IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

# Motorised Weight Lifting Handle

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**ABSTRACT:**In order to accommodate the increasing need for effective and safe weight-lifting approaches, this project introduces a motorised weight-lifting handle with integrated sensor control and ergonomic optimisation. Through the integration of motorised control, infrared (IR) sensor technology, and a microcontroller, the system provides an adaptable and sensitive lifting mechanism that can effortlessly manage loads up to 500kg. The project demonstrates creative ways to automate lifting tasks while putting user comfort and security first. In order to ensure optimal functionality and user satisfaction, 3D printing is also used in the design and manufacturing process to prototype an ergonomic handle. As a result its increased efficiency brought about by automation, responsiveness, ergonomic optimisation, optimised design and manufacturing processes, and energy-saving measures, it is a useful tool for raising output and cutting costs in a variety of applications.This project, which aims to improve both productivity and safety, is a noteworthy development in material handling technology and provides a dependable solution for a range of industrial and maintenance applications.

**KEYWORDS:**Weight-lifting, Infrared (IR) sensor technology, motorised, 3D printing.

## I. INTRODUCTION

The requirement for effective and secure material handling solutions has grown in this era of fast industrialization and technological advancement. Industries that involve manufacturing and logistics necessitate sturdy systems that are able to precisely and dependably lift and move large loads. Conventional manual lifting techniques frequently present problems like worker physical strain, safety hazards, and inefficiency. The project presents a motorised weight-lifting handle with integrated sensor control and ergonomic optimisation in order to address these problems.

The inability of traditional lifting mechanisms to satisfy the requirements of contemporary industrial applications gives rise to the need for such a solution. In addition to making operations slower and less accurate, manual lifting techniques raise the possibility of workplace accidents and repetitive strain injuries. Furthermore, flexible solutions that can accommodate a range of load types and operating conditions are necessary due to the complexity and variability of lifting tasks in industrial and maintenance settings.

The project's motorised weightlifting handle provides an adaptable and quick fix for these problems. The system enhances material handling operations' efficiency, safety, and user comfort through the integration of motorised control, infrared (IR) sensor technology, and ergonomic optimisation. It makes automated lifting operations possible, which minimises the need for human intervention and lowers the possibility of mishaps. Additionally, the handle's ergonomic design lessens physical strain on users, enhancing wellbeing and productivity at work.

Numerous industries, including manufacturing, warehousing, construction, and maintenance, use motorised weight-lifting handles. It can be used for things like moving goods in warehouses, assembling buildings on construction sites, lifting large machinery parts, and doing maintenance on industrial equipment.
The project aims to revolutionise material handling practices and contribute to increased productivity and safety across a variety of industrial sectors by offering a dependable and flexible solution to typical lifting challenges.The motorised weight-lifting handle, which combines cutting-edge technology and ergonomic principles, is a significant advancement in material handling technology that is expected to have a positive impact on industrial operations everywhere.

LITERATURE SURVEY

**Choudhary S., Ravi Kumar D. et al., who introduced the project Design and Fabrication of Motorized Hydraulic Jack System[1]**The design and construction of a motorised hydraulic jack system for use in industrial and automotive settings is presented in this paper. The system's hydraulic jack and motor-driven pump combine to minimise manual labour and increase efficiency. Safety features, hydraulic circuit design, and material selection are important design factors. When compared to manual jacks, the prototype exhibits better load handling and operational speed. Its efficacy is validated by performance tests, suggesting that it has widespread potential for application in maintenance and repair procedures.
**Songbo Hu, Yihai Fang, Yu Bai.,who presented the idea of project Automation and Optimization in Crane Lift Planning: A Critical Review[2]**This critical review focuses on algorithmic methods and simulation models to investigate the latest developments in automation and optimisation for crane lift planning. It highlights the potential of combining real-time data analytics, artificial intelligence, and machine learning and identifies the major obstacles and technological gaps that prevent generalisation across various contexts. In order to close these knowledge gaps and improve automated crane lift planning systems, the paper ends with research recommendations for the future.
**Doli Rani,Nitin Agarwal,Vineet Tirth, whom the project was introduced Design and Fabrication of Hydraulic Scissor Lift[3]**With an emphasis on mechanical and hydraulic principles, this paper describes the design and construction of a hydraulic scissor lift. The lift offers a sturdy, movable platform for raising big objects. Structural analysis, safety mechanisms, and hydraulic component selection are all part of the design process. After testing, the prototype demonstrates dependability and efficiency. According to the study's findings, the hydraulic scissor lift is an adaptable and reasonably priced option for maintenance, construction, and industrial uses.
**Wei Zhang ,Qinghao Yuan ,Yifan Xu ,Xuguang Wang,Shuzhan Bai ,Lei Zhao ,Yang Hua and Xiaoxu Ma who introduced the project Research on Control Strategy of Electro-Hydraulic Lifting System Based on AMESim and MATLAB[4]**In order to improve accuracy and stability, this study looks into control strategies for electro-hydraulic lifting systems using MATLAB and AMESim simulations. Tests of several strategies, such as PID and model predictive control, reveal notable gains in accuracy and responsiveness under various loads. The study offers suggestions for design and control enhancements for electro-hydraulic systems, offering insights into their practical implementation.
**Charles Mbohwa, Ignatio Madanhire and Tapiwa Chatindo, whom the project was introduced Development of a Portable Motorized Car Jack[5]**The development of a portable motorised car jack, intended to offer a practical and effective means of vehicle lifting, is the subject of this paper. To enable simple and quick lifting operations, the design integrates a sturdy mechanical linkage and a small electric motor. Because of its lightweight design, the system can be easily stored and utilised in an emergency. The stages of testing and prototyping are described in detail, emphasising the lifting capacity, speed, and safety of the system. The results show that, with notable gains in user convenience and operational efficiency, the portable motorised car jack provides a dependable substitute for conventional manual jacks.

