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Smart PRAM for Bedridden Patients with Self-healing ability for Health Monitoring Applications

Karthik M, Usha S, Nhanthini J, Naveen Kumar N, Soniya A, Siva S

Abstract: ***The word inability is the major threat among the people which focus on which aspect they differ from one to the other. Mobility aids were introduced to ease the mobility of the patients so that they can perform the normal activities to manage the way they differ. The normal activities that a person could perform provide a good mental health to the patients. Generally, the patients are kept in the bed and then transferred to the stretcher in case of any emergency; this transfer may injure the patient as he is already a sufferer. Sometimes the patient who is already confined to bed uses wheelchair for their movement, but the earlier designs of wheelchair could not provide the position of comfort to the patient. All these issues have got a solution through the design of wireless heartbeat monitoring PRAM which provides the comfort position and the degree of comfort could also be adjusted according their comfortness. In addition this could also monitor the pulse rate and the temperature of the patient who avail the pram. The position of the wheelchair could adjust itself if the sensed parameters are abnormal. Hence the wheelchair and stretcher are the commonly used mobility aiding parameters that would need a revolution to ease the purpose and this becomes possible by this electrical design..***

Keywords : PRAM, Stretcher, Wheelchair.

I. INTRODUCTION

The numbers of disabled individuals who are unable to get out of bed either due to illness or injury are increasing every year at a rapid rate. The impotent nature of a person could be increased when he is confined to bed. The muscles gets weakened as he does not use any of his body parts and the contracture of muscle is also caused due to the less pressure that is impressed on the muscle which may additionally cause brittleness of muscles. As a result of being bedridden Osteoarthritis is caused which causes degeneration of joints. Also there are possibilities of developing increased and decreased heart rate and cardiac output. This also leads to minor complications of thrombo- embolism and hypotension.

Once a person is identified to be in bed permanently, the position of the setup is needed to be changed for every two hours which inhibits the complications while changing the bed clothes.

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***** Correspondence Author
Karthik M*, Department of Electrical and Electronics Engineering, Kongu Engineering College, Erode, India. Email: karthik.prm@gmail.com
Usha S, Department of Electrical and Electronics Engineering, Kongu Engineering College, Erode, India. Email: sushamangal@gmail.com

Hence, mobility aids will aid the bedridden person for ease of transportation that acts as a replacement for walking.

Fig.1 shows relocating the patients from wheelchair to stretcher or to the medical bed is always an issue for the patients as well as for the care- takers as it may injure the patients. The care- taker or the attendant is to be trained enough to handle the patient at every critical situation. The monitoring of the health conditions of the patient who is confined to bed all the time is not possible. All these issues are understood by analysis and a novel model is designed to avoid the complications which serves as an assert in the medical field.

Fig. 1.Typical method of transferring a Patient

Thus, all these issues stimulate for the development of wireless controlled pram that forms a novel equipment and acts as a form of mobility aid. Hence, the proposed setup will address this issue which is capable of shifting into various positions (Chair, Semi-Chair and Stretcher) just by pressing a button. These positions can be achieved by a lead screw connected with a hinge joint. This setup is capable of converting itself based on the health condition of the patient. This could be a cost reducing technique which mainly helps paralyzed patients to carry out the daily activities and all these are done in accordance with the health issues of the patients.

II. LITERATURE SURVEY

Literature survey is one of the fundamental requirement of process to be carried out that will pave the way for the complete design of the proposed design by considering all the positives and negatives in earlier models.

From all these surveys we have observed the negatives and made it to the extent of possible positive ones. Guide To Wheelchair Selection [1] by Axelson, P clearly explains that the relevant selection of wheelchair will provide a cozy living to the patients as well as to the caretakers. The choice of selection of manually powered wheelchair depends mainly on safety as it increases the severity of injury. It should also depend on the approach in which the setup is designed. One of the exquisite approach is providing a excellent means of mobility to the patients. It is hugely counselled that an inappropriate person could be consulted with the rehabilitation specialist for the purpose of selecting the structure of wheelchair.

Wheelchair Caster Shimmy Damping [2] by kauzlarich, J.J, says that the self excited vibrations which superiors over the department of vibrations is the science that persists as the wobbling that occurs in the castor wheel. The Self-excited vibration is the part which is characterized by the quivering which is produced by the system motions like speed of the wheelchair, which is most commonly observed in the cheapest wheelchair designs. This is mainly caused due to the design of casters in the wheelchair in which sliding frictional damper is used in the spindle support in order to improve the shimmy characteristics. The understanding of the theory on the damping for the casters shows the working of shimmy prevention prevention under the ultralight conditions and the and for the powered wheelchairs.

