

# DESIGN AND DEVELOPMENT OF REMOTE CONTROL AUTOMATIC HYDRAULIC JACK

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## ABSTRACT

*This project presents the design and development of a Remote Control Automatic Hydraulic Jack system aimed at improving the efficiency, safety, and ease of vehicle lifting operations. Traditional manual jacks are time-consuming, physically demanding, and pose safety risks, especially in emergency roadside conditions. To address these challenges, an automatic hydraulic jack system is developed, which integrates an electrically-driven hydraulic mechanism with wireless remote control functionality. The system allows users to lift and lower vehicles effortlessly at the press of a button, eliminating manual effort and reducing operation time. Key components include a DC motor-powered hydraulic pump, microcontroller-based control circuitry, wireless communication modules, and safety locking mechanisms. The prototype demonstrates enhanced performance in terms of load capacity, operational speed, and user convenience, offering a practical solution for automotive maintenance and emergency use.*

**Keyword :** Dc motor, Hydraulic Jack, DCV etc.

## INTRODUCTION

The hydraulic jack is a widely used mechanical device designed to lift heavy loads, particularly vehicles, by applying a force through hydraulic pressure. Traditionally, these jacks are operated manually, requiring considerable physical effort and time. In scenarios such as roadside tire changes or vehicle maintenance in challenging environments, this manual operation can be both inconvenient and potentially hazardous. With the advancement of automation and wireless control technologies, there is a growing demand for more efficient and user-friendly lifting mechanisms. This project aims to design and develop a Remote Control Automatic Hydraulic Jack, which combines the power of hydraulics with modern control systems to create a device that simplifies vehicle lifting operations. The core of this system lies in integrating an electrically driven hydraulic pump with a wireless control interface, enabling users to lift and lower vehicles remotely with minimal effort. This innovation not only enhances user convenience but also improves safety, especially in emergency or low-visibility situations. The project addresses key engineering challenges, including load stability, control accuracy, power management, and system safety. Through careful design and development, the final prototype aims to provide a reliable, efficient, and portable solution suitable for both personal and professional automotive use.

### Need For Automation

- To achieve mass production
- To reduce man power
- To increase the efficiency of the plant
- To reduce the work load
- To reduce the production cost
- To reduce the production time
- To reduce the material handling
- To reduce the fatigue of workers
- To achieve good product quality

### Statement of Problem

Nowadays in this country, the most available jacks are manually powered, we found out that these manual hydraulic jacks were very difficult to be used by our farmers especially the female ones because of the strength and energy needed to operate it making it to be time consuming; furthermore, in scenarios of these manual hydraulic jack malfunctioning and subsequently the collapse of the machine under maintenance could lead to musculoskeletal disorders, injuries of the

neck, back and shoulder. Thus, to overcome this problem of drudgery, musculoskeletal disorders, injuries, increase timeliness and efficiency in the farm while changing tires and carrying out some other maintenance works beneath the tractor prompted the design of a remote controlled motorized hydraulic jack for tractors.

### Objectives

- To design a remote controlled system for a hydraulic jack
- To fabricate a prototype of a remote controlled system for a hydraulic jack\
- To test for efficiency of the designed and fabricated remote controlled system for a hydraulic jack

### COMPONENT OF PROJECT

A hydraulic jack remote control system typically consists of several key components. These components work together to control the hydraulic jack, allowing for lifting and lowering operations without the need to be physically near the jack. Here's an overview of the main components in a remote-controlled hydraulic jack:

#### Hydraulic Jack (Primary Unit)

This is the core of the system, consisting of a hydraulic cylinder and piston that lift the load when hydraulic fluid is pumped into the system. It includes a hydraulic pump, reservoir, and relief valve to ensure proper operation. The vertical piston of a bottle jack directly assists a bearing pad connecting the objects being raised. Only automobiles with extraordinarily high clearance may use it since the elevate with a single action piston is only about twice as high as the jack's collapsed height. The hydraulic coupling of lifting devices, such as houses, multiple vertical jacks through the valves enables the even distribution of forces whilst permitting near manipulate of elevate.



**Fig. 2.1 Hydraulic Jack**

#### Hydraulic Pump

A hydraulic pump is a mechanical source of power that converts mechanical power into hydraulic energy (hydrostatic energy i.e. flow, pressure). Hydraulic pumps are used in hydraulic drive systems and can be hydrostatic or hydrodynamic. They generate flow with enough power to overcome pressure induced by a load at the pump outlet. When a hydraulic pump operates, it creates a vacuum at the pump inlet, which forces liquid from the reservoir into the inlet line to the pump and by mechanical action delivers this liquid to the pump outlet and forces it into the hydraulic system.

