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# Development and Exploration of Controlled Automated Scissors Car Jack for Vehicle Maintenance

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## Abstract
The scissors jack is a commonly used mechanical device for vehicle maintenance and other applications. However, its operation requires significant energy input, posing challenges and complexities, particularly for certain demographics. In response, this paper presents a novel approach to automate the scissors car jack, integrating it with an Android application to enhance energy efficiency, ease of operation, and safety. The motorized lifting system incorporates a car wiper DC motor with an internal gearing system to drive the lead screw of the scissors jack, enabling smooth upward and downward motions. An electrical circuit, comprising a microcontroller, voltage regulator crystal oscillator, diode, resistor, transistor, relay, and Bluetooth module was designed to power the motor through the vehicle's 12V cigarette port and control its rotational direction. Furthermore, an Android application, developed using the MIT App Inventor, serves as a remote control for the DC motor. Through this research, significant advancements in energy efficiency and operational convenience are achieved, while also ensuring enhanced safety during vehicle maintenance. The integration of the scissors jack with an Android application allows users to remotely control the lifting process, providing a more user-friendly and intuitive experience. The findings contribute to the fields of automotive technology, automation, and mechanical systems by offering an innovative solution for efficient and safe vehicle maintenance. In conclusion, this paper presents an automated scissors car jack system integrated with an Android application, showcasing improved energy efficiency, ease of use, and safety. The research findings provide valuable insights for practitioners and researchers alike, advancing knowledge and practice in the field of automotive maintenance and automation.
**Keywords:** Lead screw, Scissors jack, Bluetooth, Mobile application, Automation, android.

## Introduction
During World War II, mechanical jacks employing screw mechanisms were commonly utilized in jeeps and trucks. Notably, the Ford GPW and Willys MB jeeps were equipped with the 41-J66 jack, a screw-type jack with a 1 1/2 ton capacity, identified by its Ordnance Part Number. These jacks were commonly stored in the toolbox of the jeeps. The selection of screw-type jacks for moderate load capacities was driven by their cost-effectiveness and minimal maintenance requirements. The origins of screw-based machinery trace back to ancient times. As early as 200 BC, Archimedes introduced the concept of utilizing his water pump's contraction principle as a screw machine. Screws were also widely favored in ancient Roman culture. However, it was during the late 1400s that Leonardo da Vinci first revealed the technique of using a jacket to bear loads. His innovative concept employed a rotating threaded worm gear to swiftly shift the load, a principle that remains relevant to this day. This mechanism relies on the rotation of a worm shaft to facilitate its operation (Abhishek., et al., 2018).

Jacks serve as essential mechanical tools for lifting heavy loads and harnessing high strengths. They employ screw threads or hydraulics to apply substantial linear forces. In the realm of vehicle maintenance, the garage jack, a commonly used car jack variant, takes precedence in lifting vehicles. These mechanical marvels utilize mechanical advantages to enable manual lifting. However, hydraulic jacks leverage hydraulic power to achieve greater elevation over extended distances.

Among the diverse range of jacks, the scissors jack stands out as a mechanical device specifically designed for vehicle maintenance (http://www.ehow.com/list_7261433_types-car-jacks.html). Resembling a pair of scissors, it primarily operates in a vertical manner. When deployed, the jack expands and contracts, engaging a cross-hatching mechanism to provide stable support. In its folded state, it takes on a diamond shape. The ingenious power screw design inherent in most scissor jacks significantly reduces the user's physical effort. Manipulating a scissor jack involves rotating a small handle affixed to one end of the screw, often fashioned in a "Z" shape. This handle fits into a ring hole at the end of the screw, serving as a point of leverage. As the crank is turned, the screw rotates, resulting in the raising or lowering of the jack. The screw functions as a transmission mechanism, with its threaded teeth engaging the two arms and facilitating the jack's operation. Through the rotation of this screw thread, the scissors jack can effortlessly raise vehicles weighing thousands of pounds.

Form the work of Kamalakkannan, Kalaiselvan, Isaac and Vijay in 2016, automation represents the utilization of process-controlled electronics and computer-controlled devices to enhance efficiency and reliability. While automation often replaces human labor in various contexts, concerns regarding increased unemployment rates accompany rapid technological advancements. Nowadays, robot assembly lines assume numerous tasks once performed by human workers in manufacturing operations across diverse industries. Automation pervades nearly all sectors, encompassing crucial components, systems, and task functions related to production, transportation, facility operations, utility services, and even marketing and sales (Rana, Belge, and Nagrare, *et al*, 2012).

Automating a scissors jack entails substituting human effort with a DC motor to rotate the jack's screw, thereby facilitating smooth raising and lowering operations. For this project, a car wiper DC motor was selected due to its internal worm gearing system, which enhances torque and reduces speed, making it particularly suitable for the task at hand. An Arduino circuit was integrated with the DC motor to enable remote control functionality, adding convenience to the automation process (Balkeshwar and Anil, 2015).

