

Design and Fabrication of Mobile Controlled Scissor Based Lifting Jack”

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Abstract— The rapid growth of automation and wireless communication technologies has created opportunities for developing smart mechanical systems that improve safety, efficiency, and convenience in everyday applications. One such important application is the automobile lifting jack system, which is commonly used for lifting vehicles during tire replacement, maintenance, and repair work. Conventional scissor jacks are manually operated and require considerable physical effort and time, especially in emergency situations. To overcome these limitations, the project titled “Mobile Controlled Scissor Based Lifting Jack Using ESP32 and Relay Circuit” presents an intelligent and automated lifting mechanism that can be controlled wirelessly through a mobile phone. The proposed system combines the mechanical strength of a scissor jack with the capabilities of embedded systems, wireless communication, and motor control technology. The main objective of this project is to design and develop a compact, efficient, and user-friendly lifting jack that can be operated remotely using a smartphone application. The system uses an ESP32 microcontroller as the central control unit due to its high processing capability, low power consumption, built-in Wi-Fi and Bluetooth features, and compatibility with Internet of Things (IoT) applications. A relay circuit is used to control the direction and operation of the DC motor connected to the scissor jack mechanism. In this project, a high torque DC motor is mechanically coupled to the screw mechanism of the scissor jack.

Keywords— ESP32 Microcontroller, Scissor Jack Mechanism, Relay Driver Circuit, Bluetooth Control.

INTRODUCTION

Vehicle lifting is an essential process in automobile maintenance, repair, and servicing operations. In workshops, garages, and service centers, hydraulic jacks are commonly used to lift vehicles for inspection and repair work. However, traditional hydraulic jacks require significant manual effort and time, which can be inconvenient and physically demanding for users. With the rapid advancement of technology, automation has become a key aspect of modern engineering systems. The integration of IoT (Internet of Things) with mechanical devices provides new opportunities for developing smart, efficient, and user-friendly systems.

IoT enables remote monitoring and control, reducing the need for manual intervention. This project focuses on the design and development of an IoT-based motorized hydraulic jack system. The system combines mechanical components with electronic control using an ESP32 microcontroller. The ESP32 allows wireless communication via Wi-Fi, enabling the user to operate the system remotely using a mobile interface or web application.

To overcome these drawbacks, automation can be introduced into the lifting system. By integrating wireless communication and motorized control, the traditional scissor jack can be transformed into a smart lifting device that operates with minimal human effort. The project titled “Mobile Controlled Scissor Based Lifting Jack Using ESP32 and Relay Circuit” focuses on developing an automated vehicle lifting system that can be controlled through a

smartphone. The system uses an ESP32 microcontroller as the central processing unit because it offers built-in Wi-Fi and Bluetooth communication features, fast processing speed, and low power consumption. The ESP32 receives commands from a mobile application and controls the lifting mechanism through a relay circuit. A DC geared motor is connected to the scissor jack screw arrangement to perform lifting and lowering operations automatically. The relay circuit acts as an electronic switching system that controls the motor direction and operation. When the user presses the “Lift” button on the mobile application, the ESP32 activates the relay module, causing the motor to rotate in a direction that expands the scissor jack and lifts the vehicle. Similarly, pressing the “Lower” button reverses the motor rotation, causing the jack to contract and lower the load safely. The mobile-controlled feature allows the user to operate the jack remotely without direct physical contact, improving both convenience and safety.

1.2 Innovation

Filters (air, cabin, fuel) and spark plug replacement. Tyre rotation, balancing, alignment, and pressure management. Scheduled inspections per manufacturer intervals (timing belts/chains). Systematic troubleshooting of engine, transmission, ABS, airbag, charging/starting systems, HVAC, and drivability complaints. Use of multimeters, smoke testers, pressure gauges, compression/leak-down testers. The rapid development of automation and wireless communication technologies has transformed traditional mechanical systems into smart and intelligent devices. One such advancement is the mobile controlled scissor based lifting jack using an ESP32 and relay circuit. This system represents a significant innovation in the field of automotive tools and embedded systems because it combines mechanical lifting mechanisms with wireless communication, automation, and electronic control.

