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Prototype Model of Forklift with Mecanum Wheel Controlled Using Mobile

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Abstract - Industrial forklifts are used to load and unload goods. Electrical forklifts consume less power to drive the vehicle. In crowded spaces with static and/or dynamic obstacles and small corridors, such as industrial floors, warehouses, offices, and hospitals, multidirectional cars could carry out crucial functions. Mecanum wheel-mounted forklifts have seen several designs developed recently to enhance their multidirectional portability and usefulness. In this project, the center of gravity of the forklift is 67mm from the front axle and mecanum wheel diameter is 60mm. The direction of the mecanum wheel is determined by the direction of the leading edge of the roller, if the roller is pointed left then it is a left wheel and if the roller is pointed right then it is a right wheel. The mecanum wheel is a device that can move a vehicle in all directions, including forward, backward, left, right, diagonal, and more. This design has empowered us to create mecanum wheel-based forklift prototype, showcasing the potential for engineering solution.

Key Words: Forklift, Mecanum wheel, multidirectional,

1.INTRODUCTION

The increased agility associated with the omnidirectional mobility of mecanum wheel requires specific safety features like enhanced load sensing and collision avoidance systems to mitigate potential risks. Efficiency optimization involves fine-tuning control algorithms and power management systems to capitalize on the omnidirectional capabilities. Cost considerations extend beyond initial costs to encompass maintenance and operating expenses, requiring a comprehensive assessment of cost-effectiveness for specific applications. Electric forklifts come in a variety of varieties, ranging from order pickers and counterbalance trucks to pallet trucks, reach trucks, and stackers. Because of this, every electric truck has unique features and advantages in addition to appropriate use considerations that collectively contribute to the successful integration and operation of mecanum wheel forklifts, emphasizing safety, efficiency, and reliability across diverse operational scenarios. Forklifts with mecanum wheels have several advantages portable in Tight Spaces, Better Load Handling, Versatile Material Handling, and Effective Inventory Management, Decreased Floor Damage and Enhanced Safety .The precise application, the operating environment, and the overall forklift system efficiency will all have an impact on how much energy is saved.

The mecanum wheels are ideal for crowded mobility with fast, low-power, and minimal ground contact[1]. Mobile robots with Mecanum wheels move in any direction instantly without realignment [2]. It uses rovers with specialized devices, collaborating to streamline data collection and rescue plan development for efficient and safe execution[3]. Mecanum wheels for superior mobility in various crowded areas, enhancing maneuverability and usefulness through diverse designs[4]. A forklift efficiently handles heavy objects with two lifting forks, ensuring ergonomic comfort, reducing manual lifting time, enhancing efficiency, and ensuring safety[5].

MATLAB and SOLIDWORKS optimized roller curvature for enhanced maneuverability in a revolutionary autonomous wheelchair design[6]. The innovative human-powered forklift method streamlines moving and

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handling large loads in the mechanical industry[7]. benefits manufacturing and production by eliminating parking risks, particularly in scrap gathering[8].

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2. MECANUM WHEEL


$$\boxed{mechanum\_wheel\_diameter = 60mm}$$

2.1 WORKING PRINCIPLE

In many industrial and warehousing applications, a forklift equipped with mecanum wheels achieves a variety of movements and boosts productivity. When the room is limited and maneuverability in tight corners and places are crucial, these forklifts come in very handy. Here, a mobile device is connected to and controls the forklift via a Bluetooth module. Forklift batteries are charged using a battery adaptor. The batteries made of lithium-ion are linked. The driving motors, the hoisting mechanism, and an additional motor for the belt pulley are all controlled by a Bluetooth module.

2.2 MODEL CALCULATIONS

1. Centre of Gravity

2. Maximum Weight

$$F_1 \times D_1 = F_2 \times D_2 \qquad F_2 = \frac{F_1 \times D_1}{D_2}$$

3. Bending stress

$$M = \frac{WL^2}{2} \qquad Z = \frac{(b \times h^2)}{6} \qquad \sigma = \frac{M}{Z}$$

(load/length= UDL load)

4.Load on each wheel

$$F_1 = W_1 + W_2 \qquad W_1 = [W_1 + F_2]$$

2.3 FABRICATION

2D sketch➔ GI sheetcutting ➔ Welding ➔ Connections ➔ Wheel fixing

Step 1: 2D sketch: This is the initial step where a twodimensional sketch or drawing is created, outlining the design and dimensions of the fabrication project.

Step 2: GI sheet cutting: The sheets are cut according to the dimensions specified in the 2D sketch.

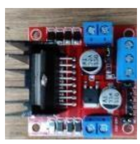
Step 3: Welding: After cutting the GI sheets, the pieces are welded together according to the design outlined in the sketch. Welding joins the individual components to form the desired structure or object.

Step 4: Connections: Once the main structure is welded together, additional components such as hinges, brackets, or fittings are connected to complete the fabrication process.

