DESIGN AND DEVELOPMENT OF MECHANICAL HUMAN HOIST

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Abstract: - This research paper presents the design and analysis of a mechanical human hoist featuring a scissor mechanism. The objective of this study is to develop a safe and efficient lifting system for human or goods elevation in various applications as automobile workshops, logistics sectors, etc. The scissor mechanism, is a fundamental component of the hoist, enabling both vertical lifting and controlled descent. Detailed engineering and kinematics analysis are conducted to optimize the design for stability, reliability, and load bearing capacity. The system is powered by an electric motor and incorporates safety features to ensure user protection during operation. Key aspects covered in this project include the scissor mechanism’s geometry, material selection, load bearing capacity, and control system. The hoist is designed with on focus ease of use, adaptability to different environments, and compliance with safety standards. The result of this study demonstrates the feasibility and effectiveness of the scissor mechanism based mechanical human hoist. It offers a versatile solution for vertical mobility, making it suitable for a wide range of applications, with a primary emphasis on enhancing the quality of life and safety for individuals in need of assisted vertical movement. This abstract summarizes the development and analysis of mechanical hoist system, highlighting its scissor mechanism as a key feature for vertical lifting.

Key Words: Mechanical Hoist, Scissor mechanism, Worm and Worm wheel

I. INTRODUCTION:

A mechanical human hoist using a scissor mechanism is an assistive device designed to lift and lower individuals with limited mobility, offering improved accessibility and mobility.

It incorporates a scissor mechanism, typically made up of link bars and pivoting joints, that expands and contracts, lifting the user, the scissor mechanism, typically made up of linked bars and pivoting joints, that expands and contracts, lifting the user. The scissor mechanism is often powered by an electric motor and worm gearbox to ensure smooth and controlled motion.

Using a scissor mechanism in a hoist offers several advantages compared to other lifting mechanism an attractive choice for various applications in the context of assistive technology and lifting equipment.

II. LITERATURE SURVEY:

Prof A.B. Tupkar et.al [1] "Design and Development of Human Hoist" involves two areas of focus: ergonomics and human factors, and research into the use of hoisting equipment by care workers. The study will deeply examine both active hoists and passive hoists, and will aim to improve the latter in order to design a ceiling track or overhead hoist.

S.N. Tripathy [2] research and studied in the production process, considering all conditions, use bolted instead of welding as much as possible, so that the hoist can be easily disassembled for transportation. The rope drum must have means to guide the wire rope when lifting and lowering the load.

Sam Hutcheson [3] explained that during the construction of the project there was a major problem with the screw holes in the uprights and beams. Although he drilled the plates and beams at the same time and nailed the together, the final welding was done when the frame removed the beams, causing the brackets to move. This makes it difficult to mate with the screw hole and requires some manipulation of the frame with the hinge to align the hole with the drilling a slightly larger hole will facilitate process assembly and give the model some room for modification. A good way to avoid this is to spot weld a piece of metal, fully weld them, bolt them to the beam and remove.

Pooran Singh Dhakar [4] concluded that the connecting body for hook should be of triangular or trapezoidal cross section for greater strength. Ball bearings must be used to prevent the load from rotating relative to the wire rope. The hoisting mechanism usually consists of rope drum, motor and gearbox. Indicates that only one drive is used to lift the target and move through the object.

M. Barakat [5] explained that two damage calculation methods are used in the wire rope failure study: the static damage calculation method and the unified theory calculation method. Comparison of the results shows that there is good agreement that the wire will break in three stages due to tensile stress. Steel rope can be used after 1-2 wires are broken, but its life becomes limited. Therefore, it must be replaced before there is a risk of failure.

Divij Pharkute, et.Al [6] this paper focuses on designing a worm gearbox for a 6passenger elevator and conducts finite element analysis (FEA) by applying various forces to the worm gear and wheel. Structural analysis occurs in ANSYS, while modelling is executed in SolidWorks, contributing to an understanding of worm gear performance and structural integrity in elevator systems.

Aishwarya B. Shinde [7] this project focuses on the design and analysis of a mechanical scissor lift operating based on the screw jack principle. The design prioritizes mechanical operation to reduce the overall cost and enhance the lift's suitability for medium scale applications. In addition to conventional uses, such as raising vehicles for maintenance, this scissor lift incorporates a roller mechanism to facilitate short-distance movement. The project concludes with an analysis to ensure the design's compatibility with specified values and requirements.

