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Fabrication of Patient Lift Wheelchair with Convertible Bed

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Abstract: ***This project presents the fabrication of a patient-lift wheelchair with a convertible bed, integrating the functions of a wheelchair, patientlift, and hospitalbedintoa compact unit. The system enhancespatient comfort andreduces caregiver effort during transfer andrepositioning. Unlike traditional wheelchairs, which provide onlymobility, thisdesignallows smooth transformation from sitting to flatbed positions using mechanical linkages, pivot joints, and motorized or hydraulic actuators. It also features a patient- lifting mechanism for vertical adjustment without manual handling. Lightweight, durable materials, locking castor wheels, and ergonomic controls ensure safety, stability, and ease of operation.The design is cost-effective, space-saving, and suitable for hospital and home care, improving independence and comfort for paralyzed, elderly, or post-surgical patients while reducing caregiver workload.***

Keywords: Patient-liftwheelchair,Convertiblebed,Caregiverassistance,Mechanicalactuators,Patientcomfort

I. INTRODUCTION

Advancements in assistive and rehabilitation technologies aim to enhance patient comfort, mobility, and safety. Conventional wheelchairs, patient lifts, and hospital beds often operate separately, increasing caregiver effort, space requirements, and costs. This project integrates a convertible bed mechanism into a patient-lift wheelchair, enabling seamless transformation from sittingto lying or semi-reclined positions using adjustable backrest and leg-rest mechanisms with mechanical linkages, pivot joints, and electric or manual actuators. The system allows vertical lifting from bed to wheelchair height, improves patient comfort, safety, and independence, and reduces caregiver strain. Lightweight, durable materials and ergonomic features ensure practicality for home and institutional care. The design supports automation, portability, and future research in rehabilitation robotics, offering a cost-effective, versatile, and efficient assistive solution.

II. METHODOLOGY

This project employs a systematic approach to develop a patient-lift wheelchair with a convertible bed. Initially, existing wheelchair and hospital bed designs were reviewed to identify limitations in space, cost, and caregiver effort. Conceptual designs were developed, integratingadjustable backrest, leg-rest linkages, andmanual actuators for smooth transformation between sitting and lyingpositions. Lightweightanddurablematerials wereselected for theframeandmechanicalcomponents. A 3DCAD model was created, followed by mechanical simulations to assess stress, stability, and functionality. The prototype was fabricated, assembled, and tested for patient comfort, vertical lifting efficiency, and caregiver workload reduction. Observations and performance data were analyzed to validate design objectives and ensure safety, ergonomics, and practicality for home and institutional use.

III. DESIGN AND CALCULATIONS

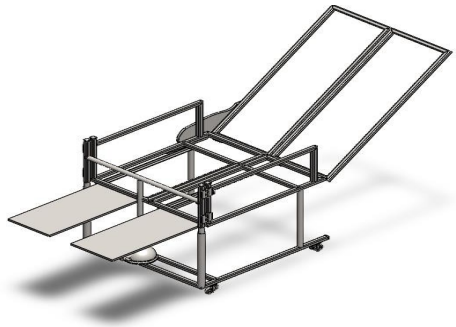

Figure1:3DDesignOfpatientliftwheelchairwithconvertiblebed

The design of the patient lift wheelchair with a convertible bed was developed using SolidWorks, where the main components—base frame, upper frame, seat, and backrest—were modeled and assembled. The base frame was designed as a strong rectangular structure using GI square pipes (25 × 25 × 2 mm) to support the entire load and ensure stability. Above this, the upper frame was created to hold the seat and backrest while allowing connection with the lifting mechanism. The seat was modeled as a flat support surfacefixed totheupper frame, whilethebackrest was designedas a separatecomponent connected through ahingejoint, enabling smooth reclining motion for bed conversion. All parts were assembled using appropriate mates in SolidWorks to simulate real-time movement and ensure proper alignment, strength, and functionalityof the complete system before fabrication

DIMENSIONOFMACHINE

- Seatlength=60 cm
- Seat width=55cm
- Backrestheight=75cm
- Backrestwidth=55 cm
- Frameheight=40cm

