

DESIGN AND FABRICATION OF INTEGRATED MECHANICAL JACKS FOR FOUR WHEELERS

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Abstract

With the increasing levels of technology, the efforts being put to produce any kind of work has been continuously decreasing. The efforts required in achieving the desired output can be effectively and economically be decreased by the implementation of better designs.

Power screws are used to convert rotary motion into translatory motion. A mechanical jack is an example of a power screw in which a small force applied in a horizontal plane is used to raise or lower a large load. The advantage of a mechanical jack is the ratio of the load applied to the effort applied. The height of the jack is adjusted by turning a lead screw and this adjustment can be done either manually or by integrating an electric motor.

This research paper analyzes the modification of the existing mechanical jack by incorporating an electric motor in the screw and attaching whole assembly to the car body (chassis) in order to make car lifting easier. In this modified design, mechanical jack and motor are attached to the four corners of chassis of car. Power screw of jack is rotated by connecting motor through coupling, plugged to the automobile 12 V battery source to generate power for the 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. With the assembly the side of punctured wheel can be easily lifted and removal of that wheel will be more easy and safe. The significance and purpose of this work is to modify the existing car jack in order to make the operation easier, safer and more reliable. The modified car jack is easy to use by women, old age persons or whoever had problem with the vehicle tyres along the road. The designed motorised jack will also save time and requires less human energy to operate.

Keywords – D.C motor, Mechanical Jack, On/Off switches, Power screw.

Introduction:

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. The general idea of project is to minimize the human effort while operating the jack.

A mechanical jack is a portable device consisting of a screw mechanism used to raise or lower the load. There are mainly three types of jacks- hydraulic, pneumatic and mechanical. A hydraulic jack consists of a cylinder and piston mechanism. The movement of the piston rod is used to raise or lower the load. Mechanical jacks can be either hand operated or power driven. Jacks are used frequently in raising cars so that a tire can be changed. The jack is made out of various types of metal, but the screw itself is generally made out of lead.

Mechanical Jacks: A mechanical jack is a device which lifts heavy equipment. The most common form is a car jack, floor jack or garage jack which lifts vehicles so that maintenance can be performed. Car jacks usually use

mechanical advantage to allow a human to lift a vehicle by manual force alone. More powerful jacks use hydraulic power to provide more lift over greater distances. Mechanical jacks are usually rated for maximum lifting capacity.

Operational Considerations of a mechanical jack:

- **Maintain low surface contact pressure:** Increasing the screw size and nut size will reduce thread contact pressure for the same working load. The higher the unit pressure and the higher the surface speed, the more rapid the wear will be possible.
- **Maintain low surface speed:** Increasing the screw head will reduce the surface speed for the same linear speed.
- **Keep the mating surfaces well lubricated:** The better the lubrication, the longer is the service life. Grease fittings or other lubrication means must be provided for the power screw and nut.
- **Keep the mating surfaces clean:** Dirt can easily embed itself in the soft nut material. It will act as a file and abrade the mating screw surface. The soft nut material backs away during contact leaving the hard dirt particles to scrap away the mating screw material.
- **Keep heat away:** When the mating surfaces heat up, they become much softer and are more easily worn away. Means to remove the heat such as limited duty cycles or heat sinks must be provided so that rapid wear of over-heated materials can be avoided.

Literature Review:

Mechanical jacks were very common for jeeps and trucks. For example, the World War II jeeps (Willys MB and Ford GPW) were issued the "Jack, Automobile, Screw type, Capacity 1 1/2 ton", Ordnance part number 41-J-66. This jacks and similar jacks for trucks were activated by using the lug wrench as a handle for the jack's ratchet action to of the jack. The 41-J-66 jack was carried in the jeep's tool compartment. Screw type mechanical jack's continued in use for small capacity requirements due to low cost of production raise or lower it. A control tab is marked up/down and its position determines the direction of movement and almost no maintenance.

Thomas J. Prather (2009): In this, there was an introduction about vehicle lift system. A drive assembly was mechanically coupled to the piston. The drive assembly was operated in first direction to raise an upper end of the piston with respect to the housing. The drive assembly was operated in a second direction to lower the upper end of the piston with respect to the housing. The drive assembly was coupled to the power supply port which is removable to supply electrical power to the drive assembly.