Step 5: Wheel fixing: Finally, wheels or casters are fixed onto the structure

2.4 COMPONENETS

Table -1: LIST OF COMPONENTS

S.NO	COMPONENT NAME	COMPONENT
1.	MECANUM WHEEL	
2.	GEARED MOTOR	
3.	MOTOR DRIVER	

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4.	LITHIUM BATTERIES	
5.	TIME BELT + PULLEY	
6.	BATTERY CHARGER MODULE	
7.	JUMPER WIRES	
8.	FORKS	
9.	BLUETOOTH MODULE	
10.	BATTERY CHARGER	

2.5 BLOCK DIAGRAM :

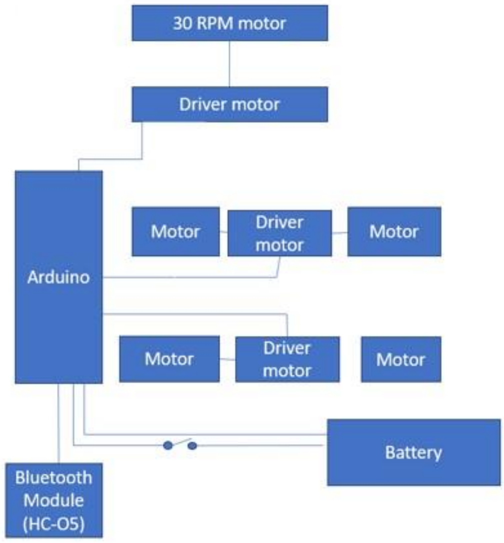

Figure: Block diagram of forklift system connection.

2.6 METHODOLOGY

2.6.1) Direction: Forward/ Reverse

Wheel Actuation: All wheels move in the forward direction/ All wheels move in the backward direction.

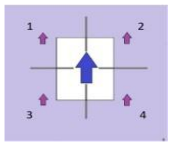

Figure1

Figure1: Wheel moving in Forward/Reverse direction.

2.6.2) Direction: Right shift/ Left shift.

Wheel Actuation: Wheel 1, 4 forward; 2, 3 backward/ Wheel 2, 3 forward; 1, 4 backward.

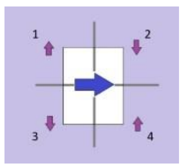

Figure 2

Figure2: Wheel moving in Right shift/ Left shift.

2.6.3) Direction: DIAGONAL

Wheel Actuation: Wheel 1, 4 forward; 2, 3 idle/ Wheel 2, 3 forward; 1, 4 idle.

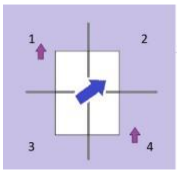

Figure 3

Figure 3: Wheel moving in CW Turn/ ACW TURN.

2.6.4) Direction: TURN MOVING AROUND A BEND

Wheel Actuation: Wheels 1, 3 forward; 2, 4 idle

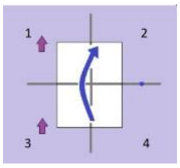

Figure 4

Figure 4: Wheel moving in DIAGONAL.

2.6.5) Direction: CW Turn/ ACW

Wheel Actuation: Wheels 1 , 3 forward; 2, 4 backward

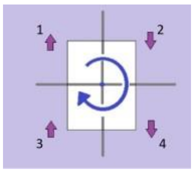

Figure 5

Figure 5: Wheel moving AROUND A BEND.

2.7 CALCULATIONS

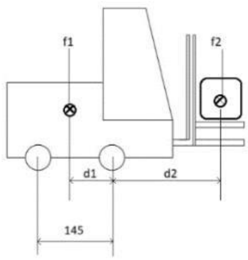

Figure: Centre of gravity acting upon the forklift.

Table 2 - Calculations

S.NO		
1.	Centre of gravity	67mm from the front axle (Fulcrum point).
2.	Maximum Weight	1.44kg.
3.	Bending stress	95.53 MN/m^2
4.	Load on each wheel	1)$W_{1,2}$=14.19N and $W_{3,4}$=12.189N. (without load) 2) $W_{1,2}$=14.1645N and $W_{3,4}$=6.0945N. (with load)

2.8 FINAL PRODUCT

Figure : Final Product

3. CONCLUSIONS

A major improvement in efficiency, control, and adaptability has been made in forklift design with the incorporation of Bluetooth technology and mecanum wheels. Using Bluetooth communication with mobile devices, forklift operators may effortlessly operate the machine remotely, improving efficiency and safety in industrial environments. Mecanum wheels' exceptional mobility makes it possible to go precisely through narrow spaces and around obstacles, which maximizes material handling activities. Since this is a prototype one can build a full-size forklift by increasing its size ratio. Advanced automation and robotics technologies can enable the autonomy of forklifts, improving efficiency and reducing the need for human intervention in repetitive tasks.

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