Push Rim Activated Power Assisted Wheelchair [3] by Cooper, Rory A describes that, on the assessment of its performance, almost 10% of all individuals were found to be blind and they depend on others for their mobility. A Smart Power Assistance Module (SPAM) for the manual pushing wheelchair has been evolved in order to supply the self-sufficient mobility to the system. This power assisted wheelchair also has the facility of obstacle detection and the movement of the system in accordance with the detection of the object. Here microprocessor offers control to the wheelchair and allows the spam to provide a smoother control over the wheelchair.

Wheelchair Transfer [4] by Jolly, M.D.E, accounts for the proper preparation that has to be taken prior to shifting the patients either from wheelchair to stretcher or vice versa. The patients suffering from paralysis would be helped by the use of sliding boards. The best sliding boards are made of hard wood which are smoothened and tapered at its ends. Support of two assistance, support straps, belts etc., will facilitate the easy transfer of the patients from wheelchair to the stretcher. The patient should not get slide into chair, instead they should be lifted from the wheelchair and to be transferred which is an optional and safety method for the transfer of patient.

Design and Development of Conceptual Wheelchair cum Stretcher [5] by Sreerag C S, Gopinath C, Manas Ranjan Mishra provides diverse notions regarding convertible wheelchair cum stretcher. Concept 1 apprise a sliding tubular frame which is fitted to the back rest of the wheelchair also a handle bar is provided which enables the caretaker to pull it easily so that the setup is converted into a stretcher. The next concept gives a perception to the hydraulic scissor lifter procedure, which enables the change of pinnacle of the setup according to the convenience of the user. A hydraulic scissor lifter mechanism lifts the entire wheelchair into stretcher. This setup is based on the gear mechanism which provides the rotation of the middle wheel, based on which the front and back seat are adjusted and finally the stretcher arrangement is achieved.

A. Existing System of Wheelchair

At present as the wheel chair as shown in Fig.2 can drive itself which was equipped with three Laser Imaging Detection and Ranging (LIDAR) sensors and the wheelchair works much like a self- driving car (Daniela 2017).

Fig. 2.Existing system of wheelchair

B. Drawbacks of Existing System

In Existing model, there are many technologies that are being fused to form a comfortable chair and it serves most of the people's needs. But still, there are some people who makes use of bed and they should be transferred to wheelchair in case of moving them to scan section or for other purposes. All those of existing models are not dependent on the parameters on which the position of the wheelchair depends. They are blindly designed to provide comfortable position.

So this process of shifting seems to be risky because the patient already has some complications on their own, May this transfer can cause some hurt externally which may lead to serious injury. If this setup is used on permanently disabled patients they need some external help from the caretakers which enables them to convert the setup to provide a comfortable position to the patient.

Thus a novel model has been introduced to comfort the patients with the cool- headed moving which is to be incorporated with the heartbeat and temperature monitoring ability.

III. PROPOSED METHODOLOGY

In the proposed design, the smart PRAM consists of a wheelchair which operates under lead screw mechanism and a provision is provided at the back rest and foot rest of the chair which acts in accordance with the heart-beat and temperature of the patient.

In some situations, the patient can't wake up from wheelchair and it is found to be very difficult for him to be transferred to bed. During that time, the patient needs help from caretakers to lift him up. In some cases if the patient is partly disabled and if the hands are normal, then he could convert the position of the wheelchair by the joystick control which is mounted on the hand bar. Since the patient always stays on bed, it also causes some additional health issues such as increased/ decreased heartbeat or sometimes may also cause variation in temperature. At the same time if the patient has abnormal temperature or heartbeat, the caretaker will not know it blindly by noticing the patient. By this innovative smart PRAM, the patient himself can able to convert wheelchair to bed by lead screw mechanism which will be driven by the Geared stepper motor. Then the smart PRAM can be automatically converted into a wheelchair while pressing a mechanical switch/button. This pram also has some additional features such as the backrest and foot rest could be adjusted according to the degree of comfort and the height of the entire setup could be rised or lowered based on the performance of the setup. When it comes to a certain emergency situation, the heart-beat and temperature of the patient is monitored and this sensing is used to provide a comfort position to the patient by controlling the Geared stepper motor.

