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Mechanism of Inbuilt Automatic Hydraulic Jack used for Light and Heavy Vehicles

Shivangi Patidar[1], Shivam Patel[2], Naman Mehta[3], Vikas Ojha[4], Suveer Chandra Dubey[5]
[1, 2, 3, 4]*UG Student,* [5]*Assistant Professor, Department of Mechanical Engineering, Indore Institute of Science and Technology, Indore, India*

Abstract: ***This paper is about the new automatic technique of inbuilt hydraulic jack system. Whenever the tire failure is occurred in the vehicle then to lifting the vehicle from ground surface is the very difficult think for human being and also, huge human effort required and more time taking process. There, this inbuilt hydraulic jack system helps to lift the vehicle from the ground instead of conventional mechanical jack, and saves the time and excess effort. Separate buttons are provided in order to raise or lower the right and left side jacks. By pushing the given button in the dashboard, the inbuilt self-jacking component gets initiated. Main parts of this project are hydraulic jack, master cylinder, valves, manifold, and oil reservoir. The inbuilt hydraulic jack will be valuable to the senior residents and for women who discover it incredibly hard to work the jack physically in any breakdown of the vehicle. This hydraulic jack will have the option to lift the wheels as indicated by our prerequisite that is on the off chance that we need to lift just two wheels, at that point it tends to be finished by moving the cylinder as needs be on the rack with the assistance of the DC motor.***

Index Terms: Hydraulic Jack, Master Cylinder, Incompressible Hydraulic Oil, Pascal's Law

I. INTRODUCTION

Hydraulics is the science of transmitting force or motion through the medium of a confined liquid. In a hydraulic device, power is transmitted by pushing on a confined liquid. The transfer of energy takes place because in a hydraulic device, power is transmitted by pushing on a confined liquid. Inbuilt hydraulic jack system is based on the principle of Pascal's law. Hydraulics is mechanical function that operates through the force of liquid pressure. In hydraulic based systems mechanical movement is produced by contained, pumped liquid typically through cylinders moving pistons. Several upstarts relate to hydraulic system and more especially, to an inbuilt hydraulic jack system. Most of the vehicles are lifted by using screw jack. This needs high man power and consumes a lot of time. Various types of jacks or lift devices has been installed on for lifting the vehicle. Conventionally we have always used a separate jack for each of 4 wheels; in steed here, we have the jacks permanently installed on the vehicle. It is an object of innovation to provide ideal jack system that can be operated by driver from inside the car. It is also an object of innovation to provide an ideal hydraulic system which is operated by cam mechanism which actuates hydraulic jack which will lift the vehicle. It is a device which will be used in future to tire changes purposes. When tire gets punctured, we need to change the tire and with the help of this system, vehicle lift by a side automatically with little chores.

II. LITERATURE SURVEY

The conceptual thought of lifting the vehicle using jacks has emerged earlier at the period of late 1920's. Pneumatic jacks were initially prescribed for this scenario since it can be compressed; it was believed that it had a far better scope than any other working fluid in nature to lift the vehicle. But as time emerged it is found that the better and efficient means of lifting vehicle was hydraulics which is still in practice in lifting the heavier loads, since hydraulics are provided with accumulators so the rate of getting injured due to failure is considerably reduced.This work is inspired by journal papers published in different international journals. These journal papers emphasized on the use of dc motor, joined with lead screw and hydraulic cylinders for lifting vehicle to reduce the human effort. Hence, hydraulic lift results in easy and safe operation.

Dr. Ramachandra C.G et al. (2013) have presented that whenever any vehicles undergo a tyre failure, it becomes a very cumbersome task for the person to lift the vehicle from the ground level and lot of manual effort is required even though a jack is used. [1]

Musa Nicholas and Abodunrin Tosin Oladipo Sarafadeen (2016) have studied that in order to mitigate the problems associated with the use of a single jack and other lifting devices to raise cars completely off the ground to effect repairs. [2]

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Aditya Masiwal [2018] an Experimental investigation of Fabrication of Inbuilt Hydraulic Jack for Four Wheelers, International Journal of Research in Engineering and Technology. This paper explains that this project not only saves human effort but also reduces the replacement time during the time of puncture. Lifting capacity is more in hydraulic jack in comparison with pneumatic. [3]