The development of the vehicle elevation system marked another milestone. The drive assembly served as the mechanical link to the piston, with the driving unit working in one direction to elevate the upper end of the piston to the housing, and in the opposite direction to lower the piston top relative to the housing. The drive unit could be connected to a power supply port, enabling the power source to drive the mechanism. This electrically propelled jack allows for the typical elevation and lowering of automobiles from the ground. It can also be employed in conjunction with a handheld automobile jack, utilizing a power boiler, rod, and various adapters.

**Objective of the Study**

The main objective of this work is to construct a screw jack that surpasses human effort, particularly addressing the challenges faced by pregnant women and the elderly. Changing a tire is often an arduous task, and women, in particular, may struggle to exert greater force. Therefore, the introduction of an electric automobile jack serves this purpose, optimizing efficiency by adjusting the various angles of the square threaded mechanical screw jack.

## Methodology

Materials employed in the study are Scissors Jack, Cigarette lighter receptacle, 12V Dc motor, IC 7805 Voltage Regulator, PIC (Peripheral Interface Controller) 16F876A microcontroller, HC-06 Bluetooth Module, Resistor, BC547 Transistor, Diode, 12V Relay, Crystal Oscillator. The methodology used in the project involved several key steps. Firstly, the DC motor was securely attached to the head of the lead screw in the scissors jack using a detachable shaft, allowing for easy detachment when required. A sturdy frame was then affixed to the jack, serving as a mounting platform for both the DC motor and the electrical circuit box. The electrical circuit box was connected to the vehicle's cigarette port receptacle using a wired connection to draw the necessary power.

In parallel, an Android application was developed using A12 app inventor, specifically designed and programmed to establish seamless communication with the microcontroller. Upon connecting the cigarette port to the vehicle, a 12V power supply was provided, which was then regulated to a stable +5V by the voltage regulator. This regulated voltage was subsequently supplied to the microcontroller. The microcontroller was further connected to a crystal oscillator and a Bluetooth module, which served as the interface between the microcontroller and the Android application.

To control the power flow, a transistor and a resistor were integrated with the microcontroller, with the resistor acting to limit the power consumption of the transistor. A relay and a diode were also incorporated into the system, with the diode ensuring the flow of current in a single direction. The relay, serving as a switch, was directly connected to the DC motor, enabling precise motor control.

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Once the power was supplied to the circuit depicted from (Osman and Ehab, 2015), the Android mobile phone's Bluetooth application established a connection with the Bluetooth module. This connection, which typically took a few seconds, enabled users to raise or lower the jack by simply pressing the corresponding buttons on the Android application. These button commands were then transmitted to the microcontroller, which in turn sent signals through the transistor to the relay, effectively controlling the DC motor and allowing for the smooth raising or lowering of the scissors jack.

By following this methodology, the project successfully achieved the integration of the DC motor with the scissors jack, enabling remote control through the Android application. The detachable design, utilization of components such as the voltage regulator and crystal oscillator, and the implementation of the Bluetooth interface collectively contributed to a reliable and efficient system for raising and lowering the scissors jack (Theraja and Theraja, 2008).