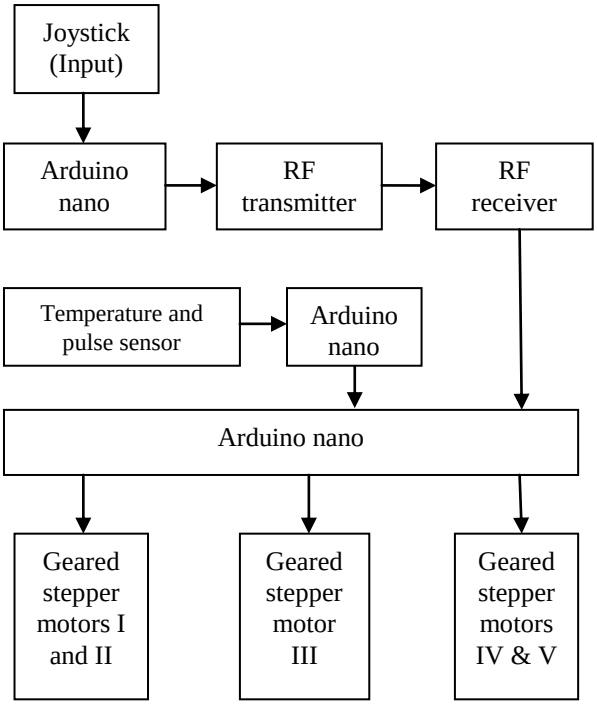

Fig. 3.Block diagram of proposed system

The proposed smart PRAM comprises of switch, battery and lead screw mechanism along with the heartbeat and temperature sensor. Lead screw mechanism is used for stretching and retracting the wheelchair. A motor which is coupled with lead screw will support in transmitting power to it. A switch is connected to the lead acid battery that controls the power flow to the various parts.

When the switch at the right end is pushed front, the motor starts to rotate in the clockwise direction and the pram starts to move forward. When the switch at the right end is pushed back, the motor starts to rotate in the anticlockwise direction and the wheelchair starts to move backward. The lead screw is connected with link and it is placed of the to and fro motion of the backrest and foot rest. When the switch is pressed, then the lead screw will start to rotate. The links which are connected in backrest and footrest will move along with lead screw which is connected to a nut. Finally wheelchair is converted to bed by the constant speed that leads to the development of smart PRAM. Fig. 3 depicts the block diagram representation of the proposed project and its associated components used in the development of smart PRAM.

A. Joystick Part

Fig.4 shows the joystick part is the one which the Arduino has its control over the joysticks. This joystick portion has two joysticks incorporated on a single board and RF trans-receiver is used for the purpose of receiving and transmitting the information. Here the position of joystick determines the motor to be operated and the direction in which the motor is to be operated. When the joystick 1 is pushed upward, the pram tends to move. This joystick is externally controlled according to the desire of the caretaker and provides a flexible control over all other parts.

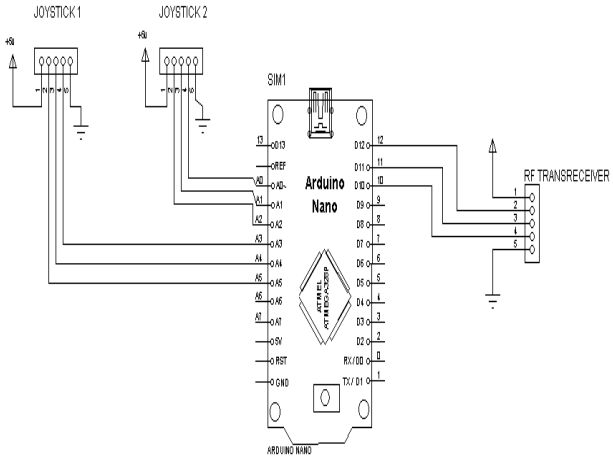

Fig. 4. Joystick part

B. Health Monitoring Part

It represents the part in which the heartbeat monitoring sensor and the temperature sensors are fixed. These sensors determines the health condition of the patient which is to be displayed on the LCD screen that is fixed to the Arduino. Monitoring the health condition is to be given much importance because the care taker always cannot afford their time on the patient. Fig.5 feature imparts a kind of relaxation to the caretaker and makes the process easier than earlier. Without enabling the setup to operate blindly, it could be made to operate on a criteria of health monitoring, which is effectively done by heartbeat and temperature sensor.