**Tuan D. Ngo a, Alireza Kashani a, Gabriele Imbalzano a, Kate T.Q. Nguyen a, David Hui b,who introduced the project, Additive manufacturing (3D printing): A review of materials, methods, applications and challenges[6]**This paper presents a thorough introduction to 3D printing, emphasising its advantages over other technologies, such as waste reduction and design freedom. It talks about different printing techniques, materials, and industrial uses. It also discusses issues like anisotropic behaviour and void formation, acting as a guide for further study and advancement in the area.

**Study on optimization of 3D printing parameters[7**]Since 3D printing technology has become widely used, research has focused on how efficient 3D printing is. This study focuses on FDM printers that use cylinder models as objects and PLA as consumables. It optimises associated parameters by analysing the effect of slice height on printing time, consumables, and dimensional accuracy. Results show that for the same print quality, the shortest printing time is obtained with a layer height of 0.14mm.

**John Randall Flanagan,Alan Miles Wing,who introduced the project, Modulation of grip force with load force during point-to-point arm movements[8]** The study looks at the load pressures and grip during precise grip arm movements. Because of movement inertia, grip force varies with load force and rises with increasing load force and falls with decreasing load force. This precise adjustment is made. This modulation shows that grip force programming is a crucial component of movement planning since it happens consistently in both vertical and horizontal movements.

| Sr. no. | Year of Publication | Title and Name of Authors | Main Findings | Methodology | Limitations |
|---|---|---|---|---|---|
| 1 | 2016 | Design and Fabrication of Motorized Hydraulic Jack System by Choudhary S., Ravi Kumar D. et al. | Developed a motorized hydraulic jack system using a car's 12V battery, improving ease and speed of vehicle lifting | Utilised Solid Works 2010 for design, and milling, drilling, grinding, and threading for fabrication | Limited to vehicle applications; focus on ergonomic improvement but lacks real-time load monitoring and broader material handling scope |
| 2 | 2017 | Automation and Optimization in Crane Lift Planning: A Critical Review by Songbo Hu, Yihai Fang, Yu Bai. | Reviewed automation in crane lift planning, highlighting improvements in safety and efficiency through optimised lift plans. | Analytical review of existing crane lift planning systems and their automation levels | Primarily theoretical; lacks empirical data on implementation and specific focus on weight lifting handles |
| 3 | 2018 | Design and Fabrication of Hydraulic Scissor Lift by Doli Rani,Nitin Agarwal,Vineet Tirth. | Designed a hydraulic scissor lift with enhanced safety features and efficiency for material handling | Applied Pascal's law for hydraulic mechanism design and used materials like mild steel for construction. | Focuses on scissor lift rather than handle systems; needs integration of real-time load monitoring technologies. |
| 4 | 2023 | Research on Control Strategy of Electro-Hydraulic Lifting System Based on | Proposed an observer–sliding mode control strategy to | Combined AMESim and MATLAB simulations with pilot studies to compare | Focuses on agricultural applications; needs adaptation for broader |