#### Reservoir

A hydraulic reservoir is an essential component of a hydraulic system that serves as the storage tank for hydraulic fluid. It holds the fluid required for the system's operation, ensures the smooth flow of hydraulic fluid, and helps maintain system performance by providing a place for the fluid to return after it has been used. The hydraulic reservoir also plays a crucial role in cooling the fluid and filtering out contaminants.

#### Ram Piston

In a hydraulic jack, the ram piston (often simply called the piston) is a critical component that plays a key role in lifting heavy loads. The piston is the part of the jack that moves within the hydraulic cylinder to raise or lower the load by using the force generated by pressurized hydraulic fluid. This is forced out or upwards as the main cylinder is filled with pressurized fluid. In a hydraulic ram piston system, the hydraulic reservoir acts as a

storage tank for the hydraulic fluid, allowing for fluid to be drawn by the pump and also providing space for fluid to return after the piston's movement.

### **Remote Control Unit**

The remote control is an essential part of the system that allows the user to control the hydraulic jack from a distance. It usually features buttons or a joystick to control the movement of the jack (raising or lowering) and might include indicators or displays for feedback. It communicates wirelessly with the hydraulic jack via RF (Radio Frequency) signals or through a wired connection. A Remote Control Unit (RCU) in the context of a hydraulic system, such as a hydraulic jack or other machinery, is an electronic device used to remotely control the operation of the hydraulic system.

### **Receiver Unit**

The receiver is installed on the hydraulic jack and receives signals from the remote control unit. It decodes the signals and triggers the relevant action in the hydraulic system, such as activating the pump or controlling the direction of movement. The Receiver Unit in a remote control system is a critical component responsible for receiving commands sent from the remote control (transmitter)

### **Hydraulic Valve System**

The hydraulic valve system is a critical component in a hydraulic system that controls the flow, direction, pressure, and volume of hydraulic fluid. These valves direct the hydraulic fluid to the necessary areas of the system, allowing operators to control the motion of cylinders, motors, and other hydraulic components. Hydraulic valves ensure that the system operates smoothly, safely, and efficiently. The hydraulic valve system controls the flow of hydraulic fluid within the jack

### **Electric Motor**

If the hydraulic jack uses an electric pump, the motor is responsible for driving the pump. It receives power from a battery or mains electricity and converts electrical energy into mechanical energy to operate the pump. An electric motor is a machine that converts electrical energy into mechanical energy. Most electric motors operate through the interaction between the motor's magnetic field and electric current in a wire winding to generate force in the form of torque applied on the motor's shaft.



**DC (Direct Current) Electric Motor**

### **Power Supply (Battery/Charger)**

The hydraulic jack may be powered by a rechargeable battery, especially if it's a mobile or portable unit. In the case of a remote-controlled jack, the remote control also requires a power source, typically batteries or a rechargeable pack.



**Battery**

A battery is a device that stores electrical energy in the form of chemical energy and converts it into electrical energy when needed. It consists of one or more electrochemical cells, each of which consists of two electrodes (an anode and a cathode) and an electrolyte.

## DESIGN CRITERIA

Hydraulic jacks are mechanical devices used in lifting heavy equipment in farms, industries and workshops. To achieve this aim of lifting a heavy load, the mechanism of hydraulic power system is implemented in fabricating the system. The mechanism of hydraulic power system is achieved by tapping 12v voltage (either from the car or the battery) as the source of power to drive the prime mover (electric motor) by whose rotation of its output spline (designed for 10mm diameter) generates a torque transmitted to the meshed gear of larger diameter; thereby achieving speed reduction for higher torque. Cranking now does its job of converting this rotary motion to rectilinear motion.

### Operating Systems

- **Power Source:-** Voltage is to be primarily sourced from the direct current receptacle on any vehicle's dashboard. A secondary provision complements with the addition of a rechargeable battery from any of which the prime mover is powered. Power provision is completed with the work of a prime mover; an electric motor in this design.
- **Electronic Control Unit:-** Further explained later in this work, a system of Electronic Control Unit joins the guiding mechanism in a big way. The system services as a measure of the control system between the user and the device through a remote or switch controlled operation. This control posed a lot of difficulty because for it to control a lifting and lowering process altogether, a provision for the valve control must be made.