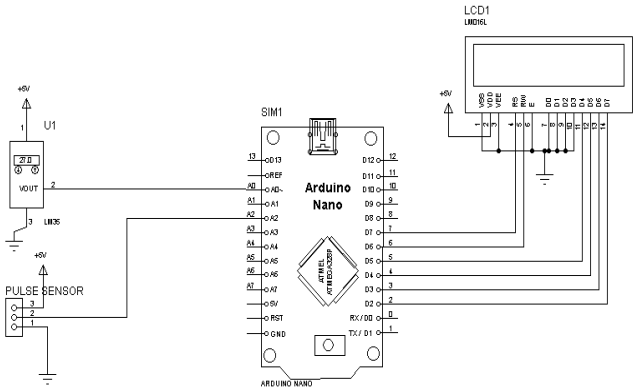

Fig. 5. Health monitoring part

C. Controller Part

The controller part has the control over the entire setup, since the H- bridge circuits for all the five motors are imparted in this controller part shown in Fig.6. In the heart beat monitoring PRAM we have used a number of five geared stepper motors. The geared stepper motor is much preferred as it operates at a minimum speed which would not disturb the patient. The geared stepper motor also has the high holding torque on its own. If any other device is used to lift the back rest or foot rest like hydraulics or pneumatics or electric cylinder, it may produce a jerk which will be out of control. Motor 1 is used to lift the back rest and motor 2 is used to lift the foot rest, motor 3 is used to make the height difference from the wheelchair to the stretcher, where as motors 3 and 4 are incorporated in right and left wheels. All these movements are made possible by the lead-screw mechanism, where the lead screw is driven by the geared stepper motors based on their functions. The motors tends to perform based on the H-bridge circuits that are implemented to control the respective motors. Here the H- bridge is used to change the polarity of the motors, so that the motors could operate in either clockwise or anti-clockwise directions based on the input given to the Arduino by the user.

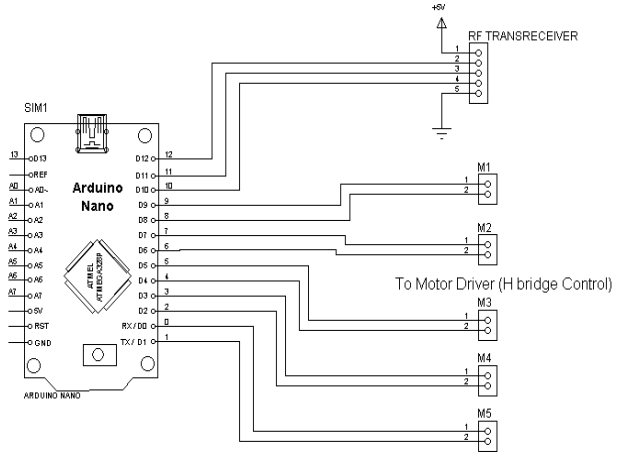

Fig. 6. Controller part

D. FLOW PROCESS

The flow process shown in fig.7 defines the entire working of the PRAM form the start to the end. It includes all the movements that are imparted in the wheelchair