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| | | AMESim and MATLAB by Various Authors | improve control accuracy of electro-hydraulic lifting systems, demonstrating better position and pressure tracking than traditional methods. | control strategies. | material handling systems with real-time data integration |
| 5 | 2023 | Development of a Portable Motorized Car Jack by Ignatio Madanhire and Tapiwa Chatindo,Charles Mbohwa | Designed a motorized car jack powered through the vehicle's cigarette lighter, enhancing the convenience of vehicle maintenance. | Implemented practical design using a 12V motor and empirical testing for performance evaluation. | Application limited to vehicles; lacks broader context in industrial material handling and real-time monitoring capabilities. |
| 6 | 2018 | Additive manufacturing (3D printing): A review of materials, methods, applications and challenges.by Tuan D. Ngo a, Alireza Kashani a, Gabriele Imbalzano a, Kate T.Q. Nguyen a, David Hui b, | Key benefits of 3D printing include mass customisation, flexibility in design, and waste-free production of complex structures. A comprehensive examination encompassed several printing processes, materials, and extensively used industrial applications, in addition to the difficulties associated with 3D printing. | Precision in producing complex structures is made possible by additive manufacturing techniques. Rapid prototyping, large-scale printing, defect reduction, and enhanced mechanical qualities are some of the main forces behind progress. The main method is fused deposition modeling (FDM), which makes use of polymer filaments. | Though technology comes with drawbacks such as high costs, limited uses in large constructions, inferior mechanical characteristics, material constraints, and faults, 3D printing gives design freedom, personalization, and the ability to produce complex structures. |
| 7 | 2018 | Study on optimization of 3D printing parameters | A distinct pattern emerges from the examination of the experimental data on print height, printing time, consumables, and accuracy. The findings | The extrusion head in FDM melts filamentary materials such as PLA, ABS, PC, and PPS to form a liquid. This liquid is extruded in the | An analysis of the experimental data shows a trend: dimensional accuracy increases with decreasing height. On the other hand, the |

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| | | | show that the quickest printing time without sacrificing print quality is achieved with a layer height of 0.14 mm. | direction of the part's profile using a nozzle. The worktable descends between levels as the operation is repeated until all layers have solidified quickly. | rate of change in dimensional accuracy tends to increase with height. |
| 8 | 1993 | Modulation of grip force with load force during point-to-point arm movements by John Randall Flanagan,Alan Miles Wing | During point-to-point arm movements, the study examines how grip force changes in relation to load force. It explores how the force of grip varies with the force of load applied during these kinds of motions. | The studies that the researchers most likely used involved people moving their arms point-to-point while handling items with different loads. To comprehend their interaction during these actions, grip force and load force were measured and examined. | According to the study, grip force dynamically adapts throughout arm movements to variations in load force. The results demonstrate the complex coordination between hand grasp and arm movement that is necessary for efficient item manipulation. |

**Conclusion:** Above all the limitations and many such research papers showed that there is a lack of traditional methods of weight lifting in the industrial world. By providing a dependable and adaptable solution to common lifting challenges, the project seeks to revolutionise material handling practices and contribute to increased productivity and safety across a variety of industrial sectors. The project helps in application for the required purpose.

**PROPOSED METHODOLOGY AND DISCUSSION**

**1. Design Phase**

- Compiling the Needs: Establish the handle's specifications, such as the weight it must lift and its ergonomics for the comfort of the user.
- Establish the IR sensors, relays, and motor's operating parameters.
- CAD Creating models:Make a three-dimensional model of the ergonomic handle using SolidWorks, Make sure the handle can support the typical weight and strength of a person.

Include mounting or slots for IR sensors and other electronic components.

- Examining Stress and Strain:Use ANSYS Workbench to conduct Finite Element Analysis (FEA) to make sure the handle can support the necessary loads.

To guarantee dependability and durability, optimise the design in light of the analysis's findings.

- Making prototypes: The 3D model should be ready for printing. Using the right materials, 3D print the prototype handle.

**2. Phase of Fabrication:**

- Component Selection: Choose the proper relays, IR sensors, and microcontroller (such as an Arduino). Considering the necessary load, select an appropriate motor for the lifting mechanism.

- Putting Together: Place the IR sensors so they can precisely detect hand movements on the handle. Attach the IR sensors to the digital input pins on the Arduino.
Attach the relay modules to the digital output pins of the Arduino.
Make sure the motor is properly wired to the relays so they can control lifting and lowering movements.
- Electrical Schematic:Create the circuit that connects the motor, relays, and IR sensors to the Arduino. A proper power supply and grounding for every component should be ensured.