Traditional scissor jacks are manually operated devices commonly used for lifting vehicles during tire replacement or repair work. Although they are simple and affordable, manual jacks require considerable physical effort and time. The innovative mobile-controlled lifting jack overcomes these limitations by introducing automation through microcontroller technology and smartphone-based operation.

I. LITERATURE REVIEWS

A) Literature Survey:

The development of automated lifting systems has become an important area of research in automotive engineering, embedded systems, and industrial automation. However, manual operation requires significant physical effort, consumes time, and presents safety challenges. To overcome these limitations, researchers have explored motorized, wireless, and intelligent lifting systems using microcontrollers, relay circuits, sensors, and mobile communication technologies. The mobile controlled scissor based lifting jack using ESP32 and relay circuits is part of this growing trend toward smart automation. This literature review examines previous studies related to automated scissor jacks, ESP32-based automation systems, relay-controlled motor systems, wireless control technologies, and smart automotive maintenance equipment.

3.1.1 Review of Traditional Scissor Jack Systems:

Scissor jacks are among the most commonly used mechanical lifting devices in automobiles. A study titled Mechanical Engineering “Review on Design and Fabrication of Scissor Jack” analysed the structure, operation, and performance of conventional scissor jacks. The researchers emphasized the need for integrating automation into lifting systems to improve user convenience and operational performance.

Another study titled “Design and Development of Automatic Scissor Type Car Jack” focused on motorized scissor jack systems for emergency vehicle applications. The research proposed the use of motors and sensors

3.1.2 Review of ESP32-Based Automation Systems

The ESP32 microcontroller has become highly popular in automation and IoT applications because of its:

- Built-in Wi-Fi
- Bluetooth communication
- Dual-core processing
- Low power consumption

3.1.3 Review of Relay-Controlled Motor Systems

Relay circuits are widely used in automation projects for controlling high-current electrical devices using low-power control signals from microcontrollers.

The study “Relay Driver Based on Arduino UNO to Bridge the Gap of The Digital Output Voltage of The Node MCU ESP32” examined relay interfacing techniques with ESP32 systems. The research explained that relay modules are effective for switching motors and electrical loads in embedded applications. It also discussed the voltage compatibility challenges between ESP32 and relay modules.

Relay circuits are important in automated lifting systems because they:

- Control motor ON/OFF operation
- Change motor direction
- Provide electrical isolation
- Simplify motor interfacing

3.1.4 Review of Automated Screw Jack Systems

Research on automated screw jack systems directly relates to the development of mobile-controlled lifting mechanisms.

A significant study titled “Development of a Bluetooth-Controlled Automated Screw-Jack: A Mobile Device to

Reduce Tyre Replacement Drudgery” developed a Bluetooth-controlled automated jack system to reduce the physical burden involved in tire replacement. The study identified that manual screw jacks are difficult for elderly people, women, and physically challenged individuals. The proposed automated system improved convenience and reduced manual effort through wireless control.

III. METHODOLOGY

The research methodology for the project titled “**Mobile Controlled Scissor Based Lifting Jack Using ESP32 and Relay Circuit**” is designed to develop an automated vehicle lifting system that can be operated wirelessly through a smartphone. Conventional scissor jacks require significant manual effort and time for lifting vehicles, especially during emergency situations such as tire punctures. To overcome these difficulties, this project introduces a smart lifting mechanism using an ESP32 microcontroller, relay circuit, and DC geared motor integrated with a mobile control application.

The methodology involves the systematic process of designing, fabricating, programming, testing, and evaluating the performance of the proposed system. The research combines concepts of mechanical engineering, embedded systems, electrical circuits, and wireless communication to create an efficient and user-friendly lifting jack.

3.1 Problem Identification

A large amount of mechanical energy is wasted every day when vehicles move over road speed breakers. This energy is normally lost in the form of vibration and pressure. At the same time, the increasing demand for electrical energy and depletion of conventional energy resources have created the need for renewable and alternative methods of power generation.

