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Development of Automatic Level Track and Height Adjustable Stretcher for Hospital Application: A Prototype Approach

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Abstract: *This paper is related to development of automatic level track and height adjustable stretcher for hospital application by prototype approach. In India mobility aids are useful for patients for transportation and a replacement for walking especially in indoor and outdoor environment. Stretchers are the most commonly used medical equipment for the transportation of patients. Transferring the patients from stretcher or to the medical bed is always an issue for the attendant or nurse during climbing inclined surface. Understanding the various issues regarding the mobility equipment and introducing a better design will be an asset for the medical field and a helping hand for disabled individuals moving on inclined surface. There is a need for a level adjusting stretcher to facilitate the disabled patient's mobility and to provide novel medical equipment for use in the Indian hospitals. Adopting various kinds of research methods helped to obtain more information about hospital mobility aids and for data collection. It has been observed that every year the numbers of disabled individuals are increasing by different kinds of accidents. The presently old stretcher designed is not meeting the user's need. From the identified need, new features like level adjustable stretcher which can be introduced.*

Keywords: Adjustable Stretcher, Hospital Application, Prototype Approach, Medical Equipment

I. INTRODUCTION

Hospital beds used by health care professionals are operated manually in most cases, which require some physical effort. In last few decades it is mainly focused that minimizing risks caused by amongothers mistakes and indisposition of the medical personnel occurring during the transport ofpatients in life-threatening conditions. Solutions include automation of bed movement by means ofmotorized devices, for both functional and transport purposes. In addition, it concerns devices that will allow the transfer of a patient from one bed to another or from a bed to a wheelchair, devices providing periodic automatic change of a lying patient's position in order to prevent the emergence of bedsores and advanced automated wheelchairs. The technical development of this kind of devices and their application in the hospital environment are facing many difficulties and limitations. This work presents a design solution for the hospital bed height adjustment mechanism developed within the objectives related to the requirements set for one of the hospitals. The main objective for the mechanism design is to provide comfort and safety for the patient as well as for the medical personnel when performing diagnostic tests. A hospital bed specially designed for patients or others in need of some form of health care. These beds have special features both for the comfort and well-being of patient and for the convenience of health care workers. Common features include adjustable height for the entire bed, the head and the feet, adjustable side rails and electronic buttons to operate both the bed and nearby devices. While designing hospital beds the most important parameter is safety of patient. The modern features of hospital beds are as follows: - wheels enables easy movement of the bed, either within parts of the facility in which they are located or within the room. Sometimes movement of the bed a few inches too few feet may be necessary in-patient care. Wheels are lockable, for safety wheels can be locked when transferring the patient in or out of the bed. Beds can be raised or lowered at the head, feet and the entire height. While on older beds this is done with cranks usually found at the foot of the bed, on modern beds this feature is electronic. Raising automatic level track and height adjustable stretcher. The head (known as fowler's position) can provide some benefits to the patient, staff or

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both. The fowler's position is used for sitting the patient upright foe feeding or certain other activities or in some patients can ease breathing. Raising and lowering the height of the bed can help bring the bed to a comfortable level for the patient to get on and out of bed. Beds have a side rails that can be raised or lowered. These rails which serve as protection for the patient and sometimes can make the patient feel more secure can also include the buttons used for their operation by staff and patients to move the bed. There are varieties of different types of side rails to serve different purposes. While some are simply to prevent patients fall, others have equipment that can aid the patient themselves without physically confining then patient to bed. Some advanced beds are equipped with columns which help tilt the bed tom 15-30degees on each side. Such tilting can help prevent pressure ulcers for the patient and help caregivers to do their daily tasks with less of a risk of back injuries. Many modern hospital beds are able to feature a bed exit alarm whereby a pressure pad on or in the mattress arms an audible alert when a weight such as a patient is placed on it, activating the full alarm once this weight is removed. This is helpful to hospital staff or caregivers monitoring any number of patients from a distance as the alarm will trigger in the event of a patient falling out of the bed or wandering off unsupervised. This alarm can be emitted solely from the bed itself or connected to the nurse call bell/light or hospital phone/ paging system, also some beds can feature a multi-zone bed exit alarm which can alert the staff when the patient start moving in the bed and before the actual exit which is necessary for some cases.

Fig.1 Existing Hospital Bed Design

II. LITERATURE SURVEY

For the literature study purposes we have selected five close topic related research papers are as follows:

Sang, L., et al. (2019)[1] investigated and designed a novel wheelchair-stretcher assistive robot, which can meet the physiological needs of patients. The following tasks are conducted: (1) the mecanum wheel is adopted as the executive device of the walking mechanism, and its kinematics is analyzed in detail. (2) A five-link mechanism with a single degree of freedom is proposed to realize the folding motion of the robot. Through the minimum conclusive area method, the optimal sizes of the armrests link and the side link are 507.9, and 332.5 mm, respectively. Based on the force analysis of the linkage mechanism, six torsion springs and an RV (rotate vector) reduction motor are used as the driving device, which reduces the driving torque of the motor. (3) Based on the STM32 (STMicroelectronics 32-bits Microcontroller) chip, and combined with the theoretical analysis, the mechanical structure and the control system of the whole prototype are designed, and the feasibility of each module is verified by experimental research. The results confirm that the proposed robot has good performance and that the control algorithm for the walking mechanism and the lifting mechanism is suitable.