Lokhande Tarachand (2012): This paper referred to optimise the efficiency of square threaded mechanical screw jack by varying different helix angle.

Manoj Patil (2014): In this general article, screw jack is developed to overcome the human effort. It is actually difficult job to operate for pregnant women and old person. Changing the tyre is not a pleasant experience. Especially women can't apply more force to operate. For that, electric operated car jack is introduced.

With the industrial revolution of the late 18th and 19th centuries came the first use of screws in machine tools, via English inventors such as John Wilkinson and Henry Maudsley The most notable inventor in mechanical engineering from the early 1800s was undoubtedly the mechanical genius Joseph Whitworth, who recognised the need for precision had become as important in industry as the provision of power.

In Alleghany County near Pittsburgh in 1883, an enterprising Mississippi river boat captain named Josiah Barrett had an idea for a ratchet jack that would pull barges together to form a „tow“. The idea was based on the familiar lever and fulcrum principle and he needed someone to manufacture it. That person was Samuel Duff, proprietor of a local machine shop, together, they created the Duff Manufacturing Company, which by 1890 had developed new applications for the original “Barrett Jack” and extended the product line to seven models in varying capacities.

The company had offered manually operated screw jacks but the first new product manufactured under the joint venture was the air motor-operated power jack that appeared in 1929. With the aid of the relatively new portable compressor technology, users now could move and position loads without manual effort. The jack, used predominantly in the railway industry, incorporated an air motor manufactured by The Chicago Pneumatic Tool Company.

There was clearly potential for using this technology for other applications and only 10 years later, in 1940, the first worm gear screw jack, that is instantly recognizable today, was offered by Duff-Norton, for adjusting the heights of truck loading platforms and mill tables. With the ability to be used individually or linked mechanically and driven by either air or electric motors or even manually, the first model had a lifting capacity of 10 tons with raises of 2” or 4”.

Since then the product has evolved to push, pull, lift, lower and position loads of anything from a few kilos to hundreds of tonnes. One of the biggest single screw jacks made to date is a special Power Jacks E-Series unit that is rated for 350 tonnes –even in earthquake conditions for the nuclear industry.

A mechanical jack that has a built-in motor is now referred to as a linear actuator but is essentially still a screw jack. Today, mechanical jacks can be linked mechanically or electronically and with the advances in motion-control, loads can be positioned to within microns. Improvements in gear technology together with the addition of precision ball screws and roller screws mean the applications for screw jacks today are endless and a real alternative to hydraulics in terms of duty cycles and speed at a time when industry demands cleaner, quieter and more reliable solutions.

Screws Application is used in the elevation of vehicles or objects. The operation of the mechanical jack is such that it comprises a handle for driving a bolt element (Lead Screw) manually so as to adjust the height of the Jack to elevate a vehicle or the object. The operation of the jack manually makes it difficult for most women and the elderly to operate since much effort is needed to drive the screw jack which results in low linear speed and time consuming. These presently available jacks further require the operator to remain in prolonged bent or squatting position to operate the jack. Doing work in a bent or squatting position for a period of time is not ergonomic to human body. It will give back ache problem in due of time. Suppose car jacks must be easy to use by women or whoever had problem with the tyres along the road. The objective of this paper is therefore to modify the existing design of car jack by incorporating an electric motor into the existing screw jack to make the operation easier, safer faster and more reliable.

1. Motorized Screw Jack:

Our survey in the regard in several automobile garages, revealed the facts that mostly some difficult methods were adopted in lifting the vehicles for reconditioning.

Now the research paper has mainly concentrated on this difficulty, and hence a suitable device has been designed, such that the vehicle can be lifted from the floor land without application of any impact force.

The motorized screw jack has been developed to cater to the needs of small and medium automobile garages, which are normally man powered with minimum skilled labour. In most of the garages the vehicles are lifted by using screw jack. This needs high man power and skilled labour.

In order to avoid all such disadvantages, the motorized jack has been designed in such a way that it can be used to lift the vehicle very smoothly without any impact force. The operation is made simple so that even unskilled labour can use it with ease. The D.C. motor is coupled with the screw jack by gear arrangement. The screw jack shaft's rotation depends upon the rotation of D.C motor. This is a simple type of automation project.