R. Sabarish [2017] an experimental investigation of Fabrication of Inbuilt Hydraulic Jack for Four Wheelers, in International Journal of Pure and Applied Mathematics. This paper concludes with the well-advanced operation of hydraulic jack overcoming the manual operation of screw jack used in most of the auto service centers. [4]

R. Sharavanan. [2017] an experimental investigation of Fabrication of Inbuilt Hydraulic Jack for Four Wheelers in International Journal of Mechanical Engineering and Technology (IJMET). The research survey revealed that few methods were adopted to lift the vehicle for reconditioning, repairing. Here they have mainly focused on difficulty in operating the hydraulic jack. [4]

Mayank Agrawal, [2018]. A "Design and fabrication of hydraulic jack" an International Research Journal of Engineering and Technology, this paper is regarding the planning of fabrication of self-jacking mechanism in four-wheeler cars. Driving a car in quite common now days, whereas tyre failure during the journey is also quite common and unexpected. In such condition lifting of car from the ground surface using a mechanical jack is a big task. This requires surplus manual effort and time. This mechanism overcomes these disadvantages. By pressing the button provided in the dashboard the jacking mechanism gets activated.[5]

Balkeshwar Singh and Anil Kumar Mishra. (2015) This research paper analyses the modification of the existing motor screw jack by incorporating an electric motor in the screw in order to make load lifting easier. In this modified design, the power screw is rotated by connecting motor through universal coupling, plugged to the automobile 12 V battery source to generate power for the prime mover (motor), which transmits its rotating speed to the power screw to be rotated with required speed reduction and increased torque to drive the power screw.[6]

Mohammed Siddique Ahmed et al. (2014). A jack is a device that uses force to lift heavy loads. The primary mechanism with which force is applied varies, depending on the specific type of jack, but is typically a screw thread or a hydraulic cylinder. Jacks can be categorized based on the type of force they employ. [7]

P.S. Rana et al. (2012)]In this research paper they have come up with the idea of Integrated Automated Jacks for 4-wheelers in which the jack is provided on both the sides of the vehicle and can be easily operated with the help of a button placed at the dashboard of the vehicle. This jack is specially designed to overcome the difficulties faced by the senior citizens and ladies who find it difficult to manually operate the jack. [8]

III. INBUILT HYDRAULIC JACK

An inbuilt hydraulic jack is a jack that uses a liquid to push against a piston. This is based on Pascal's Principle and it states that pressure in a closed container is the same at all points. Further, if there are two cylinders connected, then the applying force to the smaller cylinder will result in the same amount of pressure in the larger cylinder. On the other hand, since the larger cylinder has more area and the resulting force will be greater or in other words, the increase in area leads to an increase in force. Hence, the greater differences in size between the two cylinders have greater increase in the force will be. A hydraulic jack operates based on this two-cylinder system. A jack is a mechanical device used as a lifting device to lift heavy loads or vehicles.

In the recent past there has been a significant increase in the use of hydraulics in our industries. The use of oil hydraulic systems as a means of power transmission in modern machines evolved a few decades earlier in the western world. But its applications in Indian industries are of comparatively recent choice and hence, there is great deal of urgency and importance to master the art of its applications and maintenance. This system works by takes power from the engine of the vehicle in which it is used. Master cylinder takes power from engine and pressurizes the oil inside it. This pressure is transferred to manifold and distributed into two hydraulic cylinders.

IV. REQUIREMENT OF INBUILT HYDRAULIC JACK IN THE VEHICLE

It is believed that 'Necessity is the mother of invention'. Here the necessity lies in reducing the human effort applied during manual operation of the jacks and hence the need of the invention. In day-to-day life it is very tedious job to operate the jack manually and it is also a very time-consuming work as well. So, to make it easier for everyone especially for aged person and for lady drivers. To provide a safe and simple automatic hydraulic jacking system without manual effort. To provide a novel jacking system that can be operated from within the vehicle by means of a dashboard control panel. There are certain mechanisms already available for the same purpose which has a definite capacity to lift the car on 2 wheels viz. a screw jack. But the general idea of the project is to minimize the human effort while operating the jack. To provide a novel hydraulic jacking system that is directly and permanently incorporated into the vehicle frame in such a way as to prevent the additional risk of damage or weathering.