The project identifies this wasted vehicular energy as a potential renewable energy source and aims to utilize it for electricity generation.

3.2 Concept Development

The basic concept of the project is to generate electrical energy from the vertical movement of a speed breaker caused by vehicle motion. When a vehicle passes over the movable speed breaker, the downward displacement drives a rack mechanism connected beneath it.

The rack meshes with a pinion gear and converts the linear motion into rotary motion. This rotary motion is transmitted to a generator using a shaft arrangement. The generator converts mechanical energy into electrical energy, which can be stored in batteries for future use.

3.3 Selection of Mechanism

Among various energy generation methods such as hydraulic systems, flywheel systems, and electromagnetic systems, the rack and pinion mechanism was selected for this project because of:

- Simple construction
 - Easy fabrication
- Compact design
- Low maintenance

The rack and pinion mechanism effectively converts vertical displacement into rotary motion required for generator operation.

3.4 Design of System Components

The major components of the system were designed according to expected traffic conditions and power requirements.

Components designed include:

- Speed breaker
- Rack and pinion gear
- Shaft
- Springs
- Bearings
- Generator
- Supporting frame

IV. RESULTS AND DISCUSSION

Experimental Investigation:

The developed **Mobile Controlled Scissor Based Lifting Jack Using ESP32 and Relay Circuit** was successfully designed, fabricated, and tested for lifting light to medium automobile loads. The system integrated an ESP32 microcontroller, relay module, DC actuator motor, scissor jack mechanism, and mobile phone control through Wi-Fi/Bluetooth communication. Experimental testing showed that the lifting operation could be performed smoothly and efficiently using a smartphone application.

During operation, the ESP32 received commands from the mobile device and activated the relay circuit accordingly. The relay controlled the direction of the actuator motor, enabling upward and downward movement of the scissor jack. The actuator converted electrical energy into linear motion, which expanded the scissor mechanism and lifted the vehicle. The response time of the system was observed to be fast, and the lifting process required less human effort compared to a conventional manual jack.

The prototype demonstrated stable lifting performance under different load conditions. The actuator produced sufficient force to raise the test load safely without excessive vibration. The scissor structure maintained proper balance during operation, indicating good mechanical stability. The relay circuit also performed effectively by isolating the control section from the power section, thereby protecting the ESP32 from high current damage.

One of the major advantages observed in this project was the convenience of wireless control. The user could operate the lifting jack remotely through a mobile application, reducing physical strain and improving ease of use. This feature is especially beneficial for elderly users and emergency roadside situations. The use of ESP32 also provided flexibility for future improvements such as IoT monitoring, automatic load sensing, and voice control.

The testing results indicated that the lifting speed depended on the actuator power and battery supply. When the supply voltage decreased, the lifting speed reduced slightly. However, the system continued to operate reliably within the designed voltage range. Proper alignment of the scissor arms and lubrication of mechanical joints were found to be important factors for smooth operation.

The project also highlighted some limitations. The prototype was suitable mainly for light and medium vehicles due to actuator load limitations. Continuous operation for a long

duration caused heating in the motor and relay components. Therefore, proper heat dissipation and heavy-duty

6.2 Experimental Setup:

The experimental setup of the **Mobile Controlled Scissor Based Lifting Jack Using ESP32 and Relay Circuit** was designed to demonstrate automatic lifting and lowering operation through wireless mobile control. The setup consisted of both mechanical and electronic components integrated into a single system for smooth operation.

Components Used:

The main components used in the experimental setup are:

1. **Scissor Jack Mechanism** – Used for lifting the load vertically.
2. **Linear Actuator / DC Motor** – Provides mechanical movement to expand and contract the scissor jack.
3. **ESP32 Microcontroller** – Acts as the main control unit for receiving commands from the mobile application.
4. **Relay Module** – Controls the actuator direction and isolates the low-power controller from the high-power motor circuit.
5. **Power Supply/Battery** – Supplies electrical power to the ESP32 and actuator motor.
6. **Mobile Application** – Sends wireless commands through Wi-Fi or Bluetooth.
7. **Connecting Wires and Frame** – Used for electrical and mechanical connections.