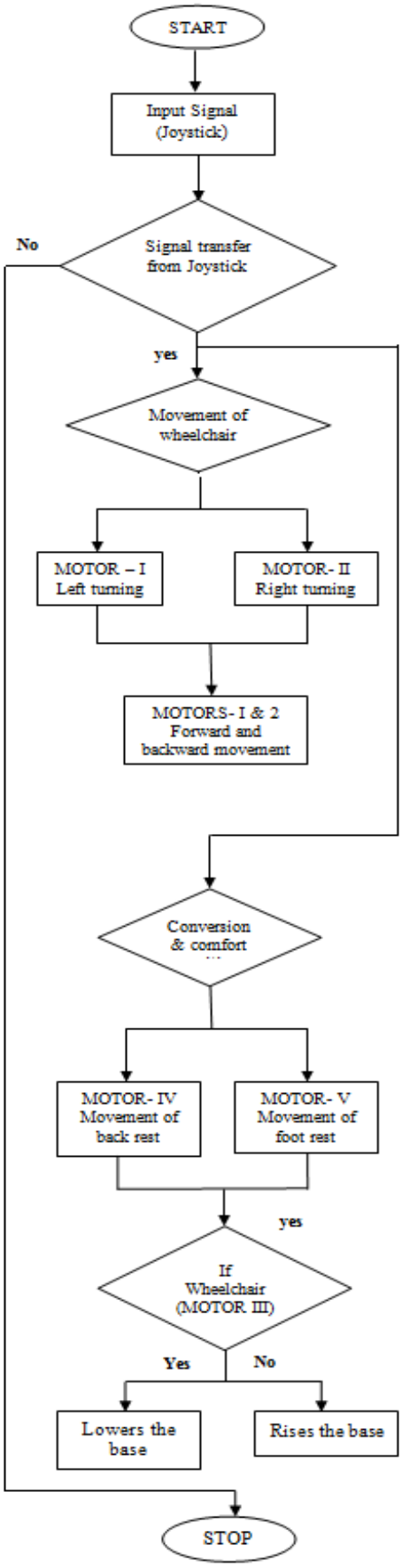

Fig. 7.Flow chart of the process flow

IV. RESULTS AND DISCUSSION

A. Entire hardware setup

Fig. 8. Entire hardware setup

The entire hardware setup is shown in fig.8 In this figure the model is shown in the position of wheel chair which could be converted to wheel chair by simply pressing the knobs on the joystick.

B. Controlling Portion

The controlling part is the part shown in Fig.9 in which the controllers are installed which senses the signal which are transferred from the joystick which is formed as a result of command given by the patient and also as a result of the heartbeat and the temperature of the patient. Here five H-bridge circuits are installed, which controls the geared stepper motors. And all these H- bridge circuits are controlled by Arduino nano. This is the internal portion which performs all the mandatory operations in a hidden manner.

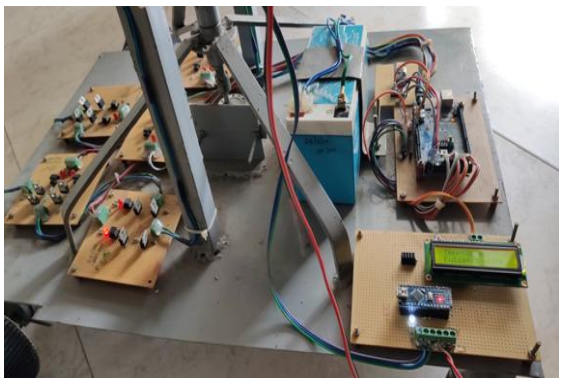

Fig. 9. Controlling portion

C. Joystick Portion

The joystick is the part of the control, which has been made wireless for the purpose of easy control. The joystick is the external part that could be controlled by the attendant. The purpose behind this is all the time the attendant could not move at the speed of the pram. This joystick part acts according to the control which is given by the operator (ie. Manually controlled). The backrest and footrest can be moved by moving the sticks of the joystick front and back and similarly, the height of the wheelchair could also be changed.

The joystick portion is made wireless by imparting RF tans- receiver. This is one of the main advantages because all the time while controlling the setup the attendant could not move along with the setup at its speed. The wheelchair could turn right by moving the left handle of the joystick at the angle of 45 degrees approximately and vice versa. The backrest could be moved by simply holding the left handle and pressing the right handle upwards and vice versa for the footrest.

The RF Trans-receiver is also imparted in the setup shown in Fig.10 since the entire setup is made wireless, because they are used for transmitting the information that is given by the attendant. This information is then received by the RF trans-receiver that is imparted in the setup. The setup could be made to move according to the desire of the patients and attendents. Thus this turns out to be a good and easy controlled and manually operated device without incurring any risks that takes place in all the other cases of control.

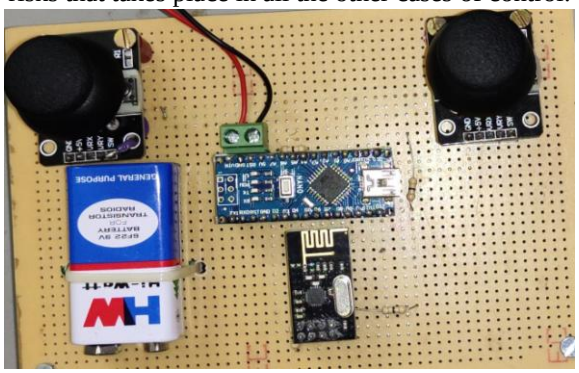

Fig. 10. Joystick portion

D. Leadscrew Mechanism

The implementation of leads screw mechanism is shown in Fig.11. Here the lead screw method is implemented in order to reduce the cost and also the jerk that are the drawbacks of the existing system. The only disadvantage of this lead screw mechanism is that it needs to complete one whole rotation to move slightly. We have opted lead screw mechanism, which has a minimal number of disadvantages over all the other mechanisms. This mechanism of lead screw will be efficient which is based on the speed of the motor, so that there will be a smooth movement of the wheelchair.