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V. FEATURES OF INBUILT HYDRAULIC JACK SYSTEM

Hydraulic jack used on engine uplift has similar parts to other hydraulic jacks, major disparity is that these jacks are lengthy in height, so that the ram can lift the boom of a hoist in a greater height. The hydraulic jack consists of a cylinder, where the hydraulic fluid is held, around the cylinder is an oil chamber. Oil is used as a hydraulic fluid, because it also lubricates other parts of the jack. Inside the cylinder is a ram which is moved up or down by increasing or decreasing the oil pressure inside the cylinder. On the bottom of the ram inside the cylinder is a piston, which is properly sealed, to not let the pressure to bypass on the other side. On top of the ram a boom of the hoist is attached, so pumping the jack will raise the boom. There are multiple smaller copper washers, O-rings and sealing gaskets inside the jack to properly seal the oil, so the jack does not start to leak oil while lifting heavy loads. On the side of the jack is a pumping system that moves oil from one cylinder to other. The pumping system consists of a pump cylinder, a handle socket, a handle, which is inserted into the handle socket and power to apply pressure inside the cylinder, and other small rings, pins, links and steel balls to cover the pump cylinder and washers.

All in all, hydraulic jacks are pretty simple devices when looking at their construction, but they are capable to lifting very large amounts of weight, applying relatively small amount of force to them.

VI. PASCAL'S LAW FOR HYDRAULIC JACK

Blaise Pascal was French scientist. He is discovered a law of hydraulics is known as Pascal's law and Pascal's principle of hydraulics. The law of Pascal's is that a change in pressure at any point in an enclosed fluid at rest is transmitted undiminished to all points in the fluid. And also, it determines that when there is an increase in pressure at any point in a confined fluid, there is an equal increase at every other point in the container. It is only. Pressure is equal to the force upon the area on which it works. According to this law, in a hydraulic system a pressure forced on a piston produces an equal increase in pressure on another piston in the system. If the second piston has an area five times that of the first, the force on the second piston is 5 times greater, though the pressure is the same as that on the first piston. This effect is exemplified by the hydraulic jack, based on Pascal's principle.

The hydraulic jack is a device used for lifting heavy loads by the application of much smaller force. It is based on Pascal's law, which states that intensity of pressure is transmitted equally in all directions through a mass of fluid at rest.

VII. USES OF HYDRAULIC JACK CYLINDER IN THIS PROTOTYPE

A jack is an instrument that uses pressure to raise up the heavy loads. In the seminal state procedure with which pressure is applied varies, depending on the specific type of jack, but is typically a screw thread or a hydraulic cylinder. Jacks can be classifying based on the type of force they employ: mechanical or hydraulic. Mechanical jacks, such as car jacks and house jacks, lift heavy equipment and are rated based on lifting capacity (for example, the number of tons they can lift). Hydraulic jacks tend to be stronger and can lift heavier loads higher, and include bottle jacks and floor jacks. The hydraulic fluid is incompressible and using a pump plunger is forced into the cylinder of the jack. Oil is used because of its stable and self-lubricating nature. When the plunger pulls back, oil is drawn out of the reservoir and it goes inside the pump chamber. When the plunger moves forward, the oil is pushed back into the cylinder. This oil movement builds up pressure in the cylinder. And it is this pressure which leads to the working of the hydraulic jack.

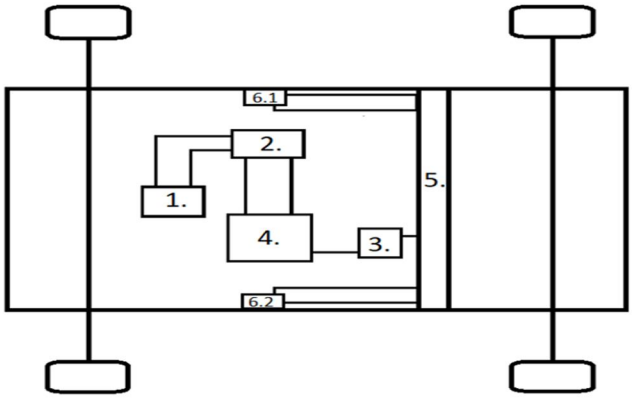


Fig. 1 Line Diagram of Model

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VIII. CONSTRUCTION OF COMPONENTS AND DESCRIPTION

The major components involved in the Fabrication Inbuilt Hydraulic Jack for Four Wheel as follows:

1) *Frame:* It is made up of mild steel material. It is the main supporting structure of the model. All parts are mounted on this frame structure with the suitable arrangement. It is compared to the skeleton of an organism. The material used i.e., mild steel, is a pipe which is square in shape and hollow. It has to deal with the loads without undue deflection or distortion. It consists of rack on which pinion consisting of cylinder and DC Motor slides. Two axles i.e., front and rear, are mounted on the frame to which the wheels are connected. The main functions of a frame are:

a) To support the mechanical components and body

b) To deal with static and dynamic loads, without undue deflection or distortion. (Mild Steel)

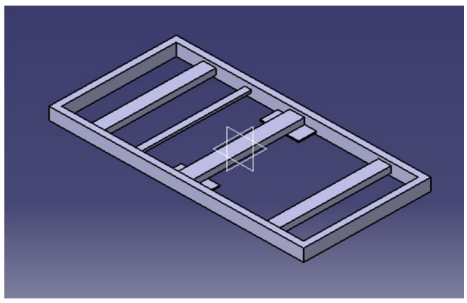


Fig. 2 Line diagram of model

2) *AC Motor:* It is an electric gadget which changes over electrical energy into the mechanical energy. The AC Motor comprises of stator and rotor and driven by an alternating current. It is used to run the vane pump. The smaller shaft of the pulley is connected to the AC Motor. It is used to transmit the power through pulley to the pump with the help of the V belt. (12-volt, 300 rpm, Torque = 0.012 kg-m).

3) *DC Motor:* It is a device which converts DC electricity into energy. DC Motor drives the pinion on the rack present in the frame. (200 rpm, Torque- 0.015 kg-m)

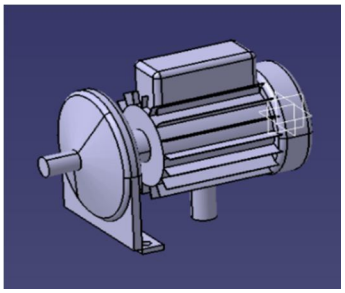


Fig. 2.1 DC Motor

4) *Vane Pump:* This is a positive displacement pump consists of vanes mounted on a rotor which rotates inside a cavity. Pulley of larger diameter is mounted on the pump shaft. It has a circular rotor rotating inside a larger circular cavity. The focuses of those two circles are offset, causing eccentricity. (Max pump pressure = 20 MPa), (Max speed = 2650 rpm)

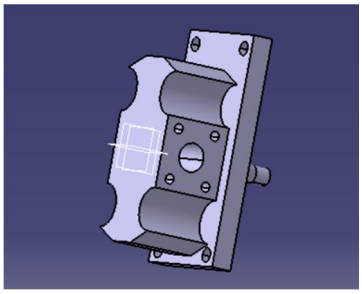


Fig. 2.2 Vane Pump

5) *Master Cylinder:* Here we make use of single acting spring return cylinder. Single acting cylinders even have a spring inside the cylinder. It works with the assistance of packed gas to incite the piston single way and utilizations spring force to come back to the base position. As soon because the air supply is stop, the connecting rod retracts by spring force.

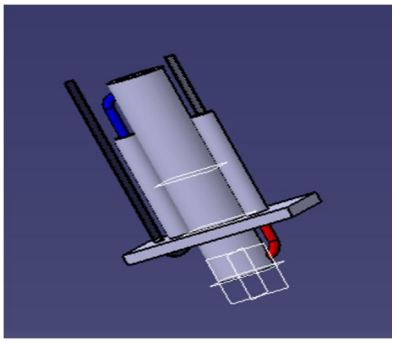


Fig. 2.3 Master Cylinder

6) *Storgae Tank:* It is facilitated in the hydraulic jack in order to store the hydraulic oil. It can be called as a storage part of the model. The storage capacity of the reservoir is 2 liters. The supply of the hydraulic oil takes place from the reservoir.

