Smart Car Jack Using Internet of Things

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Abstract

This research explores the integration of smart technologies in traditional car jacks, aiming to enhance efficiency and user safety. By incorporating sensors and automation, the smart car jack introduced in this study not only streamlines the lifting process but also provides real-time data on load distribution and stability. ethodologically, the study involves the design, prototyping, and testing of the smart car jack, assessing its performance in various scenarios. Results demonstrate a significant reduction in lifting time and improved safety measures, positioning the smart car jack as a viable innovation in the automotive industry. The implications of this technology extend to increased convenience for users and a potential reduction in roadside accidents. This research contributes to the ongoing evolution of automotive tools and underscores the benefits of merging smart technologies with traditional equipment.

Keywords: Internet of Things; Car Jack, Smart, ESP32

1. Introduction

This paper addresses the challenges of roadside emergencies, such as flat tires, and the limitations of conventional scissor car jacks that require physical effort and can lead to backache problems. To tackle these issues, the paper presents a modified car jack design that is safe, easy to operate, and reduces physical effort for lifting and lowering vehicles during automobile repair, especially for roadside situations. The study explores the integration of Internet of Things (IoT) technology in automotive tools, particularly in the development of smart car jacks. The aim is to revolutionize the traditional car lifting process, making it smarter, safer, and more efficient. By incorporating IoT, the proposed smart car jack offers convenience and enhanced control over vehicle maintenance tasks [1].This paper introduces a novel smart car jack design that leverages IoT technology to improve the efficiency and safety of roadside repairs, alleviating the burden on car owners during emergencies. The focus is on developing a user-friendly and cost-effective solution that can significantly reduce the physical effort required for car maintenance tasks [2].

2. Methodology and Experimental Setup

A. Software and microcontroller

In this project, software holds a pivotal position in designing and developing a smart car jack with Internet of Things (IoT) capabilities. To achieve the project's objectives, the software utilized includes the Blynk platform and the Arduino Integrated Development Environment (IDE) [3]. Blynk serves as a mobile platform, enabling remote control of various hardware modules like Arduino and ESP32 over the internet. With Blynk, developers gain access to an array of features, empowering them to control hardware components, store, and display data, visualize information, and more. It simplifies the process of connecting input/output components with hardware devices and facilitates seamless data transfer between them. The Blynk server, functioning as a cloud-based backend service, establishes communication between the smartphone application and the hardware, making it highly convenient for developers to manage and control their IoT systems efficiently [4]. In this project, the ESP32 is utilized as the primary microcontroller. The ESP32 is a powerful and versatile microcontroller that operates using the Arduino IDE, an open-source software platform for writing and uploading code to Arduino boards.

The ESP32, integrated with the Blynk platform, allows for enhanced remote control and monitoring of the smart car jack's hardware components.

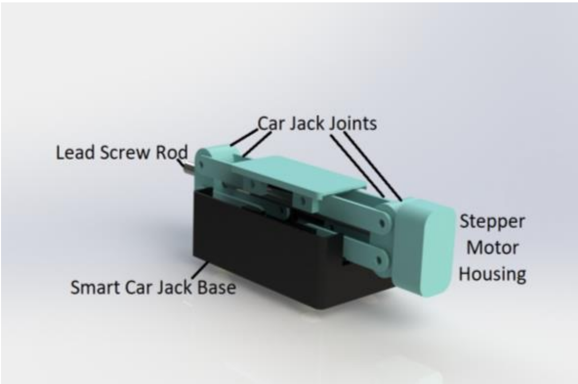

Fig. 1. Prototype Design

To establish the connection between the ESP32 and the Blynk platform, the Blynk library was installed in the Arduino IDE [5].This library provides an interface for seamless communication between the ESP32 and the Blynk cloud server and mobile application. Once the library is installed, developers can utilize the Blynk API to program the ESP32, enabling control and real-time monitoring of the smart car jack's various hardware functionalities [6].

B. Prototype Design

This section presents the final design for the smart car jack project, as depicted in Fig. 1. The design features a scissor jack prototype mounted on a movable base, allowing for increased mobility. The prototype is equipped with mecanum wheels driven by a DC gear motor, transforming it into a smart car jack. To control the lifting mechanism, a steel rod is connected to a stepper motor, which receives instructions from the microcontroller, ESP32. The components of the design, except for the steel rod, are 3D printed using robust PLA+ (Polylactic Acid) material, renowned for its improved mechanical properties like enhanced toughness and impact resistance compared to standard PLA. This ensures the smart car jack's stability and durability during the car lifting process. The final design incorporates a movable scissor jack prototype with mecanum wheels, operated by a stepper motor controlled by the ESP32 microcontroller. The use of PLA+ material for 3D printing ensures the structure's strength and ability to withstand the pressure exerted during the lifting operation.

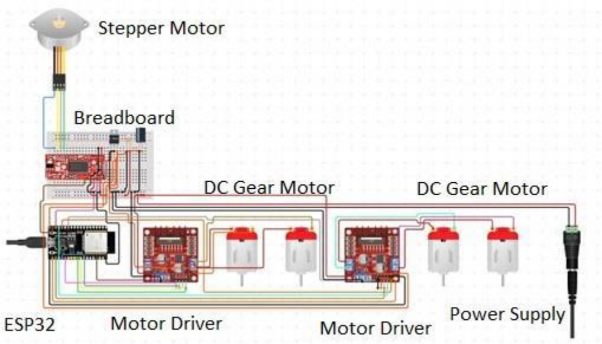

Fig. 2. System wiring diagram.