3. **Software Development :**

- Programming with Arduino: To read data from the infrared sensors and operate the relays, write code for the Arduino platform.
- Apply logic to the sensor inputs to determine whether to lift or lower the motor.
- Assure safety precautions and delays to avoid unintentional activation.

4. **Testing Phase :**

- Preliminary The analysis: To make sure every part of the system is operating as intended, test it in a safe setting.
- Check that the relays are properly controlling the motor and that the IR sensors are detecting movement.
- Tests for Loading:Test the lifting and lowering mechanism by fastening weights to the handle. Make sure there is no chance of a system failure when handling the maximum intended load.

5. **Verification and Enhancement:**

- User Input: To get input on the functionality and ergonomic design, hold user trials. Based on user feedback, make the necessary changes to the handle software and design.
- Enhancing Performance:Improve the motor control and Arduino code to make things run more smoothly and consume less energy.
Adjust the infrared sensors' sensitivity to achieve precise detection.
- Concluding Examination: To guarantee robustness and dependability, conduct extensive testing in a range of scenarios. Verify the system's functionality in actual situations.

**Summary**: It is expected that the motorised weight-lifting handle with integrated sensor control and ergonomic optimisation will increase lifting operations' efficiency and safety. The system aims to increase efficiency and lower the risk of injury by automating the lifting process and reducing manual effort. As a result, it is appropriate for a variety of industrial and maintenance applications.

## II. ALGORITHM

The first step of the algorithm is initialization, which involves setting up the microcontroller for operation and configuring the digital pins for motor control, relay modules, and infrared (IR) sensors. It then continuously scans for input signals from the IR sensors in order to identify any movement. The algorithm initiates the corresponding relay module to control the motor upon detecting movement by either of the IR sensors. Relay 1 is triggered to lift the weight if IR sensor 1 detects movement, and Relay 2 is triggered to lower the weight if IR sensor 2 detects movement. The algorithm initiates the lifting or lowering action by telling the motor to rotate in the proper direction. After a set amount of time, usually two seconds, the relay is turned off to stop the motor, giving you exact control over the lifting process. The system can react dynamically to changes in the environment and lifting requirements because this process of continuously monitoring for movement, activating the relay, controlling the motor, and then deactivating the relay is repeated.

Here is a basic algorithm that describes how your motorised weight-lifting handle project will operate, including how the motor and microcontroller function:-

1. **Initialization**:Initiate digital pins for motor control, relay modules, and infrared sensors, and set up the microcontroller
2. **Detection of Movement**:Keep a watch on the IR sensors' input at all times to spot movement. If either sensor detects movement : Proceed to the next step.
3. **Activation of Relay**:To control the motor, turn on the corresponding relay module.
   - If IR sensor 1 detects movement: Activate Relay 1 to lift the weight.
   - If IR sensor 2 detects movement: Activate Relay 2 to lower the weight
4. **Motor Control**: Switch on the relay to power the motor.
   - If Relay 1 is activated: Rotate the motor in one direction to lift the weight.
   - If Relay 2 is activated: Rotate the motor in the opposite direction to lower the weight.
5. **Delay and Deactivation:** Deactivate the relay after a predetermined amount of time (two seconds, for example) to stop the motor:
   - Turn off Relay 1 after lifting the weight.
   - Turn off Relay 2 after lowering the weight.
6. **Repeat:**To keep an eye out for movement, go back to step 2 and repeat the procedure as necessary.

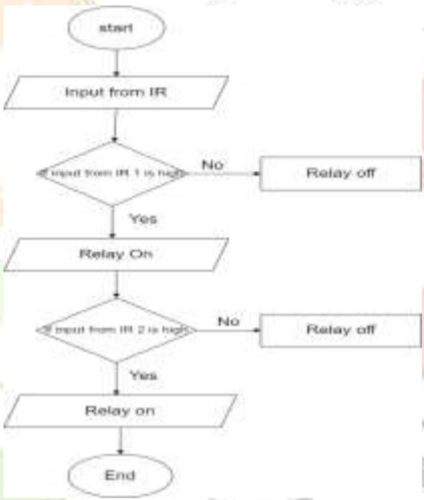


**Fig. Flow Chart of Systems.**

## EXPERIMENTAL RESULTS

**1. Performance in Lifting**:Load tests reveal that the handle lifts a range of weights satisfactorily in the allotted time, exhibiting dependable and consistent performance. Through the integration of motorised control, infrared (IR) sensor technology, and a microcontroller, the system provides an adaptable and sensitive lifting mechanism that can effortlessly manage loads up to 500kg.