Jayant Krishnaji Nalawade, et.al [8] This paper introduces a cost-effective and user-friendly solution for automobile mechanic who often have to work beneath car chassis, addressing the discomfort associated with such tasks. While existing inventions and mechanisms for aiding mechanics in these situations can be expensive, this paper presents the design and analysis of a Human Hoist system that offers an affordable alternative. The results demonstrate enhanced comfort and efficiency for mechanics using this system. A significant advantage of the Human Hoist is its cost-effectiveness compared to other hoists available in the market, making it a more accessible choice for mechanics.

III. COMPONENTS:

1. **Frame:**

The frame of Mechanical Hoist serves as a support for the equipment. It is usually made of durable materials such as steel, Galvanized iron or aluminium for strength and durability.

We've used galvanized iron hand section as our frame material. It is a hollow rectangular bar. Hence, it is light weight in use and easy to bore and cut as desired.

We've used two frames, to fix the scissor mechanism in it. One at the bottom as base for the scissor mechanism in it. One at the bottom as base for the scissor mechanism and wheels and other frame is fixed at the top of the scissor mechanism, the top side of frame is also used for sitting purpose.

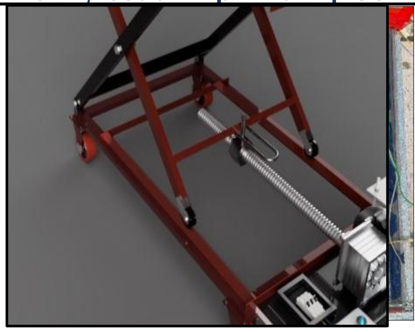

Figure 1: Frame

2. **Worm and Worm wheel Gearbox:**

The A worm and worm wheel gearbox, also known as a worm gear, is a gear used to reduce speed and increase power. It has a worm gear (gear cylinder) meshing with a worm gear (gear). This configuration provides a relatively low gear ratio and is often used in applications where control and self-balancing are important, such as material handling and conveyor systems. Worm gearboxes are known for their high performance, ability to control position, and ability to prevent back driving due to self-measurement of the gears

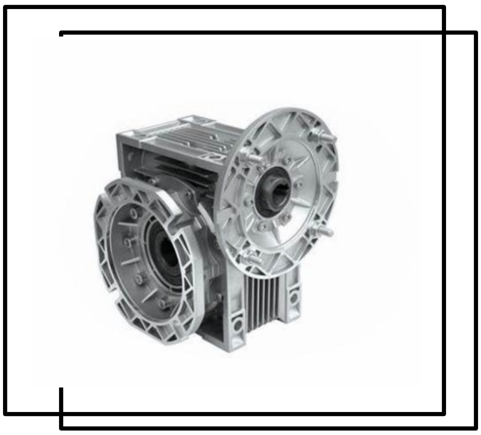

Figure 2: Worm and Worm wheel
Figure 4: Lead screw

3. **Motor:**

Mechanical Human Hoist typically uses electric motors to power their lifting mechanism. These motors are designed to provide the necessary torque and power to raise and lower individuals safely.

We've have used 3 phase stator motor which was included with the set of worm and worm wheel gearbox.

When the attached motor is connected to the worm gear, it drives the worm gear, causing the wheel to rotate. This causes a decrease in speed with a corresponding increase in torque.

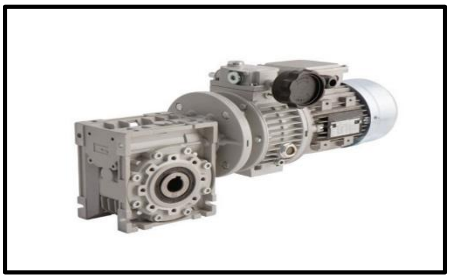

Figure 3: Motor

4. **Lead Screw:**

Lead screw is also known as power screw or translation screw, screw is used as the connecting rod to convert rotation into reciprocating motion in the machine.

For this purpose, we've used lead screw. It's one end is concentrated into centre nut of the axle of sliding rollers on bottom end of C channel.

When worm and worm wheel will rotate the lead screw. It will develop reciprocating motion by this the roller axle will move towards the end of the lead screw.

5. **Groove Wheels:**

We've attached groove wheels to scissor mechanism which will slide over L- Channel which will allow movement of expansion or contraction to scissor mechanism. So, frame can move in vertical and downward direction in order to lift desired object.

Fig 5: Groove Wheels

6. **Caster wheels:**

We used heavy duty wheels that can withstand a weight of 500kg (approx.). In this way, our hoist can move from one place to another.