C. Coding and Programming

The code implemented in this project outlines the core functionalities and control logic of the Arduino sketch for the IoT-enabled car jack. It begins by including essential libraries for Wi-Fi communication, Blynk (the IoT platform), and Stepper motor control. The Blynk template ID, obtained from the Blynk website, along with the name and authentication token, is defined to establish communication with the Blynk app. Wi-Fi credentials are set to connect the ESP32 board to the network. In the setup function, the code connects to Wi-Fi, initializes Blynk, and sets up the motor control pins, ensuring the motors start in a stationary state. The loop function continually checks for incoming commands from the Blynk app through virtual pins. Corresponding functions are executed to control the car jack's movements or perform other desired actions. Additional functions are defined for precise motor control, including forward, backward, left, and right movements. The Stepper1 function governs the stepper motor's rotation based on specified parameters for direction and the number of rotations required [7]. This pseudocode provides a concise overview of how the IoT-enabled car jack interacts with the Blynk app, processes input commands, and controls the motors to achieve specific movements.

D. Connections

Fig. 2 illustrates the interconnected setup of the Smart Car Jack Prototype, comprising two power supplies, three motor drivers, one stepper motor, four DC gear motors, and the ESP32 microcontroller. The motor drivers are connected to the power supply and the respective motors, with specific pins interfacing them to the ESP32 for control signals.

Regarding the stepper motor, pin connections were established using pins 25, 26, 21, and 19 as IN1, IN2, IN3, and IN4 for its motor driver. These specific pins allow precise control and coordination of the stepper motor, significantly contributing to the overall functionality and performance of the Smart Car Jack Prototype.

3. Results and discussion

Tests to analyse the performance of the smart car jack: A. Prototype efficiency on different ground surfaces. Table 1 shows the car jack performance while moving on different surfaces, The prototype demonstrated varying speeds on different surfaces. It achieved the highest average speed of 0.41 m/s on asphalt, performed moderately on grass with an average speed of 0.23 m/s, but encountered challenges on sand, getting stuck in all trials and unable to complete the one-meter test. Surface conditions significantly affected its mobility and effectiveness [8].

Table 1. Test Results

Surface	Time taken (s)	Average speed (m/s)
Asphalt	2.46	0.41
Grass	4.32	0.23
Sand	Failed to finish	-

B. Analysing the performance of the car jack with no load.

The data of the car jack with no load has been tabulated in Table 2 and illustrated in Fig. 3 which shows that the car jack's consistent and efficient performance in both jacking up and jacking down processes without any load. The mechanism is well-calibrated and operates smoothly, ensuring reliable and convenient operations for users during routine tasks [9].

Table 2. Test Results

	Time taken (s)	
Trial Number	Jack Up	Jack Down
1	14.23	13.34
2	13.58	12.56
3	13.45	13.13

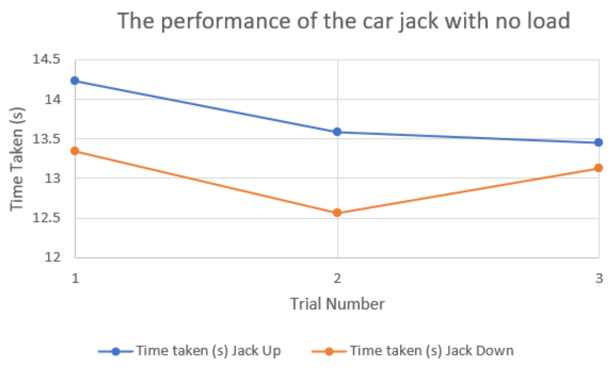

Fig. 3. The performance of the car jack with no load

C. Analysing the performance of the car jack with different loads.

The results reveal that the jacking up time increases with the load on the jack, indicating a direct relationship between them. Conversely, the jacking down time decreases as the weight applied to the prototype increases, showing an inverse relationship. These results provide valuable insights for optimizing the prototype's performance under varying load conditions, as illustrated in Table 3.

Table 3. Test Results

	Time taken (s)	
Weight (N)	Jack Up	Jack Down
150	23.58	11.54
200	27.34	10.28
250	31.27	9.56

D. Determining the maximum height of the prototype.

This test findings determine the prototype's maximum safe height as 30 cm, beyond which the stability and safety of the car lifting process could be compromised. Establishing this critical height limit provides valuable guidance for users to safely operate the smart car jack, ensuring both user and load safety during lifting operations. Table 4 shows the stability of the car jack with different heights.

Table 4. Test Results

Height (cm)	Observations
15	Completely Stable
25	Stable
30	Stable
35	Risky
40	Not Stable

E. Comparison between the jacking up speed of manual scissor car jack and the proposed prototype

The smart car jack prototype reaches its maximum height significantly faster than the manual scissor car jack, thanks to the use of a stepper motor that ensures precise and consistent movements. The elimination of human factors during operation contributes to enhanced efficiency and reliability, making the smart car jack an appealing choice for users seeking faster and more reliable lifting operations, as shown in Table 5.

Table 5. Test Results

Trial Number	Result to accomplish the task jack up and down (s)	
	Manual Scissor Jack	Proposed prototype
1	31.27	12.51
2	27.28	13.13
3	25.46	13.47

4. Conclusion

This study aimed to develop a smart scissor car jack with IoT capabilities, incorporating mecanum wheels and a stepper motor, controlled through the Blynk application. The prototype demonstrated remarkable performance, lifting a 200 N toy car to 30 cm in just 13.13 seconds, outperforming manual alternatives. The success of this project highlights the potential of IoT-integrated automotive tools in enhancing efficiency, safety, and convenience in vehicle maintenance. Future recommendations include improving mobility with larger wheels, implementing intelligent positioning systems, and enhancing safety mechanisms through IoT sensors. These enhancements will transform the smart car jack into an advanced and user-friendly automotive solution for various terrains and vehicles.

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