Deshmukh, P. V. M. (2019) [2] proposed the design of a smart stretcher. Nowadays, the lifestyle of a human being is becoming smarter due to smart electronics equipment for personal as well as domestic applications. The medical field is also powered by the use of advanced technologies in hospitals. Ambulances play a significant role to transport patients from home to hospital or from one hospital to another hospital. At the time of transportation of the patients, ambulances face many critical situations like heavy traffic, traffic signals, bad road including condition potholes, etc. Moreover, the patient in the ambulance bears the road conditions like up and down and the vibrations of the ambulance. Considering such facts, it is proposed to design the smart stretcher. The aim of the present research work was to reduce the effect of potholes on roads, road structures, and vibrations of an ambulance on a patient traveling on a stretcher in a typical ambulance. Vibrations are sensed by a smart sensor and the electronic system is designed to adjust the stretcher stand smoothly, hence the effect of potholes on roads, vibrations of ambulances are removed and it becomes easy for the

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healthcare team to transport the patient. The electronic system consists of signal processing and actuators. The signal processing unit processed the sensed data from the signal and according to that, the output signal is produced to actuator. On implementation of the system, it is observed that the proposed system works satisfactorily.

Park, K. H., (2007) [3]introduced a new robotic smart house, Intelligent Sweet Home, developed at KAIST in Korea, which is based on several robotic agents and aims at testing advanced concepts for independent living of the elderly and people with disabilities. The work focuses on technical solutions for human-friendly assistance in motion/mobility and advanced human-machine interfaces that provide simple control of all assistive robotic systems and home-installed appliances. The smart house concept includes an intelligent bed, intelligent wheelchair, and robotic hoist for effortless transfer of the user between bed and wheelchair. The design solutions comply with most of the users' requirements and suggestions collected by a special questionnaire survey of people with disabilities. The smart house responds to the user's commands as well as to the recognized intentions of the user. Various interfaces, based on hand gestures, voice, body movement, and posture, have been studied and tested. The paper describes the overall system structure andexplains the design and functionality of some main system components.

Campos, A., et al.(2021) [4] studied portable mechatronic rehabilitation system easily adaptable to different situations—e.g., different body members, training modes, and physical spaces—using Internet of Things communication and designed applying a methodology based on user requirements, named SARPA, is developed. Bedridden patients, i.e., those who stay in bed for long periods, often have diseases due to immobility. Conventional rehabilitation to mobility recovery is conducted by therapists who present humanly limited strength characteristics (force, speed, etc.), mainly if the patient is overweight. Mechatronic rehabilitation systems aim to optimize comfort, cost, force, and time to the user, i.e., the patient and therapist pair. However, in general, these systems are conceived to execute just one training mode on just one determined body member in the lower or upper limb. Therefore, a different system is often required for a different training mode or body member. Using SARPA, users may select a body member (among lower or upper limb), an active (isokinetic, isotonic, or isometric), or passive mode and configure it according to a specific therapy. SARPA is configured through a Human Machine Interface based on the Internet of Things, with characteristics that may exceed the values of a human-made conventional rehabilitation. The SARPA flexibility allows several rehabilitation options using a single system. Through SARPA, it would be possible to program games or competitions among patients using the Internet of Things technology, improving their mood and autonomy level during therapeutic sessions. This paper, it is presented the SARPA system design methodology—based on user requirements, construction,and preliminary applications in a hospital.
Elsokah, M. M., et al. (2019) [5] presented a Medical Care Bed with the Internet of Things Solutions a bed designed specifically for patients in hospitals or other people who need some forms of health care that can be used with a button, voice commands and phone applications for control the Smart Bed System using sensors, to voice-controlled application, we are continuously trying to find a better way to control electrical and electronic devices to ease our daily life. Common features include adjustable height for the entire bed, head,and feet, adjustable, adjustable, temperature, pressure, voice command, and application to run both families using sensors and monitoring the patient's body temperature, measuring the proportion of oxygen in the blood and heartbeat using Arduino board. Thesefamily features are special features for both the ease and comfort of the patient and the comfort of health care workers.
By referring to the above papers, we have fixed the strategy of our academic project.

III. Problem Statement, Scope, Objective

3.1 Problem Statement

It is generally observed that, during a patient carrying on stretcher in inclined slope ramp, the stability of patient is not maintained. To overcome this problem, we are going to design and manufacture automatic position adjusting bed, to improve patients comfort and safety.