THEORETICALLOADCALCULATION

- Material=GIsteel
- Yieldstrength,σy=250MPa
- FactorofSafety,FOS=3

AllowableStress

$$\sigma_{allow}=\frac{\sigma_y}{FOS}$$
$$\sigma_{allow}=\frac{250}{3}$$
$$\sigma_{allow}=83.33\text{MPa}$$

MaximumBendingMoment

$$M=\sigma_{allow}\cdot Z$$
$$M=83.33\times1307.6=108960Nmm$$

LoadonBeam
Forsimplysupportedbeam:

$$M=\frac{W\cdot L}{4}$$
$$W=\frac{4M}{L}$$
$$W=\frac{4\times108960}{600}=726.4N$$

TotalLoadCapacity
Assumingseatcarries70%oftotalload:

$$W_{total}=\frac{726.4}{0.7}=1037.7\text{N}$$

ConverttoLoadinkg

$$m=\frac{W}{g}=\frac{1037.7}{9.81}$$
$$m\approx106kg$$

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IV. COMPONENETS USEDFOR FABRICATION

A. GI Pipes

Theframeisconstructedusing25×25×2mmsquareGIpipes,offeringagoodbalanceofstrength,rigidity,andlightweightdesign. Thehollowsectionsprovidesufficientload-bearingcapacity,whilethe2mmthicknessresistsbendingandimpactduringoperation. The galvanized coating protects against corrosion, enhancing durability and reducing maintenance in harsh conditions**.**

Figure2:GISquarePipe

B. SeatBackHingeRecliner

The car seat recliner mechanism works based on a ratchet and pawl with gear locking system that allows controlled angular movement of the backrest. In its normal condition, the internal gear teeth are engaged, locking the seat firmly at a fixed position. When the user operates the release lever, the pawl disengages from the gear teeth, allowing the backrest to rotate freely about the pivotjoint. This rotation enables adjustment of the seat angle from an uprightsitting position to a reclined orflat position. Once the desired position is reached, releasing the lever activates the spring mechanism, which pushes the pawl back into engagement with the gear teeth, therebylocking thebackrest securelyin place. This simplemechanical arrangement ensures smooth operation, stable positioning,and safe load-bearing capacity, making it suitable for applicationslikea convertible patient lift wheelchair cum bed.

Figure3:SeatBackHingeRecliner

C. Hinges

Thehingeoperates on asimplerotationalmotion principle. Thetwoplates areconnected bya centralpin, which acts astheaxis of rotation. When force is applied, one plate rotates relative to the other around this pin, allowing angular movement. The design ensures smooth motion while maintaining alignment and load support between the connected parts

Figure4:Hinges

D. Screwjack

The screw jack works based on the principle of a power screw. When the handle is rotated, it turns the threaded screw insidethe nut. Due to the helical threads, this rotational motion is converted into vertical linear motion, causing the lifting head to move upward or downward. The friction betweenthe screw and nut helps to hold the load in positionwithout slipping, making the system self-locking in most cases.

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Figure5:ScrewJack

E. Casterwheels

The caster wheel works on a combination of rolling and swiveling motion to provide smooth and flexible movement. The wheel rotates about its horizontal axle, allowing forward and backward motion with minimal friction. At the same time, the swivel mechanism at the top contains a bearing assembly that allows the entire wheel to rotate 360 degrees about a vertical axis. This enables the wheel to automaticallyalign itself in thedirection of movement, making it easyto change direction without lifting the structure. When the brake lever is applied, it restricts the rotation of the wheel and/or the swivel motion, thereby locking the position and ensuring stability. This dual-motion mechanism makes caster wheels highly effective for applications requiring easy mobility and control, such as in a patient lift wheelchair cum bed.

Figure6:CasterWheels

V. FABRICATION PROCESS

Metal fabrication is the process of cutting, shaping, and assembling metal materials to create structural components and parts. It involves operations such as cutting, drilling, welding, grinding, finishing operation & painting to achieve the desired shape and strength. In this project metal fabrication is used to construct the frame, trailer platform, and mounting structures, ensuring durability, stability, and proper alignment of all components. The fabricated parts are designed to withstand applied loads and provide reliable performance of the system.

F. Cutting

Cuttingoperationinmetalfabrication involvesremovingunwantedmaterial frommetalpiecestoobtainrequiredshapesandsizes for trailer components likethe frame and brackets. In this project, square pipes are cut to required dimensions and prepared for welding. Cutting is done using tools such as hacksaw and cutting machines. Proper measurement and accurate cutting ensure correct fitting, strength, and ease of assembly. Edges are finished after cutting toremove burrs and ensure safety.