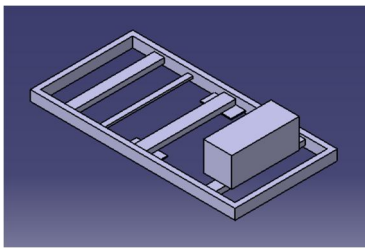


Fig. 2.4 Storage Tank

7) *Push Buttons:* It is a simple switch mechanism for controlling a machine or process. There are two push buttons. They are used to actuate the valve. They are connected to the 240V power supply. Pressing, depressing, mashing, slapping, hitting, and punching are most commonly used terms in pushing of button. Buttons are made up of hard material, usually plastic or metal.
8) *Ball Valve:* A ball valve is a form of quarter-turn valve which uses a hollow, perforated and pivoting ball (called a "floating ball") to control flow through it. It is open when the ball's hole is in line with the flow and closed when it is pivoted 90-degrees by the valve handle. The handle lies flat in alignment with the flow when open, and is perpendicular to it when closed, making for easy visual confirmation of the valve's status.
9) *Pipes:* These are used for the transferring of the hydraulic oil from one part to the other in the hydraulic jack starting from the reservoir. The hoses used must be strong enough for the smooth transfer of the hydraulic oil. The shape of a hose is typically cylindrical (having a circular cross section). Hoses are likewise called pipes however lesser inflexible than pipes. In light of a necessary application and execution the hoses will be structured. Size, pressure rating, weight, length, straight hose or coil hose, and chemical compatibility are most regular elements.
10) *Lever:* Direct acting manually operated directional control valve with subplate mounting interface hydraulic lever used for the transmission of power upto 35 MPa. Manual lever and actuation element can be rotated in 90° increments for flexible installation.
11) *Battery:* It is used in the hydraulic jack is of 12V and 7.2 A. It is used to drive the DC motor which is used to run the cylinder containing the pinion on the rack.
12) *Hydraulic Oil:* A hydraulic fluid or hydraulic liquid is the medium which moves power in hydraulic machines. Mineral oil or water is the most commonly used fluids. Excavators, transmissions, hydraulic brakes, power steering systems, aircraft flight control systems, lifts and industrial machinery are the examples where we use the hydraulic fluids.

In this study, the experiment purpose used hydraulic oil with grade 46 which is made out of top notch dissolvable refined base oils. It is liberated from debris making parts, silicone and zinc, additionally have generally excellent anti-wear and anticorrosion properties, awesome oxidation, thermal stability and water division qualities.

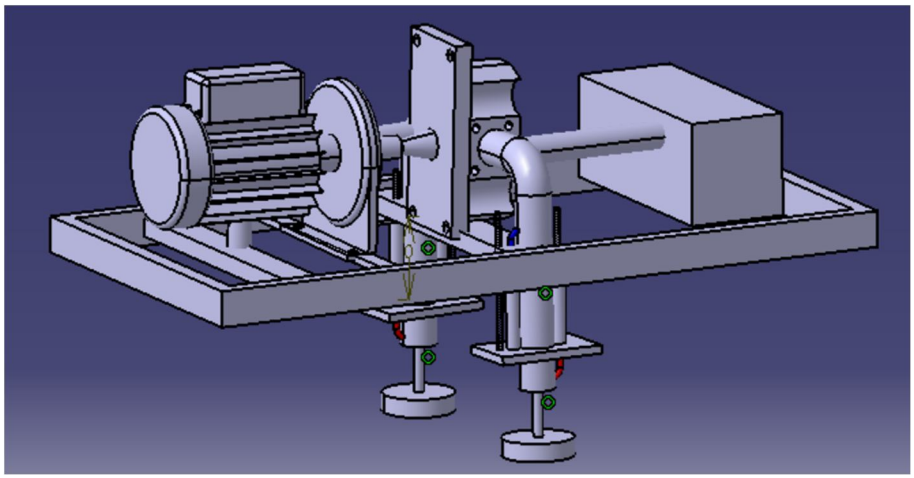


Fig. 2.5 Complete Assembly of Model

IX. ADVANTAGES

The maintenance of the vehicle will be very easy by using this type of jack. This will make servicing the vehicle easier and cheaper. This type of system is very useful especially for women because women may have more difficulty in doing mechanical work, to avoid this during tire puncture problem, they can change wheel easily and in working time. It has a well-designed mechanism to prove to be a time-saving system in use as well as maintenance. It is also very useful for heavy vehicles like trucks and buses, as leaf spring plates break is a common problem, this system will help to replace leaf spring plates. A lonely person can go on long drives without worrying about getting stuck on the way. Since the entire system is battery operated, the jack will work even when the vehicle is not in the starting condition. Both the jacks used in this mechanism can work simultaneously. The vehicle can also be easily washed at home thereby reducing human effort to a great extent. It also has a special feature that it can be operated even when the vehicle is not in the starting condition. Its use also seems to be necessary because it has been seen that due to its use, the damage caused by rubbing hard parts together can be reduced to a great extent. A hydraulic jack uses fluids to transfer energy, with liquids working better than solids because they can take different shapes. It is suitable for uneven surfaces and often these problems are seen in such places.

