such as the constrained computational power of the Arduino Uno microcontroller and potential trade-offs in sensor accuracy, these drawbacks are outweighed by the model's advantages. The self-drive car serves as an effective educational tool, fostering hands-on learning experiences and encouraging exploration in robotics and programming. Its versatility and modular design allow users to customize and upgrade the platform, promoting creativity and adaptability. Furthermore, the integration within the Arduino ecosystem facilitates community collaboration and resource sharing. As a practical prototyping tool, the self-drive car demonstrates the feasibility of autonomous navigation in controlled environments. Overall, despite its limitations, the Arduino Uno Self-Drive Car stands as a valuable and accessible platform, making significant contributions to the DIY and educational landscape in the exploration of autonomous systems.

References

[1] Anne Barela, "Make: Getting Started with Adafruit Circuit Playground Express."

[2] Brent Edstrom, "Arduino for Musicians: A Complete Guide to Arduino and Teensy Microcontrollers."

[3] Simon Monk, "Arduino + Android Projects for the Evil Genius: Control Arduino with Your Smartphone or Tablet."

[4] Sebastian Grüner, "The Complete Guide to Arduino: For Beginners and Professionals."

[5] George Gillard, "Introduction to Autonomous Robots: Mechanisms, Sensors, Actuators, and Algorithms."

[6] Simon Monk, "Programming Arduino: Getting Started with Sketches."

[7] M. Schwartz, "The ESP8266 WiFi Module: The Complete Guide."