LiftAssist: An Assistive Mechatronic System for Load Handling

In industries like dairy, agriculture, and manufacturing, workers frequently lift heavy loads manually, facing severe physical strain, worker fatigue, and high risks of musculoskeletal injury. This repetitive task not only impacts the health of workers but also reduces operational efficiency and productivity. Current manual assistance solutions like commercial forklifts and cranes are either too costly, complex, or entirely unsuitable for small-scale environments.

To address these challenges, We developed LiftAssist, a compact, semi-automated mechatronic system designed to assist workers in lifting and transporting objects such as milk cans and vegetable crates. The primary goal was to reduce manual effort while developing a simple, easy to operate system. A key objective was to design a prototype that workers could operate without requiring any specialized training.

Mechatronic System Design

Mechanical Structure and Mobility: The prototype was constructed using a steel square-pipe frame to provide a rigid and stable supporting structure for the integrated components and handled loads. For mobility, the system incorporates BLDC wheel motors connected to dedicated motor controllers. These motors provide powered movement, reducing the manual effort required to transport materials. The front steering arrangement utilizes a rack-and-pinion mechanism connected to the wheel linkages. This mechanical assembly converts steering input into controlled directional movement of the front wheels. The integration of powered mobility and mechanical steering enables operators to easily transport heavy loads across a workshop floor with minimal physical effort.

Motorized Gripping and Lifting Mechanism

A major functional component of LiftAssist is its adjustable gripping assembly, developed to grip objects such as milk cans and vegetable crates. The gripping system consists of a horizontal track arrangement with extended gripper arms. High-torque wiper motors actuate the mechanism, enabling the arms to move inward and outward along the track. This movement allows the gripper to adjust its opening width according to the dimensions of the object being handled. The mechanism was designed to provide controlled gripping movement while maintaining a relatively simple mechanical construction.

For vertical lifting, an electric jack was integrated into the system to raise and lower the gripping assembly along with the secured load. The electric jack provides motorized vertical actuation, reducing the physical effort required from the operator during lifting and lowering operations.

Both the gripping and lifting mechanisms are operated through dedicated manual control buttons, allowing the operator to control the opening and closing of the gripper arms as well as the upward and downward movement of the electric jack. This button-based control arrangement provides straightforward and independent operation of both mechanisms without requiring specialized technical training.

Embedded Control and Electronics

LiftAssist uses dedicated motor controllers and manual control buttons to operate its mobility, gripping, and lifting mechanisms.

For powered mobility, the BLDC wheel motors are connected to dedicated motor controllers responsible for the motor operation. The gripping mechanism uses high-torque wiper motors, while an electric jack handles vertical lifting. Both the gripping and lifting mechanisms are operated independently using manual push-button controls

This arrangement allows the operator to control the vehicle's movement, gripping, and lifting functions through a simple and easy to use control system.

Prototype Implementation and Outcomes

The final LiftAssist prototype successfully integrated powered mobility, adjustable gripping, and electric jack-based lifting into a compact material-handling system. The prototype demonstrated smooth movement of the platform, motorized opening and closing of the gripper arms, and vertical lifting and lowering of loads using an electric jack. These mechanisms worked together to provide a simple, affordable, and easy-to-operate solution for handling heavy loads in small-scale agricultural and industrial environments.

Development Challenges

During development, we experimented with using a Raspberry Pi to control both the vehicle's movement and its front steering mechanism. The front wheels were connected through a motor-driven rack-and-pinion steering system, allowing the vehicle to turn left and right. By coordinating the front steering with forward movement, we were able to make LiftAssist travel along a predefined path during experimental testing. This demonstrated basic path-following capability, although the autonomous system remained in the experimental stage. The final prototype therefore focused on reliable manually controlled movement, gripping, and lifting operations.

Achievements

LiftAssist was presented at the i2i National-Level Project Competition, hosted by COEP Technological University in association with Eaton. The competition evaluated 700 entries across multiple sectors, including Technology, Health and Humanity, Education, Agriculture and Entrepreneurship.

Since LiftAssist was designed to help small-scale businesses, agricultural and dairy industries handle heavy loads, we presented it in the Entrepreneurship category. Following the initial evaluation, approximately 40 projects were shortlisted for the national-level final presentations at the COEP campus. LiftAssist was awarded the Best Overall Project Award, recognizing the project across different sectors.

LiftAssist was featured in The Times of India

https://timesofindia.indiatimes.com/city/pune/homegrown-innovations-shine-in-coeps-i2i-programme-12-finalists-from-rural-colleges-felicated/articleshow/118793647.cms