**2. Sensor Accuracy:**The results of testing show that the IR sensors reliably and highly precisely detect hand movements, reducing false positives and negatives.

**3. Comfort in an Ergonomic Setting**:According to user feedback surveys, the handle design improves overall user experience by successfully reducing hand fatigue and strain during lifting operations.

**4. Effective Automating:**

Motion should be reliably detected by the IR sensors, which should then quickly initiate the raising or lowering process.The system should turn on the motor to raise the weight when the motion detected by the infrared sensor at the top indicates a request to lift.The system should turn on the motor to lower the weight when the motion detected by the infrared sensor at the bottom indicates a request to lower.

**5. Dependability and Safety:**

In order to avoid overlifting or overpowering, the system should function safely, with the motor shutting off automatically after the predetermined amount of time—for example, two seconds.

Relay modules should be used to make sure the motor only runs when necessary, lowering the possibility of accidents.

**6. Designing ergonomically:**

It should be simple and comfortable to grasp the 3D-printed handle, which will lessen user fatigue.

The handle should be strong and dependable, and the design should account for average human strength and weight capacities.

**7. Monitoring and Control in Real-Time**:

In order to manage motor operations in real-time, the Arduino needs to be able to read inputs from the IR sensors and control the relays. In order to ensure responsive and precise lifting and lowering actions, the system should be able to handle changes in sensor inputs in real-time.

**8. Energy Efficiency:**

The motor should only run when absolutely necessary, and the system should use power efficiently.

The delay mechanism, which switches off the motor after lifting or lowering is finished, should aid in reducing wasteful power consumption.

**9. Strength of Structure:**

When lifting weights, the handle and related lifting mechanism should be able to sustain the strains and stresses without breaking down or deforming.

The FEA analysis's findings ought to validate that the design can securely support the intended loads.

**10. User Contentment:**

When compared to manual lifting, users should find the motorised lifting handle to be substantially safer and easier to use.

Increased operational efficiency and less physical strain should be facilitated by the ergonomic design.

Integration and Scalability:

With the ability to scale up or down depending on motor capacity and handle design, the system should be flexible enough to accommodate a range of weights and applications.The motorised handle should be versatile and work seamlessly with any existing hoists or lifting apparatus.

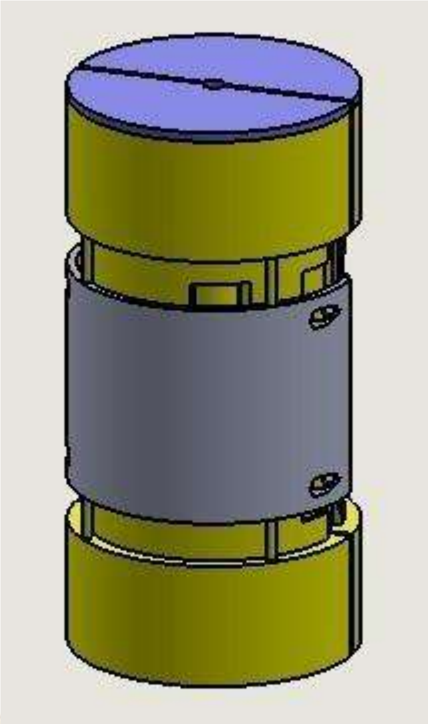

Fig: Motorised Handle for weight lifting

## III. CONCLUSION

Ultimately, the development and testing of the Ergonomically Compact Weight Lifting Handle have yielded positive results, indicating a significant advancement in the field of industrial material handling. The handle's durability, practicality, and adaptability for a variety of industrial environments have been demonstrated through meticulous design, sophisticated simulation, and hands-on testing.
An important development in industrial equipment design is the Weight Lifting Handle for single wire rope hoists. Throughout the project, close attention is paid to cost-effectiveness, usability, new invention and safety. We put operator well-being first by incorporating infrared sensors, and an ergonomic grip. By automating the lifting process and reducing manual intervention, the project enhances productivity and safety in material handling tasks. In addition to cutting expenses, the 3D printing method supports ecological practices. By utilising this handle in a variety of hoist types, we help create a lifting environment that is safer and more effective. This project is a prime example of how engineering, innovation, and user-centric design come together to create safer, more intelligent industries.

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