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Figure8:Cutting

G. Drilling

Drilling operation was performed to create accurateholes in the frame of the patient lift wheelchair for proper assembly. A bench drilling machine with suitable drill bits was used to achieve the required hole sizes. The workpiece was securely clamped, and marking was done before drilling to ensure precision. Cutting fluid was applied to reduce heat and improve toollife.This operation ensured strong fastening of components like hinges, seat, backrest

Figure 9:Drilling

H. Welding

Welding operation was carried out to join the metal parts of the patient lift wheelchair frame securely. Arc welding was used to provide strong and permanent joints between structural members. The surfaces were cleaned before welding to ensure good bonding. Proper safety measures like wearing gloves and a welding helmet were followed. This operation ensured high strength, rigidity, and durability of the wheelchair structure.

Figure10:Welding

I. Grinding

Grinding operation in thisproject iscarried outtosmoothen thecut and welded surfacesofmetal components. It isused toremove sharp edges, burrs, and excess weld material to improve surface finish and ensure safe handling. Grinding also helps in achieving proper fitting of parts and enhances the overall appearance and quality of the fabricated wheelchair.

Figure11:Grinding

J. Painting

Painting operation in this project is carried out to protect metal components from rust and corrosion and to improve the overall appearance of the trailer. After proper surface cleaning, paint is applied evenlyon all partsto ensuredurability, smooth finish, and longer service life.

Figure12:Painting

K. UpholsteryWork

Finishingoperationinthisprojectiscarriedoutusingawirebrush forsurfacecleaning,polishing,andremovalofrust.Thisprocess improves surface quality and prepares the metal components for painting or further treatment, ensuring better appearance and durability.

Figure13:UpholsteryWork

VI. FINALPRODUCTANDOPERATION

Figure14:FinalProduct

Figure15:wheelchairsittingandlyingposition

The final product developed in this project is a patient lift wheelchair with a convertible bed, fabricated using galvanized iron (GI) material to ensure strength, corrosion resistance, and long service life. The GI frame is joined using proper welding techniques to provide durability and stability under load conditions. A screw jack and hinge mechanism are incorporated to enable smooth conversion from wheelchair to bed and to assist in safe patient lifting with minimal effort. The wheelchair is equipped with caster wheels for easy movement and locking mechanisms for safety during stationary use. Cushioning and upholstery are provided on the seat and backrest to enhance patient comfort and reduce the risk of pressure sores. Overall, the use of GI material makes the system cost-effect.

VII. RESULT AND DISCUSSION

The patient lift wheelchair with convertible bed was successfully designed, fabricated, and evaluated under practical conditions. Thesystem enabled smooth conversion between wheelchairand bed positions, ensuring patient comfort and easeofoperation.The screw jack mechanism provided controlled and safe lifting and lowering, while the casterwheels and braking system ensured stable movement and safety. Experimental testing with a 70 kg load showed no signs of deformation, instability, or structural failure, confirming the reliability and stability of the design.

Theoretical analysis indicated a maximum load capacity of approximately 100 kg, providing an adequate factor of safety for real-world applications. Minor deflections observed during testing were within acceptable engineering limits and did not affect performance. While the GI frame offered high strength, replacing it with aluminium can reduce the overall weight by about 50% with only a slight reduction in strength, improving portability. Overall, the system is cost-effective, safe, and suitable for use in hospitals andhome care environments, with scope for further improvements such as motorized lifting and lightweight materials.

VIII. CONCLUSION

ThePatient Lift Wheelchair with Convertible *Bed* wassuccessfullydesigned, fabricated,andtested tomeet theintendedobjectives of improving patient handling and comfort. The system effectively combines lifting and bed conversion mechanisms into a single unit, reducing theneed for multiple equipment in healthcare settings. The screw jack mechanism provided smooth and controlled lifting, while the reclining arrangement ensured easy transformation between wheelchair and bed positions. Experimental testing with a 70 kg load demonstrated stable performance withoutanystructural failure, validating thereliabilityof the design within the theoretical capacity of 100 kg.