X. METHODOLOGY

The mechanism used in this study is mainly used for lifting the car. The method used here is automatic which replaces manually operated screw jack. A separate system consisting of two hydraulic jacks, pump and a control valve will be connected and positioned in the vehicle. The mechanism is powered by the battery. The control of the mechanism will be provided at the user hand. When the operator presses the switch, the battery will run the hydraulic pump. The pump will press the oil from the reservoir to the control valve. The flow of oil to the double acting hydraulic cylinder can be controlled with the help of this control valve. When control valve directs the oil to the cylinder for a lifting stroke the pressure will be imparted to the piston and the stroke will take place. Then the piston will start lifting the car from the ground level. For the down movement of a lifted car the user can again operate the control valve which will direct the flow of oil to the other side of cylinder and the stroke will be imparted with pressurized oil. After operation the user will press the off button and that will cut-off the electrical power to the motor. This will stop the pump and the circulation of oil in the system.

XI. WORKING PROCEDURE

The hydraulic pressure in the cylinders is in the form of hydraulic fuels that are stored under pressure in these cylinders. The energy stored in these oils is converted into motion. In a complete hydraulic system, a hydraulic motor consists of one or more hydraulic cylinders. A pump regulates the oil flow in the hydraulic system. The pump is a part of the generator of a hydraulic system. The hydraulic cylinders initiate the pressure of the oil, which cannot be more than that required by the load. A hydraulic cylinder consists of a cylindrical barrel, piston, and a piston rod. The piston that is placed within the barrel is connected to the piston rod. The cylinder bottom, and the cylinder head, closes the bottom and the head of the barrel respectively. The cylinder head is the side from where the piston rod exits the cylinder. The piston rod starts moving outwards, as the hydraulic fluid is pumped into the bottom side of the hydraulic cylinder. In the reverse process, the hydraulic fluid is pushed back into the reservoir by the piston. In this way, the expansion and retraction (push and pull) action of the hydraulic cylinder is generated.

When the DC supply is given to the motor, the motor will start to run where the motor and the vane pump is initially meshed each other with the help of gear arrangements which in terms it makes the vane pump to rotate. The oil from the reservoir is pumped out and passes to the control valve. The control valve controls the flow of oil and direct the oil into the inlet of the double acting cylinder. The double acting hydraulic cylinder will have one piston within a cylindrical housing. When hydraulic will be supplied to its cap end port, hydraulic pressure force will be applied over the piston or plunger. Hence, piston will be extended and this stroke of cylinder will be termed as forward stroke. During extension of the cylinder piston or plunger, hydraulic oil at rod end side will be pushed out and will be directed towards the control valve which actuate or retard the hydraulic cylinder in the basis of manual control. Hence double acting hydraulic cylinder will be operated hydraulically in both direction i.e. during extension or forward direction and also during retraction or return stroke. Direction of hydraulic oil will be changed with the help of directional control valve and it is also being used for changing the direction of flow of fluid.

XII.CONCLUSION

With some design consideration an inbuilt car lifting mechanism can easily be fitted in all light weight automobiles. The project works on hydraulic power provided by battery. Maintenance and service of the vehicle can be easily done by this project. With this project the usage of automobile can be made easy for women and old people. Some extra automation like solenoid control valve can add great value to the project. The inbuilt jack is operated by batter so it can also be used when the vehicle engine is not started. Automatic inbuilt jacking system in automobiles will not only save the effort of a person but will also save one's precious time under critical circumstances. This concept will eliminate the need of carrying a conventional mechanical jack while travelling. Motor operated mechanical jacks are already in the market but the jack's design is the area of concern. In order to make built-in jack system practical, jack's shape and type need modification. Mechanical jacks are pretty easily operated but their effectiveness and maintenance may become an issue as they will be move with chassis, constantly underneath hence, chances of rusting and damage is high. Hydraulic jacks look convenient to use and can also prove quite effective and easy to maintain (as completely closed) in long run, they will provide more power too but there are also some challenges like keeping low production cost and designing of jack which can be carried with the chassis given, common ground clearance level of an automobile, and keeping in check the increase in weight of automobile.