This is an era of automation where it is broadly defined as replacement of manual effort by mechanical power in all degrees of automation. The operation remains to be an essential part of the system although with changing demands on physical input, the degree of mechanization is increased.

2. Parts of Motorized Screw Jack:

The main parts of the motorized screw jack are as follows:

- (i) **D.C. motor:** An electric motor is a machine which converts electrical energy to mechanical energy. Its action is based on the principle that when a current-carrying conductor is placed in a magnetic field, it experiences a magnetic force whose direction is given by Fleming's left hand rule.

Principle of Operation of DC Motor:

The conductors are wound over a soft iron core. DC supply is given to the field poles for producing flux. The conductors are connected to the DC supply through brushes.

An electric motor is all about magnets and magnetism: a motor uses magnets to create motion.

- (ii) **Universal Joint:** A universal joint is a positive, mechanical connection between rotating shafts, which are usually not parallel, but intersecting. They are used to transmit motion, power, or both.

The simplest and most common type is called the Hooke joint. It consists of two yokes, one on each shaft, connected by a cross-shaped intermediate member called the spider. Good design practice calls for low operating angles, often less than 25°, depending on the application. Typical applications of universal joints include aircraft, appliances, control mechanisms, electronics, Instrumentation, medical and optical devices, ordnance, radio, sewing

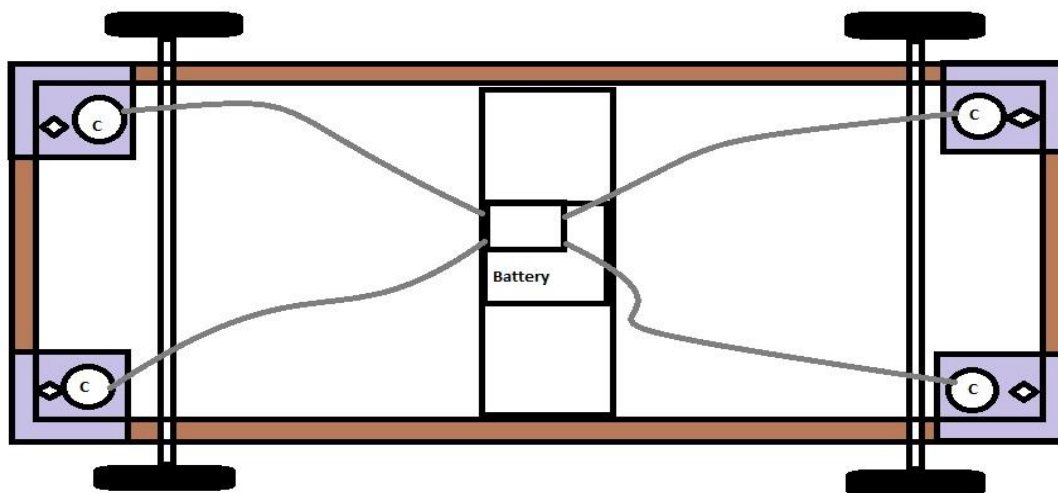
machines, textile machinery and tool drives. Universal joints made of steel have maximum load-carrying capacity for a given size.

(iii) Remote control: A remote control is a component of an electronics device, which is attached to the dashboard of car for operating the device from a short line-of-sight distance.

Process involved:

Fabrication and assembly of Integrated Mechanical Jacks for Four Wheelers is as follows:

- Making of coupling:** We have cut the blank of mild steel rod having diameter 60 mm and length 70mm by using power hacksaw machine from the given rod. Turning operation of MS rod has done on lathe machine which reduces the diameter up to 50 mm. Machining operation has done on CNC milling machine for making slot. Drilling operation has done on drilling machine for making hole of 10mm diameter for fixing bolt and nut. Surface finishing operation has done by grinding machine and filing.
- Supporting component:** Supporting component has used for fixing the D.C. motor. It has cut from the channel by using power hacksaw machine in required size. Drilling operation has done on drilling machine for fixing bolt. Finishing operation has done on bench vice using file.
- Base plate:** Base plate is made from mild steel plate. It has used for fixing all components of motorized lifting jack. Base plate has cut from mild steel plate of bigger size in to required size of 120mmx100mm by using gas cutter machine. Surface finishing operation has done by using grinding machine. There are 4 holes made in the base plate by using drill bit of 10mm diameter on drilling machine.
- D.C. Motor:** A DC Motor of 12 Volt with a Current of 14 Amps is to produce the movement of the machine. The motor is internal geared one. So it is strong enough to give the required torque. It can give two different speeds in one direction and two different speeds in the opposite direction.
- Final finishing work:** First mechanical jack of 2 ton capacity has fixed on the chassis of car using bolt and nut. Mechanical jack has connected to one end of first coupling by using nut bolt. First coupling has connected to one end of universal joint with the help of bolt and nut. The other end of universal joint connected to second coupling with the help of bolt and nut. Finally DC motor is connected to other end of second coupling with the help of nut and bolt. DC motor has connected to main supply through DC power supply. Whole assembly is connected to four corners of a car near wheels for easy operation.



Where, C = Mechanical jack

<> = Motor

B = Battery

Fig-1: Line diagram of Integrated Mechanical Jacks for Four Wheelers

Fabricated Model of Integrated Mechanical Jack system:

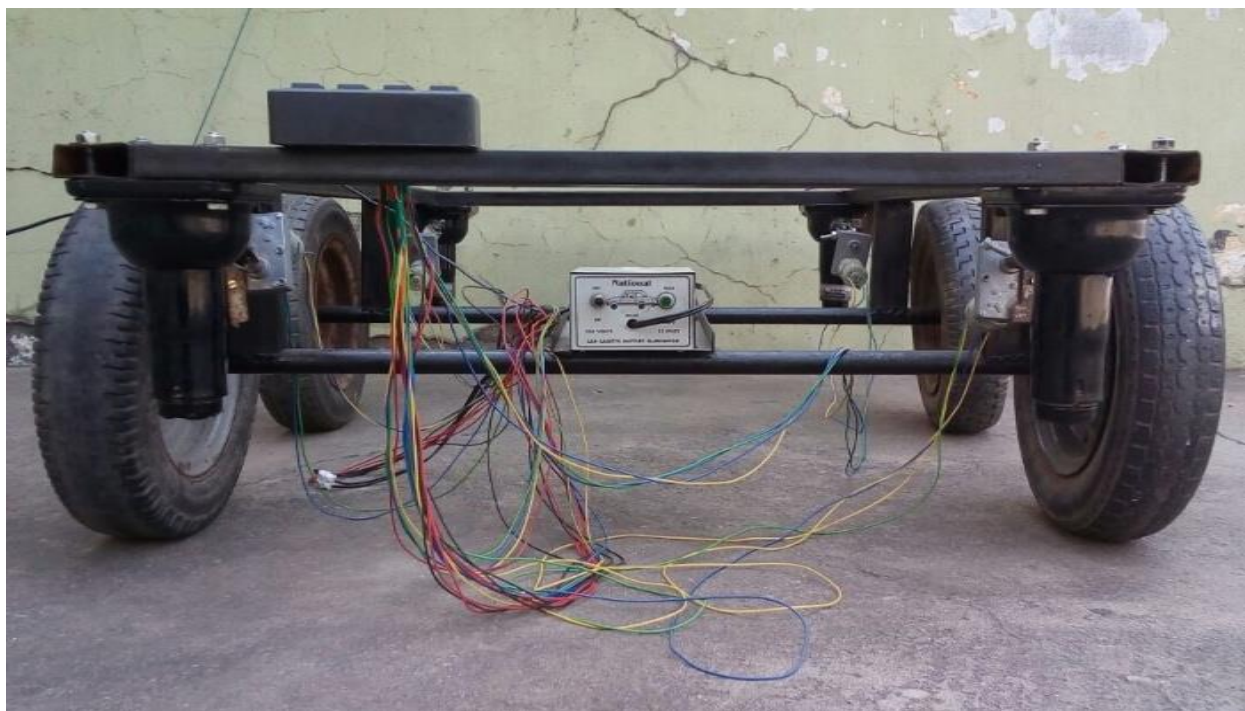


Fig-2: Front view of vehicle at original position



Fig-3: Top view of vehicle at original position

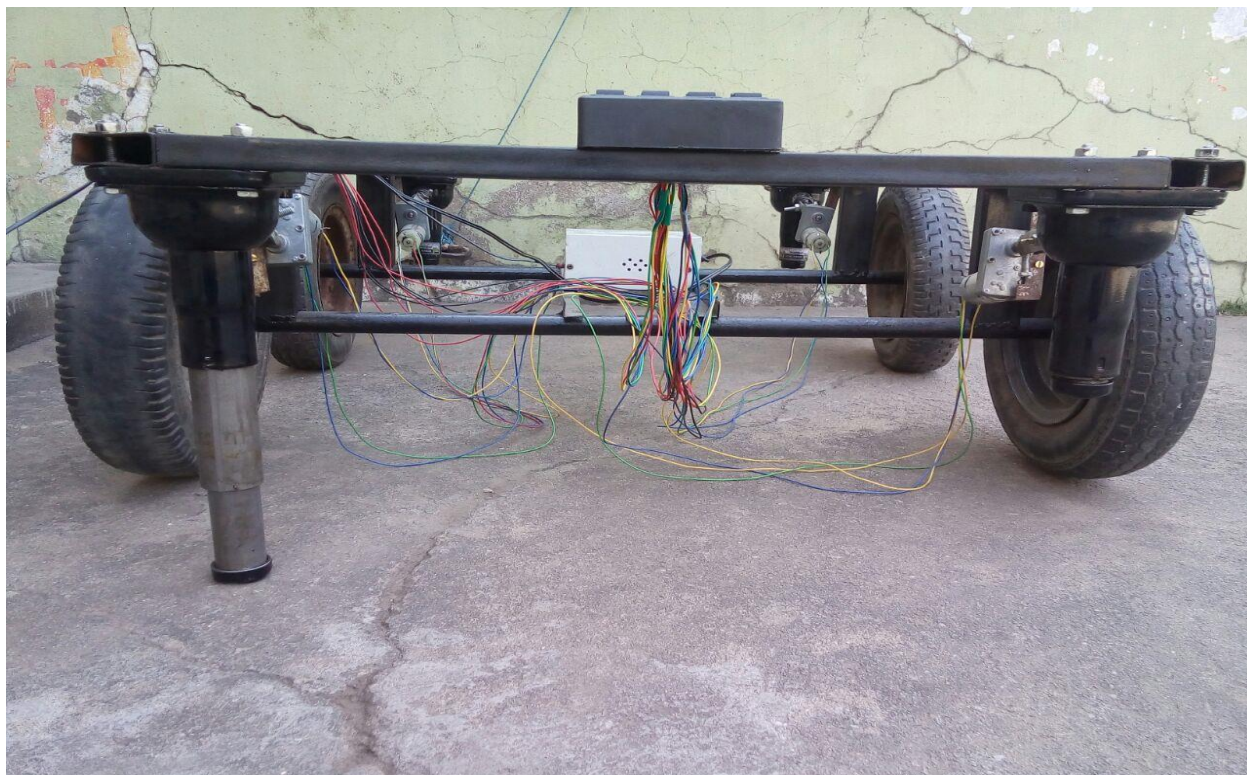


Fig-4: When front right wheel of vehicle is lifted



Fig-5: Side view of vehicle when front right wheel of vehicle is lifted

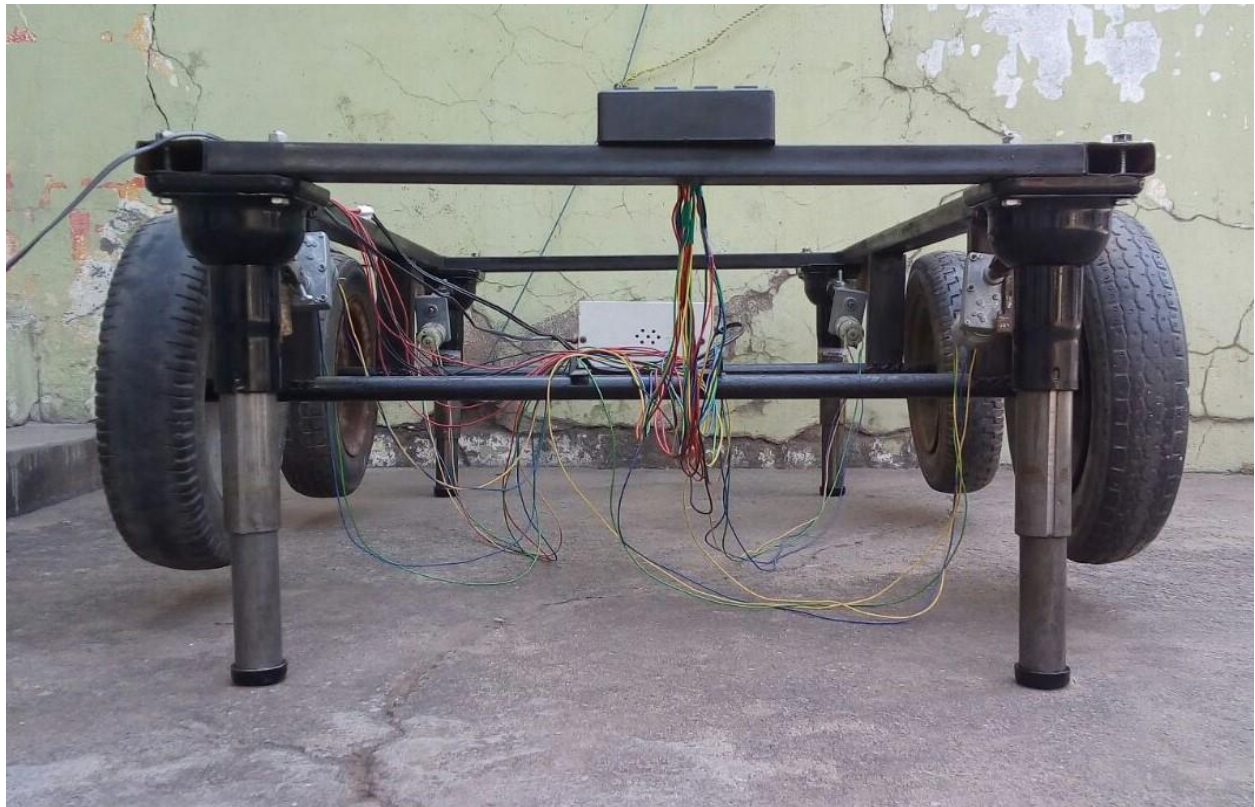


Fig-6: Front view of vehicle when all 4 wheels are lifted



Fig-7: Side view of vehicle when all 4 wheels are lifted

Results and Conclusion:

The project carried out by us made an impressive task in the field of automobile and automobile workshops. It is very useful for women and old aged persons who drive cars. This project has also reduced the cost involved in the corner. Our motto is to reduce the human effort and increase the safety.

References:

- 1) Bansal, R.K.(2012),” Strength of materials” Revised Edition, LAXMI PUBLICATION(P) LTD.
- 2) Khurmi, R.S. and Gupta, J.K. (2005), “A Textbook of Machine Design”, Eurasia Publishing House (P.V.T) Ltd.14th Edition.
- 3) Farhad Razzaghi, US. “Apparatus and method for an electric jack” United States Patent Issued on November 8, 2007, Patent Number: US 2007/0256526 A1.
- 4) Manoj Patil, Gaurav Udgirkar, Rajesh Patil and Nilesh, “Automated Car Jack”, International Journal of Current Engineering and Technology (Vol.4, No.4, Aug 2014) E-ISSN 2277 – 4106, P-ISSN 2347 – 5161.
- 5) Thomas J. Prather, US. “Vehicle lift system” United States Patent Issued on January 6, 2009, Patent Number: US 7472889 B1.
- 6) <http://hubpages.com/hub/Automobile-Jacks>.
- 7) <http://www.powerjacks-de.com/Screw-Jacks-FAQ.html>.
- 8) <http://www.radicon.com/screw-jacks.php>.
- 9) <http://www.powerjacks.com/PowerJacks-History-The-Screw-Jack-Story.php>.