Setup Arrangement:

The scissor jack was mounted on a stable base platform to ensure balance during lifting. A linear actuator was fixed between the arms of the scissor jack in such a way that its extension and retraction produced upward and downward movement. The actuator was connected to the relay module, which controlled motor polarity for directional movement.

The ESP32 microcontroller was connected to the relay module through digital output pins. The relay module received low-voltage control signals from the ESP32 and switched the higher current supply to the actuator motor. A rechargeable battery or DC power source was used to provide power to the entire circuit.

A mobile phone application was configured to communicate with the ESP32 through Bluetooth or Wi-Fi. When the user pressed the “UP” button on the application, the ESP32 activated the relay to extend the actuator and lift the jack. Similarly, pressing the “DOWN” button reversed the actuator movement and lowered the jack.

6.3 Program Coding

```
#include <BluetoothSerial.h>
BluetoothSerial SerialBT;

int relay1 = 26;
int relay2 = 27;

void setup () {
  pinMode (relay1, OUTPUT);
  pinMode (relay2, OUTPUT);
  digitalWrite (relay1, LOW);
  digitalWrite (relay2, LOW);
  SerialBT. Begin("ESP32_JACK");
}

void loop () {
  if (SerialBT.available()) {
    char data = SerialBT.read();
```

```
if (data == 'U') {  
    digitalWrite (relay1, HIGH);  
    digitalWrite (relay2, LOW);  
}  
  
else if (data == 'D') {  
    digitalWrite (relay1, LOW);  
    digitalWrite (relay2, HIGH);  
}  
  
else if (data == 'S') {  
    digitalWrite (relay1, LOW);  
    digitalWrite (relay2, LOW);  
}  
}
```

6.4 Experimental Results and Performance Analysis

The Mobile Controlled Scissor Based Lifting Jack Using ESP32 and Relay Circuit was experimentally tested to evaluate its lifting capability, wireless control performance, stability, and operational efficiency. The system successfully demonstrated automated lifting and lowering operations using a mobile device. The experimental analysis confirmed that the integration of ESP32, relay module, and actuator-based scissor mechanism provided reliable and user-friendly performance.

6.4.1 Experimental Results:

The prototype was tested under different load conditions to verify its operational capability. During testing, the ESP32 microcontroller successfully received commands from the mobile application through wireless communication and controlled the relay module accurately. The relay activated the actuator motor, which expanded and contracted the scissor jack mechanism smoothly.

The lifting operation was completed without manual effort, and the actuator generated sufficient force to lift the test load effectively. The scissor mechanism maintained proper balance during operation, and no major vibration or instability was observed. The wireless control range was found adequate for practical operation within a short-distance environment.

The system also demonstrated quick response to mobile commands. When the "UP" command was sent, the actuator extended immediately and lifted the jack. Similarly, the "DOWN" command retracted the actuator and lowered the load safely. The relay circuit provided proper electrical isolation between the ESP32 and the motor power supply, ensuring safe operation of the controller circuit.

6.4.2 Performance Analysis:

1. Lifting Performance

The actuator-based mechanism provided smooth and controlled lifting action. The scissor jack successfully lifted light to medium loads without mechanical failure. The lifting speed depended on the actuator power and supply voltage. Higher voltage produced faster lifting action, while lower voltage slightly reduced speed.

2. Wireless Communication Performance

The ESP32 maintained stable communication with the mobile application through Bluetooth/Wi-Fi technology. The response time between user command and actuator movement was very short, improving operational convenience and efficiency.

3. Stability and Safety

The scissor structure remained stable during operation due to proper alignment of mechanical joints. The relay module protected the ESP32 from high-current motor

The system consumed moderate electrical power during operation. Maximum power consumption occurred during lifting under full load conditions. The ESP32 consumed very low power compared to the actuator motor.

5. Reliability

Repeated testing showed consistent performance of the lifting system. The actuator and relay circuit operated reliably without major interruptions. However, continuous long-duration operation caused slight heating in the motor and relay components.