3.2 Scope for Study

Flat beds cause improper spinal alignment which causes great discomfort during movement in stairs. In some cases, viz. Slopes, irregular road surfaces, ups and downs on the corridors, bed becomes inclined. To make a stretcher for the ease of transportation & to provide comfort during operation of patient.

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3.3 Aim and Objective of Study

The basic objectives of present study are as follows:

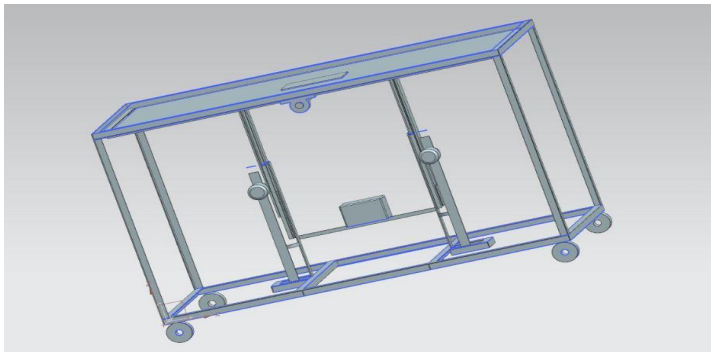
- To study existing model's hospital beds and to analyse the components and functions of each.
- To determine additional features that could be useful in a modern hospital bed and then begin the design process.
- To improve quality, safety, efficiency and effectiveness and to provide safe and therapeutic environment.
- To incorporate more flexible design to minimize the risk and impact of patient falls.
- To provide stability and easy to use controls for the patient but is also built to satisfy the needs of patient.
- To have a position convenient for resuscitation in case of emergency this ensures patients safety.
- To improve the aesthetics of bed while maintain no additional costly components.

IV. METHODOLOGY

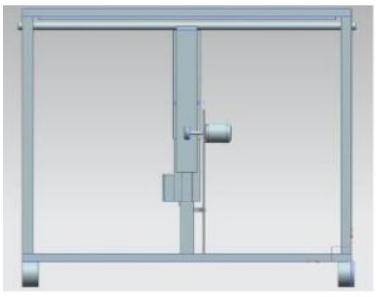
The following steps are implemented during project execution:

- Step 1: Finalizing area of project i.e. Medical Engineering.
- Step 2: Problem identification by visiting various hospitals and studying research papers.
- Step 3:Finalizing objectives of project work.
- Step 4: Rough Designing of Project Idea.
- Step 5: Final Dimensions and Final Design in Software with Analysis.
- Step 6: Final electronics parts specifications which are used in project.
- Step 7: Material of Parts Finalization.
- Step 8:Actual fabrication of Project Prototype.
- Step 9: Testing of prototype.
- Steps 10: Doing any correction in design.

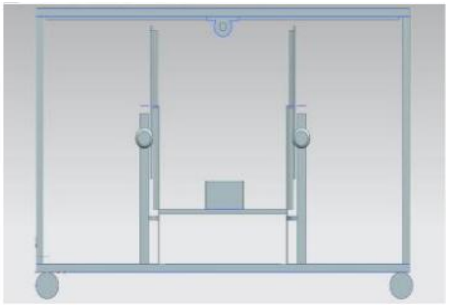
V. PROPOSED DESIGN



(A)



(B)



(C)

Figure 2: (A) Assembly View, (B) Side View, and (C) Front View of Project

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Figure 2 shows the proposed design of hospital bed. Our main aim is to maintain the horizontal position of the bed. On uneven or inclined surfaces, the bed should be in horizontal position to provide safety and comfort to the patients. It consists of frame which is main body of the bed. It supports the other parts of the bed. It uses a 12-voltLead acid battery which is main power supply of the bed. It supplies electric power to the motor. There are two motors on either side of the bed. Pinion is mounted on these two motors. Rack is continuously meshing with the pinion. The upper side of the rack is hinged to the plywood. Supporting column is used to support the plywood. Supporting column attach to the frame by using two bearings which are mounted on both sides of the frame. So that it can rotate freely according to the inclination of the bed. Adxl sensor is use to sense the position of the bed and according to the position it sends the required signal to the controller and then controller allow to pass the electric power the motor through battery. Level sensor senses the position ofthe bed and according to it sensor sends the signal to the controller. After that according to the position controller sends the required current to the motor through battery. There is a rack and pinion arrangement which controls the position of the bed. Rack is mounted on motors haft. So that according to the current, pinion rotates this is in mesh with the rack so that rack moves in vertical direction and lifts or lowers the bed according to the inclination.

VI. Conclusion

Finally, we can conclude that by doing mentioned changes in hospital bed, the quality and performance of hospital bed can be improved up to the mark. Our prototype is successfully working at present scaled model.

Acknowledgment

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