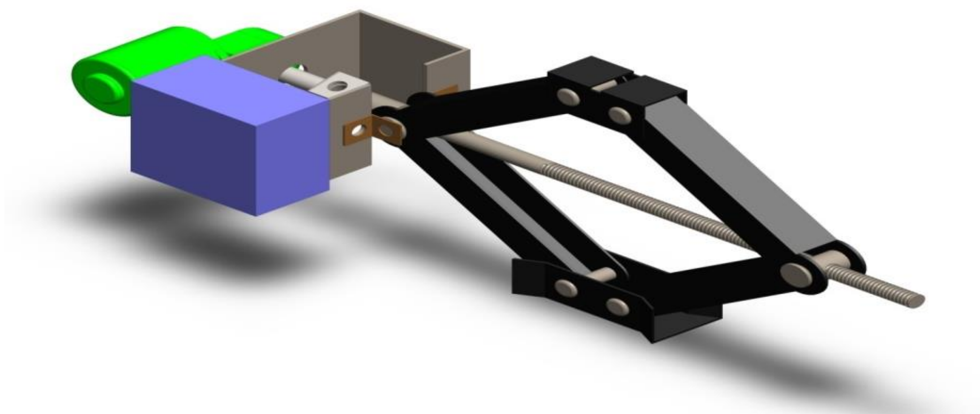

**Figure 1** Solid works Design of Automated Scissors Jack
(Source: Khurmi and Gupta,2004, Duniya and Babatunde, 2021)

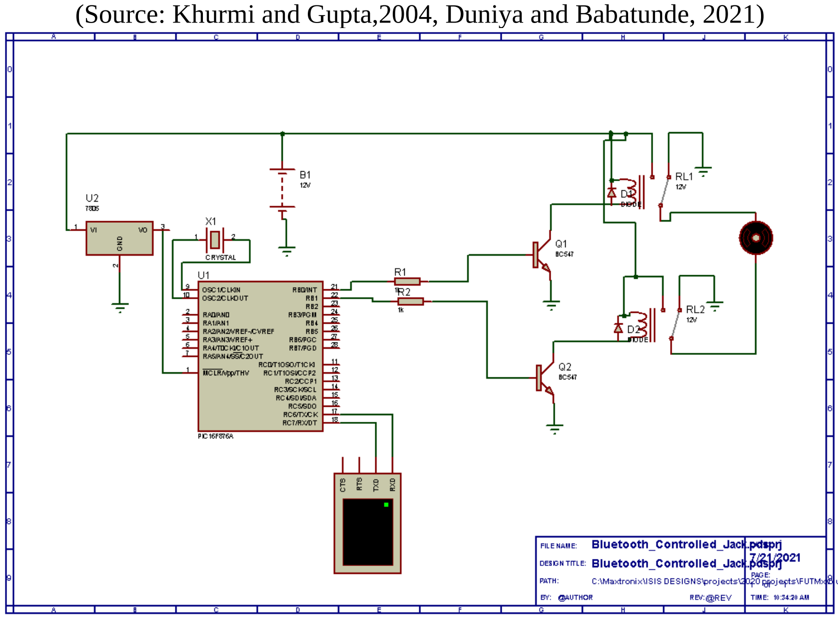


**Figure 2** Arduino Circuit diagram (Source: Rana, *et al*,2012)

## Results

## Jack Android Application

The android application was successfully created using an app inventor. The application operates on all android smart phones of version 8.0 and above, it contains the commands necessary for the smooth operation of the jack. The android application achieved its purpose of serving as the remote control of the Automated Scissors Jack.

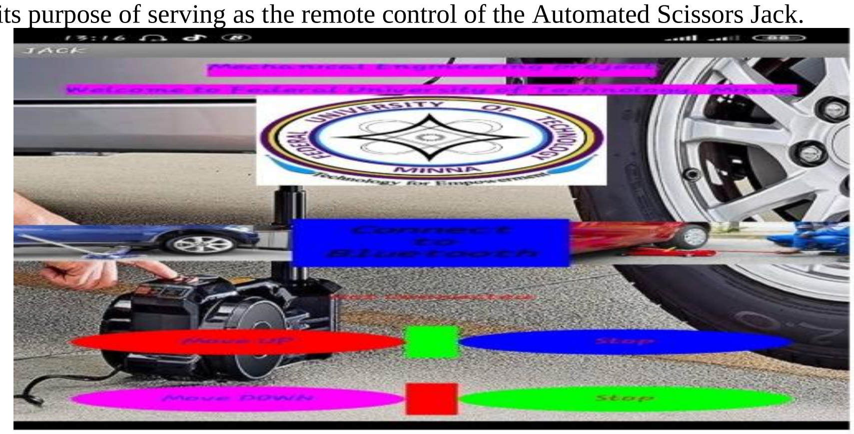


**Figure 4** Screenshots from the Jack Android Application
(Source: Duniya and Babatunde, 2021)

**Figure 4** Side view of Android Controlled Automated Scissors car Jack
(Source: Duniya and Babatunde, 2021)

The objectives of this project were successfully realized, demonstrating significant achievements in the following areas:

## Automation of the Existing Scissors Jack

The automation of the existing scissors jack proved to be highly successful. Rigorous testing procedures were conducted to assess the efficiency of the project. During testing, the automated scissors jack performed optimally without any load and when subjected to varying degrees of load. It exhibited satisfactory rotational capabilities in both clockwise (upward) and anti-clockwise (downward) directions of the lead screw (jack). Under load conditions, the rotational speed of the jack was slightly reduced compared to the unloaded state, but it remained within acceptable limit (Khurmi and Gupta, 2004).

## Integration of jack with android

The seamless integration between the scissors jack and the Android application was achieved with remarkable ease. The Bluetooth module effortlessly establishes a connection with the Android devices, typically ranging from 2 to 5 seconds, depending on the proximity of the Android device to the jack and the specific Android version in use. The responsiveness of the system to user commands is immediate, again influenced by the proximity of the Android device to the jack and the Android version utilized and it compares significantly with the report of (Rana, Belge, and Nagrare, *et al*, 2012). The successful realization of these objectives underscores the effectiveness and efficiency of the automated scissors jack project. It demonstrates the project's capability to enhance the functionality and user experience through automation and integration with the Android platform.

## Conclusion

In conclusion, this work has successfully developed an Android-controlled automated scissors jack. The selection of components prioritized local materials availability, cost-effectiveness, and quality assurance. The Android application was designed to be compatible with Android devices running versions 8.0 to 11.0, with a Bluetooth range of 0m to 9m. The project achieved promising results, demonstrating satisfactory stability and performance, even under load conditions. This innovative solution enhances the functionality and ease of use of the scissors jack for vehicle maintenance. Future improvements could focus on further enhancing the device's robustness, exploring additional features to enhance the user experience, and conducting extensive field tests. By advancing the technology, this Android-controlled automated scissors jack has the potential to become a valuable tool for efficient and convenient vehicle maintenance.

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