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Implementation of Pressure Sensors based Motorized Hospital Stretcher with Omnidirectional Mobility

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Abstract

This paper presents a motorized hospital stretcher with omnidirectional mobility using pressure sensors for efficient patient transportation. The main objectives are to reduce the manpower during patient transportation and work related injuries. Thus man power and time can be saved. Pressure sensing technology are used for controlling the direction and movement of the stretcher. The stretcher can also detect the obstacles on their way using ultrasonic sensors. Implementation of this design is highly efficient compared to conventional system of patient transfer since this system provides omni-directional mobility and patient loaded stretcher can be easily moved with low manpower. Micro controller is used for programming and the conversion pressure of signals. Logic Signals are produced according to pressure variations. Thus the perfect design is implemented.
Keyword- Pressure Sensor, Omni-Directional Mobility, Micro Controller, Logic Signals

I. INTRODUCTION

People face a lot of problems like work related problem, health problems etc. in various industries. One such industry is hospitals where a lot of physical works are needed. Patient transportation is one of the main and difficult tasks in hospitals which require a lot of man power. Operators are exposed to various work related injuries like back pain, musculoskeletal disorders, shoulder troubles. Lack of manpower and high incidence of work related injuries eventually affects the efficiency of patient transportation.

Currently it requires two persons to transport a patient; one to steer from front and other to push from behind. A nurse will follow them often to watch the patient and the medical equipment. This makes the scene of patient transfer a large procession and leads to a tight work schedule for the hospital staffs as they have to walk along with the stretcher all around the hospital. Worker shortage can also cause work delay in transferring patients to the operating room and waste the valuable time of the doctors and nurses in the operating room.

Hospital environment features long and narrow corridors, crowded lifts rooms. Patient transportation through these corridors becomes a more difficult task both physically and mentally. Porters are required to constantly push and the stretchers with patients which weighs around 100-150kg throughout their long shifts which lasts for up to 8 hours with little rest.

The proposed system introduces a novel motorized robotic hospital stretcher (MRHS) with Omni-directional mobility for patient transfer in hospital environment. This MRHS, which consist of an optimized omnidirectional mobility unit, an intuitive and user-friendly interface, and control system which can be easily operated by operator who can travel along with the MRHS. A human machine interface which can offer easy and safe control of the motorized stretcher so that it could be manured and parked in tight spots or narrow corridors. The mechanical design features of the stretcher, kinematic analysis and control system is designed keeping the priority to the safety of the patient and operator. In order to avoid human errors in controlling the device an obstacle detector using ultrasonic sensors will be used. This will achieve efficient transportation of patients in emergency situations. Conventional motorized bed movers use skip-steering drive for their mobility: two independently motorized wheels. They can turn and move forward but can't move to the sideward due to non-holonomic constraints. In this proposed system we use active split castors for stretcher wheels which can provide Omni directional mobility.