- **Gearing Systems 1 And 2 :-**

Two different gearing assemblies were made:

1. To transfer the torque/motion of the prime mover to the crank link.
2. To transfer the motion of an auxiliary gear to control the opening and closing of the check valves.
3. Speed reduction for torque multiplication and more power are the guiding desires for the choice of NO.1 gear assemble. All systems here obey the gear laws.

**The Crank Mechanism And Linkage System:-** Aimed at achieving motion conversion, this serves as a measure of additional mechanical advantage and conversion of the rotary motion of the gear to a rectilinear motion needed by the jack plunger (piston).

**The Lever System:-** This system was simply added as a measure of mechanical advantage and its efficiency as a simple machine.

**Hydraulic System:-** Based on the principle of Pascal's law, this system guiding the bottle jack itself is the most essential in this design.

**Valve Control :-** The normal operation of a bottle jack (manually) involve a step of either closing or opening a check valve to permit lifting and lowering process respectively. It is in replacement of this manual control as well that a valve control system is added. This system wholly controlled by the ECU has a gearing system as its primary control.

### Materials

The general consideration in designing this machine is producing a machine that can be easily assembled and disassembled, a machine in which loads will be lifted effectively with minimum power.

#### 1.1.1 Description of Components

- **Power Source:** Voltage receptacle from vehicle direct current receptacle part rating 12 DC. 12v, 6.5A lead-acid Dry cell rechargeable battery of mean dimension.
- **Electronic Control Unit (Remote):** Keypad switch, PIC microcontroller, infra-red light emitting diode (LED), transistor, capacitor, resistor.
- **Cablings:** High Resistance Electric cables with coating. For extension wire from socket to direct current receptacle part. For inter connection between socket and
- Battery and as well for both between motor and micro chip (Electronic Control Unit).
- **Prime Mover:** 12v, 312W, 2650rpm electric motor of mean dimension with off put shaft splined to 10mm diameter and 9 teeth, through 18.4mm width (length).
- **The Body**
  - Valve control motor: Low speed, 60 watts, 11.5NM torque, 13.5V DC motor.
  - Support: These include the component's stands, i.e. motor stand, battery barrier and gear support welded to base plate and of steel material.
  - Bottom/Base plate: Steel metals, cut and welded and covers a dimension of 216x216x30mm and shell to 4mm thickness. Drills were made for both ways.
  - Casing: Covers a dimension of 220x220x180mm. Made of thin sheet 2mm thickness. Cut out of switches, sensors, bolts.

- Cover: Covers a dimension of 216x216x30mm. With a thickness of 2mm and cut away for the ram.
- Joining: Three major types of joints were used. Screw, Pin and Weld.
- Bolt and nuts: Used for temporary joining of non moving parts 10mm and 14mm sizes (steel material).
- Pin: Used for temporary joint of moving parts e.g. the joint between connecting rod and lever (steel material).

**1.2 Sizing/Functional Relationship**

**1.2.1 Gearing System Spur (Driving Gear)**

To maintain the rpm of the electric motor and also to encourage compactness, the input gear of the motor was adopted.

No. Of teeth ( $T_p$ ) = 9

Diameter ( $D_p$ ) = 10mm

Speed ( $N_p$ ) = 2650rpm.

Power ( $P$ ) = 312watts

- **Torque generated**

$$\tau_p = \frac{P \times 60}{2\pi N_p} = \frac{312 \times 60}{2 \times \pi \times 2650} = 1.12 \text{ NM} \dots\dots\dots(1)$$

- **Gear Module**

$$\frac{D_p}{T_p} = \frac{10}{9} = 1.11 \text{ mm}$$

This will be same for both gears Face width 18mm

- **Driven Gear**

No. Of teeth (TG) = 62

Diameter (DG) = 69mm

Speed (NG) = 584rpm

These parameters show a desire for speed reduction for torque multiplication

- **Torque / gear ratio**

$$\frac{N_p}{N_G} = 6.9$$

Often also known as its mechanical advantage, it is determined by the gear ratio (Paul, 1979). = 6.9

- **Torque Generated**

Since torque ratio equals to 6.9

$$\tau_G = \tau_p \times \text{Gear Ratio} \dots\dots\dots(2)$$

Where,  $\tau_G$  = torque generated (Driven Gear)

This consideration is to achieve a torque multiplication from 1.12NM to 7.75NM.

$$\tau_p = \text{torque generated (Driving Gear)}$$

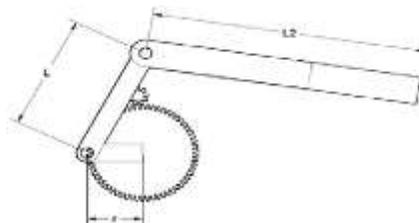
**1.2.2 Mechanism**

To convert rotary motion of the motion to a rectilinear (to and fro) motion of the plunger. A crank mechanism is used; a four link (bar) mechanism is the basis of this conversion with an arm of increasing the mechanical advantage.