Overall, the project proves to be a cost-effective and practical solution for hospitals and home careapplications, enhancing both patient safetyand caregiver convenience. Although the use of GI material ensured sufficient strength, it increased the overall weight ofthesystem. Futureimprovements such astheuseoflightweightmaterialslikealuminium,motorized liftingmechanisms, and enhanced ergonomic features can further improve efficiency, portability, and user comfort. This project demonstrates strong potential for real-world implementation and further development in assistive healthcare devices.

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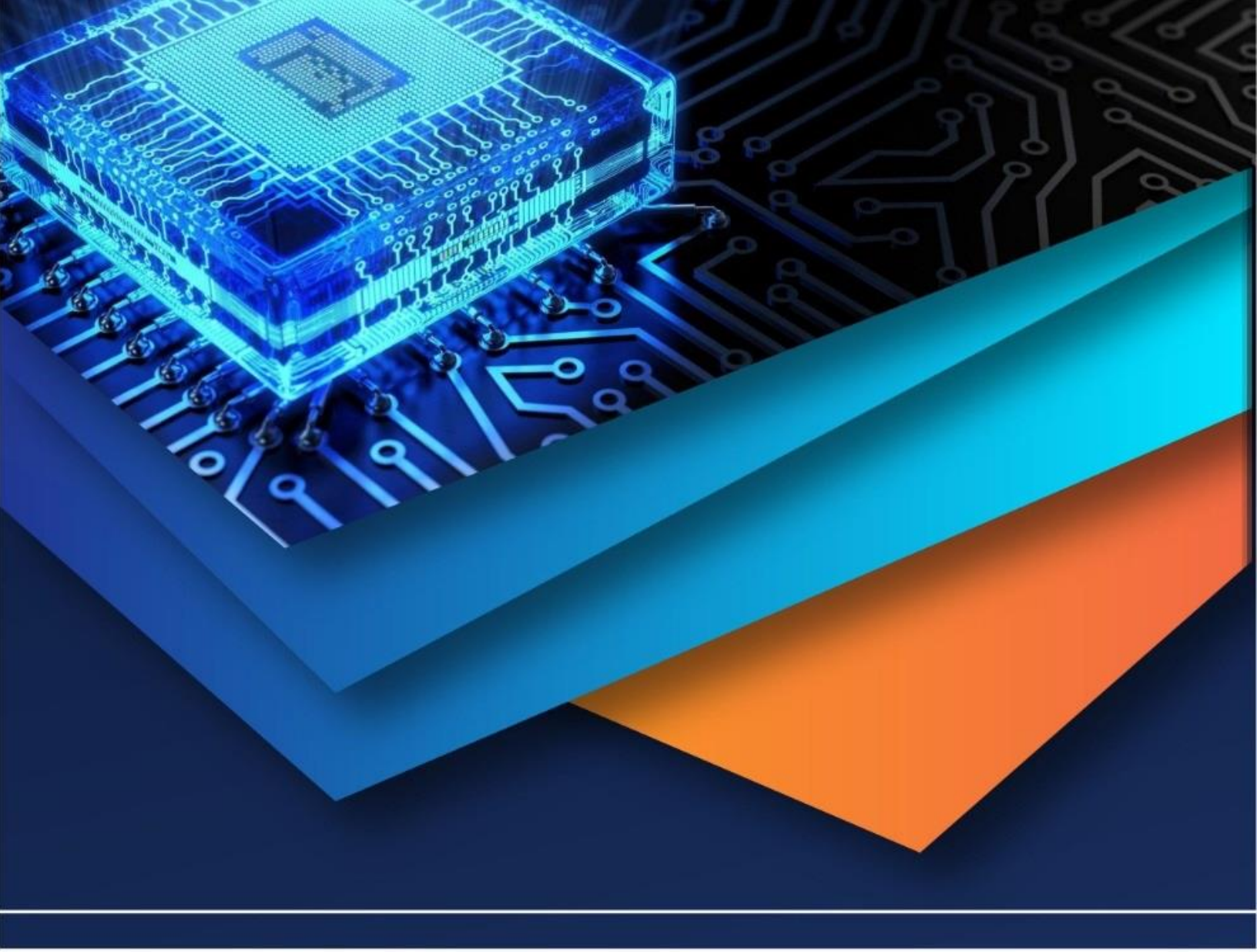

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