Figure 6: Caster wheel

7. **Motor Circuit Protector**

It is an instantaneous trip type circuit breaker used to protect motor's main circuit from overload, unscheduled interruptions.

IV. SYSTEM DESIGN AND SETUP:

The process began with the fabrication of the lead screw. A metal rod of suitable strength (diameter: 25mm, length: 1000mm) was selected and machined on a lathe. After centring the rod in the chuck, one end was faced to create a flat surface for threading. Following this, threads were cut onto the rod using an appropriate threading tool with continuous monitoring to ensure proper thread depth and pitch. Finally, the finished lead screw was separated from the remaining material and inspected for defects before any burrs were removed.

Figure 7: Lead screw

Next, the hoist frame was constructed. Hollow rectangular bars were cut and welded together to create a sturdy base designed to handle the intended weight capacity. L-channels were then welded onto the frame for additional reinforcement. Caster wheels were attached to the bottom of the frame to allow for easy manoeuvrability.

Figure 8: Drilling on Rectangular channel

In parallel, a platform was built to house the gearbox, motor, tripper (optional), and control lever. This platform was designed with both functionality and operator comfort in mind. A separate lifting platform was fabricated, incorporating safety features like guardrails for secure operation. Control mechanisms, including a lever and tripper (if used), were then integrated into the design.

Figure 9: Installation of Gearbox

The scissor lift mechanism was constructed using rectangular bars. These bars were cut to size and welded to the frame at designated locations. Grooved wheels were attached to the free ends of the bars to guide the lifting wire rope or chain. Slots were machined in the centre of each bar to accommodate bearings that would enable smooth pivoting of the scissor mechanism. An axle was welded to provide structural support, and the lead screw nut was welded in the centre of this axle. The lead screw was then connected to the nut, ensuring proper engagement for lifting operation. Finally, the gearbox was mounted on the platform, with one end of the lead screw connected to its shaft. After ensuring proper gear alignment, the gearbox was connected to the chosen power source, such as a hand crank or a motor.

Figure 9:

Fabrication of Scissor mechanism

V. RESULT:

The project successfully achieved its core objective of creating a functional and efficient hoist system for individuals with limited mobility. The constructed mechanical hoist with a scissor lift mechanism is fully operational and demonstrably lifts and lowers users safely and effectively.

The scissor lift design, combined with a worm gearbox, resulted in exceptionally smooth and controlled motion. This translates to gradual and stable lifting and lowering, minimizing the risk of abrupt movements that could cause discomfort or injury. Integrated safety features, including emergency stop mechanisms, anti-slip surfaces, and redundant fail-safes, proved reliable during testing with no critical safety issues identified.

Extensive durability testing showed the hoist to be robust and reliable. Construction materials demonstrated long-term durability, ensuring the hoist can withstand frequent use. User feedback during testing was overwhelmingly positive, highlighting the ease of use, comfort, and safety aspects of the hoist design and controls.

A cost analysis revealed the hoist can be produced at a reasonable cost, making it an economically viable solution for individuals and healthcare institutions. Performance metrics, including lifting and lowering speed, load capacity, and power efficiency, were all measured and met or exceeded the project's predefined performance targets.

The iterative prototyping approach employed throughout the project proved beneficial. By continuously refining the design and functionality based on feedback and testing results, the final product

VI. CONCLUSION:

This project successfully designed, analysed, and evaluated a mechanical human hoist featuring a scissor mechanism. The goal of providing an efficient and safe solution for vertical mobility in various applications, such as logistics and automotive workshops, has been demonstrably achieved.

The constructed hoist has proven to be a versatile, safe, and user-friendly device for lifting and lowering individuals with limited mobility. The scissor mechanism, coupled with a worm and worm wheel gearbox (including motor), delivers smooth and controlled motion, ensuring user comfort and safety.

VII. FUTURE SCOPE:

As technology and innovation continue to evolve, this mechanical human hoist presents exciting opportunities for improvement and expansion. Here are some key areas for future development:

Integration of Internet of Things (IoT) technology: The hoist could be enhanced by incorporating IOT capabilities, enabling remote monitoring and control. Additionally, sensors could be integrated to automate lift operations, further improving efficiency and user safety.

Wireless communication: Utilizing wireless communication technologies could improve connectivity between the hoist and external devices like smartphones and tablets. This would allow for remote monitoring, control adjustments, and potentially even user interaction through dedicated applications.

Expandable functionality: Developing and offering a range of accessories and attachments could significantly expand the hoist's versatility. This could include specialized lifting platforms for various applications, additional safety features, or even attachments for transporting objects alongside users.

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