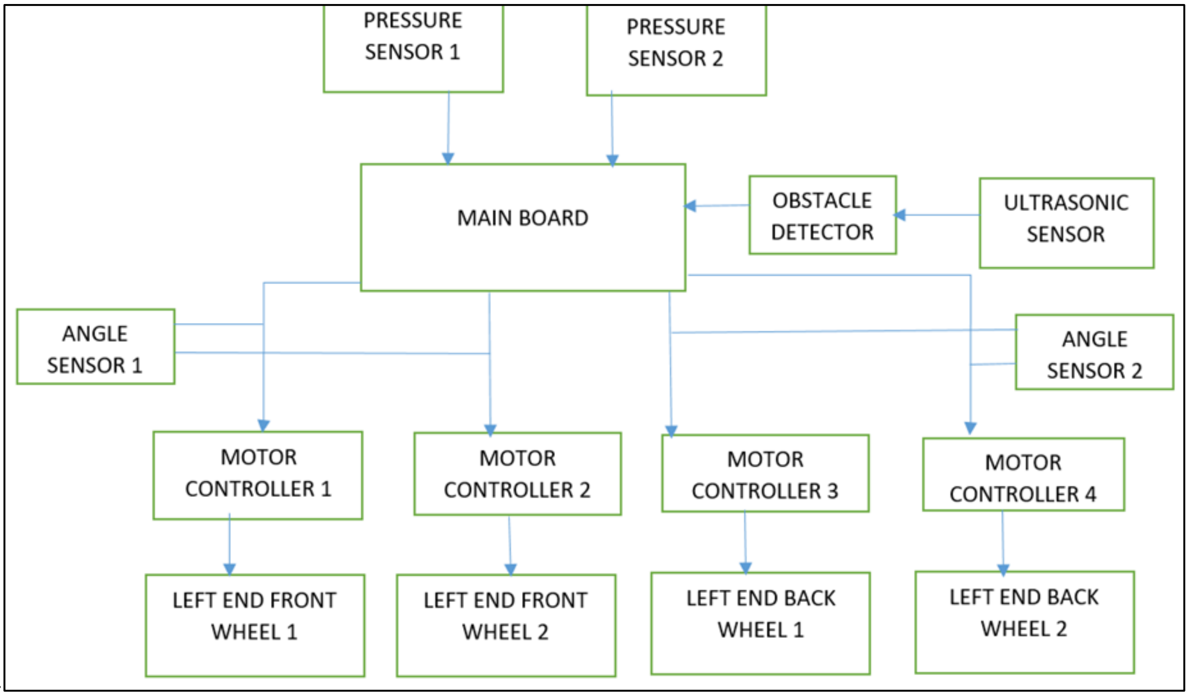

Fig. 1: Block Diagram

II. WORKING PRINCIPLE AND EXPLANATIONS

Manual wheels are replaced with BLDC motor operated wheels. Two pressure sensors are used to control the movement of the stretcher. Movement of stretcher is controlled using pressure applied on two sides of the handle bar. There are 2 pressure sensors on left and right side of handle bar.

When pressure applied on left side it initiates to turn left and when on right side stretcher turns right.

For forward motion pressure must be applied to both sides. The pressure sensor sends the signal to the main board. Main board in turn send this signal to motor controller to control the wheel accordingly.

Speed of the wheel is controlled using servo mechanism. Regenerative braking is used for braking the stretcher. There are 2 motor controllers each for 2 wheels. It also contains an obstacle detector by using ultrasonic sensors

A 12- 36 volt, 350 to 500 w motor is used and 15A, 12 to 36 volt control board is used. Pressure sensor of specification BMP180 is used.

III. SPLIT CASTOR DESIGN

The stretcher consists of four active split caster wheels and two passive casters. Active split casters wheels are connected at the left end (one set of active split caster at the front end and other set at the back) of the MRHS and at the right side passive casters. Active split casters wheels steering principle helps MRHS to move 360 degrees which includes two coaxial wheels independently driven by two 350W hub motors. These two wheels are connected with a link to the platform at the joint center. The motor controller is used to control the speed of each wheel.

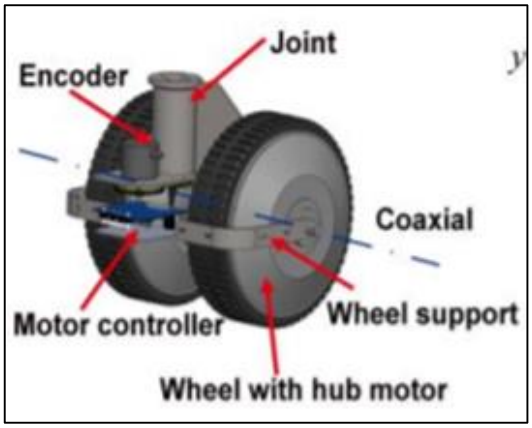

Fig. 2: 3D model of wheel

This MRHS utilize a powered Omni directional mobility unit for optimal maneuverability. The omni directional drive provided better control especially in tight areas with one step "parallel-parking" ability, in which it will be applied in a hospital environment to investigate its performance when exposed to various real external factors.

IV. BLDC MOTOR WHEEL

The brushless BLDC motor is also referred to as an electronically commuted motor. There are no brushes on the rotor and at certain rotor positions commutation is performed electronically. Magnetization of the permanent magnets and their displacement on the rotor are chosen in such a way that the back-EMF (the voltage induced into the stator winding due to rotor movement) shape is trapezoidal. This allows a rectangular-shaped 3-phase voltage system to create a rotational field with low torque ripple.

V. RESULTS AND DISCUSSION

Hardware is based on a 3 phase BLDC/PWSM low voltage motor control driver board module. Solution for testing and developing low power consuming drives is obtained and with this micro controllers and DSC daughter boards are chosen according to the requirements.

A mini stretcher is designed according to the requirements. Ultrasonic sensor, pressure sensor, arduino is used. The main board is designed using arduino. The arduino sends the command to control the wheel to the motor controller. The stretcher speed is controlled using servomotor. Obstacle detector is included to avoid any obstacle on the way.

The stretcher is useful for easy and fast transfer of patients in hospital. There is no need of large manpower as required for manual stretchers.

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