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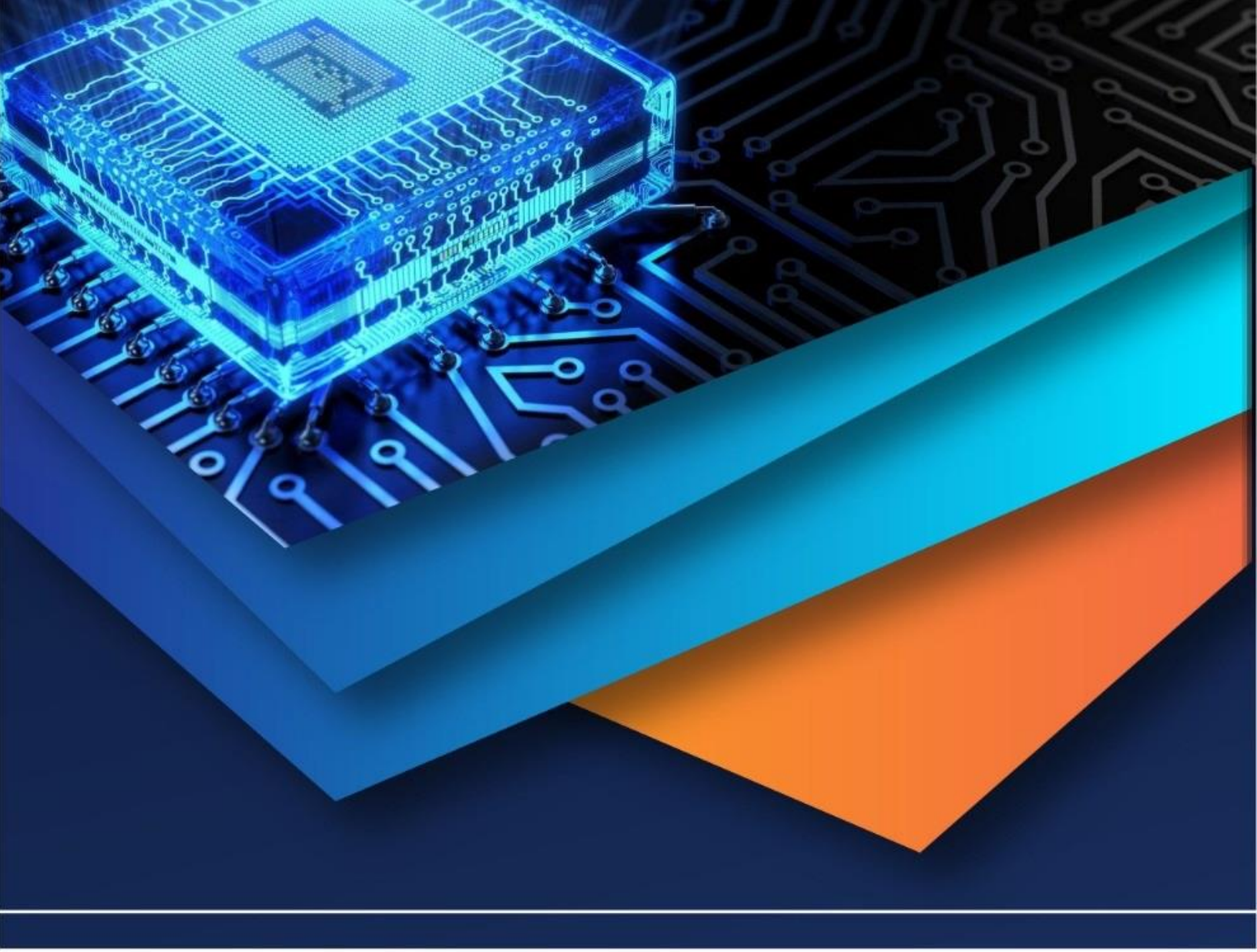
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