- **The Crank system**

Length of connecting rod

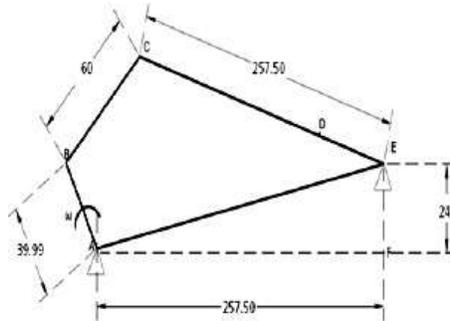
Diagram of the Crank System



After optimum consideration, the n valve of 3 was adopted,

Therefore  $l = nr = 3 \times 39.99 = 119.97\text{mm}$ .....(3)

• **Linkage Diagram**



• **Linkage System Design Diagram**

AB = r = Crank = 39.99mm

BC = L = Connecting rod = 119.97mm

CE = Le = Lever arm = 257.50mm

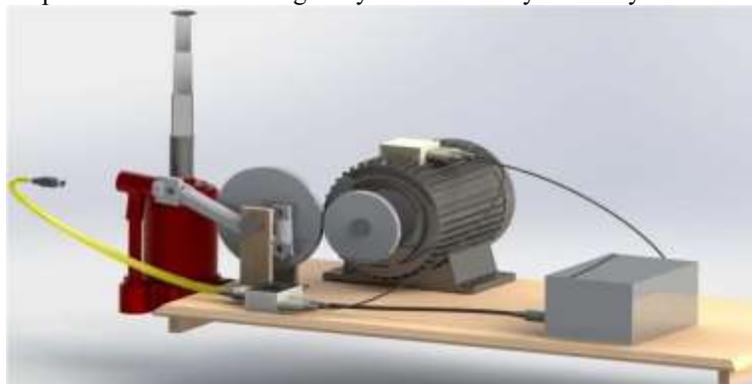
EF = Distance between axis along x-axis= 240mm

AF = Distance between axis along y-axis = 257.50mm

**2. METHODOLOGY**

**2.1 Construction of Project**

The remote-controlled hydraulic jack underwent testing using automobiles equipped with 12V batteries as their power source. Durable electric cables with high corrosion resistance were employed to establish connections between the electric motor, micro-controllers, and the battery's cathode (-) and anode (+) via extension wires. The core component responsible for generating torque in the system is a 12V, 40-watt, 2650 rpm electric motor, which drives a pair of meshing spur gears. The purpose of the gear system, consisting of a driver gear and a driven gear, is to transmit the rotational motion from the prime mover to the crank link. To convert the rotational motion of the gears into the linear motion required by the hydraulic cylinder, a crank mechanism was positioned between the gear system and the hydraulic cylinder.



**Fig. 6.1. Front View of the Design Setup**

**2.2 Working Principles**

The motor connection cables are connected to the car battery terminals which provides power for the jack operation immediately after the power button is switched on. The jack consists of an electric circuit, electric

motor, a switch, a control box, and the jacking assembly. The motor is supplied power through the electrical leads. When the switch is turned on, current flows to the control box, to power it on. Meanwhile majority of the current flows to the motor to start the rotation of its shaft, the driving gear is connected to a larger driven gear for torque amplification. This rotation causes the four bar crank mechanism on the driven gear to rock the lever on the push rod to and fro thus pumping the fluid in the jack cylinder and by Paschal principle of pressure transmission, thus the piston begins to rise raising any load in its path. The power source for the jack, either an external battery or an automobile battery, connects to the motor terminals as soon as the power button is activated. The jack consists of several components, including a control unit, switch, electric motor, electric circuit, and jacking assembly.

### 3. CONCLUSIONS

This project work has provided us an excellent opportunity and experience, to use our limited knowledge. We gained a lot of practical knowledge regarding, planning, purchasing, assembling and machining while doing this project work. We feel that the project work is a good solution to bridge the gates between institution and industries. In conclusion remarks of our project work, let us add a few more lines about our impression project work. Thus, we have developed an “Design And Development of Automatic Hydraulic Jack” which helps to know how to achieve low-cost automation. The operating procedure of this system is very simple, so any person can operate. By using more techniques, they can be modified and developed according to the applications.

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