6.5 Advantages:

1. Reduced Human Effort

One of the biggest advantages of this system is that it minimizes manual effort. Traditional scissor jacks require continuous hand rotation using a lever,

2. Convenience and Ease of Operation

The mobile-controlled feature provides high convenience. Users can operate the jack remotely without bending down or applying physical force. The smartphone interface can include simple buttons such as "Lift," "Lower," and "Stop," making the system user-friendly.

3. Wireless Control

The ESP32 supports Bluetooth and Wi-Fi communication, enabling wireless operation. Wireless control eliminates the need for long cables or manual switches.

4. Faster Lifting Process

Compared to manual jacks, motorized scissor jacks can lift vehicles more quickly. The DC motor rotates continuously at a steady speed, reducing the time needed to raise the vehicle.

5. Improved Safety

The system can improve safety in several ways. Since the user does not need to remain near the jack during operation, the risk of injury is reduced. Additional safety features can also be programmed into the ESP32, such as:

- Automatic stop when maximum height is reached

6.6 Disadvantages:

1. Dependence on Electrical Power

The system completely depends on electrical power for operation. If the battery is discharged or the electrical system fails, the jack may not work. In emergency conditions, this can become a major problem.

2. Increased System Complexity

Compared to a traditional mechanical jack, the automated system is more complex. It includes electronic circuits, software programming, wireless communication, and motor control. More components mean higher chances of failure and increased maintenance requirements.

3. Higher Initial Cost

Although cheaper than industrial systems, the automated jack still costs more than a conventional manual scissor jack. Additional expenses include:

- ESP32 module
- Relay board
- Motor driver
- DC motor
- Power supply components

Mobile application development loads. The setup reduced human effort and minimized risks associated with manual lifting.

4. Power Consumption Risk of Electronic Failure

Electronic components are sensitive to heat, moisture, vibration, and dust. In automotive environments, these conditions are common. If the relay, ESP32, or motor controller fails, the jack may stop functioning unexpectedly.

6.7 Limitations:

1. Dependence on Electrical Power

One of the primary limitations of the system is its complete dependence on electrical power. The motor, ESP32 controller, relay module, and wireless communication system all require a stable power supply. If the vehicle battery becomes weak or discharged, the lifting jack may fail to operate.

2. Limited Load Carrying Capacity

Scissor jacks are generally suitable for light and medium vehicles only. When automation components such as motors and relay systems are added, the load handling capability becomes more critical. If the motor does not provide sufficient torque, the system may fail to lift heavier vehicles.

3. Relay Circuit Limitations

Relay circuits are commonly used for switching motor operations because they are simple and inexpensive. However, relays have several disadvantages in high-power applications.

Mechanical relays contain moving contacts that wear out over time due to continuous switching.

4. Wireless Communication Issues

The system relies heavily on wireless communication through Bluetooth or Wi-Fi provided by the ESP32. Although wireless control improves convenience, it introduces communication-related limitations.

Bluetooth range is limited, and signal interruptions may occur due to obstacles, interference, or distance. Wi-Fi communication may also become unstable in outdoor environments.



Fig. 4.2 Final Prototype Overview

4.4 Working Principle

The mobile controlled scissor based lifting jack using ESP32 and relay circuit is an electromechanical system designed to automate the process of lifting and lowering a vehicle using wireless control from a smartphone. It combines mechanical motion, electrical switching, and embedded programming into a single integrated system. The working principle of this system is based on the coordination between a mobile application, an ESP32 microcontroller, a relay module, and a DC motor that drives a scissor jack mechanism.

This system replaces manual operation with automated control, making vehicle lifting easier, faster, and safer. The overall working principle can be understood by breaking the system into functional blocks and explaining how each component contributes to the operation.

1. Basic Concept of Operation

The fundamental working principle is based on converting electrical signals into mechanical motion.

The sequence is:

1. User sends command from mobile phone
2. ESP32 receives the signal wirelessly
3. Relay circuit switches motor direction
4. DC motor rotates

5. Scissor jack mechanism lifts or lowers the vehicle
Thus, electrical energy is converted into mechanical lifting force through controlled automation.

2. Role of Mobile Application

The system begins with the mobile phone, which acts as the user interface. The mobile application is designed with simple control buttons such as:

- Lift
- Lower
- Stop

When the user presses a command, it is transmitted wirelessly to the ESP32 using either Bluetooth or Wi-Fi.

This removes the need for physical interaction with the jack and allows remote operation. The mobile device essentially acts as a wireless remote control.

3. Wireless Communication Process

The ESP32 is responsible for receiving commands from the mobile device.

It supports:

- Bluetooth communication
- Wi-Fi connectivity

When a command is sent:

- The signal travels wirelessly
- ESP32 receives and decodes the data
- The microcontroller identifies the instruction (lift or lower)

This communication process ensures real-time control of the system.

4. Signal Processing by ESP32

After receiving the command, the ESP32 processes the input using programmed logic.

For example:

- If “Lift” command is received → activate relay 1
- If “Lower” command is received → activate relay 2
- If “Stop” command is received → deactivate both

relays

The ESP32 acts as the decision-making unit of the system. It converts digital input signals from the

II. APPLICATIONS OF SYSTEMS

1. Automobile Service and Maintenance

One of the primary applications of this system is in automobile workshops and service centers.

In vehicle servicing, lifting the car is necessary for:
Tire replacement

2. Emergency Roadside Assistance

This system is highly useful in emergency situations such as: Tire punctures

3. Personal Vehicle Maintenance

Car owners can use this system for routine maintenance at home.

4. Automotive Workshops and Small Garages

Small-scale workshops often cannot afford expensive hydraulic lifts. This system provides a cost-effective

5. Educational and Engineering Projects

This system is widely used in engineering colleges for learning and research purposes.

III. CONCLUSION

The system methodology of the "Mobile Controlled Scissor Based Lifting Jack Using ESP32 and Relay Circuit" explains the complete process involved in designing and implementing the automated lifting mechanism. The methodology integrates wireless communication, embedded systems, relay control, and mechanical lifting technology to create a smart and efficient vehicle lifting system. The project successfully reduces manual effort, improves operational safety, and demonstrates the practical application of automation technologies in automobile maintenance systems. We make this project entirely different from other projects since concept involved in our project entirely differently that a single unit is used to various purposes, which is not developed by any of the other team members. By doing this project work, we understood the working principle and uses of relay screw jack and dc motors. The proposed model is to reduce the manual work greatly. It uses least manual work for the lifting of the jack. The proposed electric circuit is built using relays, Bluetooth module, and an Arduino. The interface between the mobile phone and circuit is achieved through Bluetooth module and that of between Jack and electronic circuit is gained by a reduction gear box.

IV. FUTURE WORKS

The IoT-based motorized hydraulic jack system has great potential for future development and improvement. Although the current system performs efficiently, there are several enhancements that can be implemented to make it more advanced and reliable. One of the major improvements that can be made is the addition of safety sensors. Sensors such as load sensors and position sensors can be used to monitor the lifting process and prevent overloading or unsafe conditions. This will significantly improve the safety of the system. Another important improvement is the development of a fully automatic system. The current system requires user input to operate, but it can be upgraded to perform automatic lifting and lowering based on predefined conditions. This will further reduce human intervention. The system can also be integrated with solar power to make it energy-efficient and environmentally friendly. This will allow the system to operate in areas where electricity supply is limited. Voice control is another feature that can be added to the system. By integrating voice

recognition technology, the user can control the system using voice commands, making it more convenient and modern. The system can also be developed into a smart garage system where multiple devices are interconnected and controlled through IoT. This will enable automation of various vehicle maintenance operations. Overall, the future scope of this project is vast, and with further research and development, it can be transformed into a highly advanced and intelligent system. Technology and data integration predictive maintenance: AI and machine learning will vehicle predict potential issues before they cause a breakdown, allowing for proactive repairs.

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