Fig. 11. Lead screw mechanism

E. Geared Stepper Motor

The geared stepper motor shown in Fig.12 is the device that has a high holding torque and could easily move in both the directions with the load on it for a certain period of time. The setup of geared stepper motor is used in five places as for right and left movement, up and down movement of foot rest and backrest, for the special lifting mechanism. The main concept behind the convertion of wheelchair to stretcher is made by the movement of backrest and the footrest. When the backrest is above 45 degree and foot rest is below 45 degrees, the setup is as wheel chair whereas when both backrest and footrest are at 0 degrees then the total setup is as stretcher.

Fig. 12. Geared stepper motor

F. Sensor Portion

The sensor part is the one in which the heartbeat and temperature sensors are implemented which would measure the pulse and the temperature of the patient and the signal from the same are given to the arduino nano which is used. The signal from the sensor is transmitted to the arduino by a RF trans-receiver.

The sensor part is also connected to the LCD display which displays the pulse and the temperature of the patient. If the heartbeat and temperature of the bedridden patient seems to be abnormal, the setup is capable of converting itself into the stretcher upto a certain angle that provides comfort to the patient. The normal heart rate of an adult lies between 60 BPM to 100 BPM. This is the data that is dumped into the Arduino that produces the movement in backrest and foot rest. A research says, when a person is in their sitting posture the heart beats at a faster rate whereas the heartbeat rate gets lowered when the posture is changed to lying. Considering a situation where initially the pram acts as a wheelchair, when a high pulse rate is measured the setup could convert itself to the stretcher. Considering another situation where the pram is initially in the stretcher position, when the low pulse rate is measured, the setup converts itself to a wheelchair to make up with the pulse rate. This would create a revolution in the medical field since it incorporates innovative ideas which are in accordance with the health of the patients.

The pulse of the patients that was measured is shown in Fig.13. The temperature displayed is the normal room temperature and the pulse that is displayed is in its normal rate.

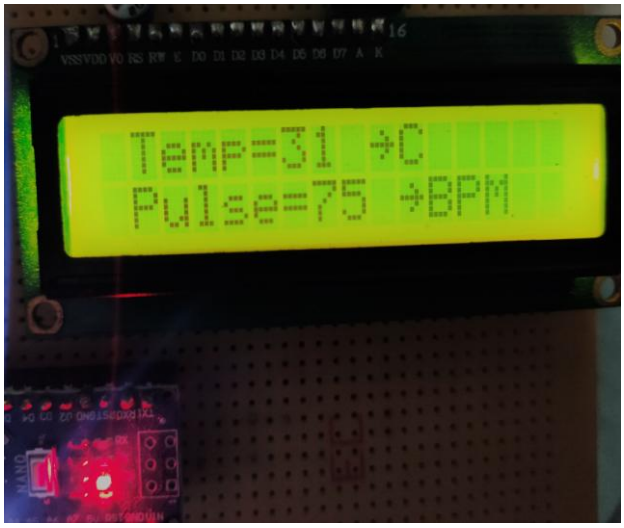

Fig. 13. Display of patient Pulse rate

V. CONCLUSION

The existing system has the limitation of shifting patients from wheel chair to stretcher. This product will be helpful for paralyzed patients, movement impaired personals, as well as for old age persons. This proposed design will eliminate the separate use of wheelchair and stretcher in hospitals; thereby the step of shifting the patient from one setup to another could be skipped effectively. In addition to all these facilities, the health of the patient is monitored and the wheelchair acts according the extent of health of the patient. The wheelchair will consume less space and is manufactured at low cost. Such equipment can induce self-reliability and satisfaction in the users. This system could be improvised by incorporating the technology of machine vision camera accompanied by obstacle detection.

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AUTHORS PROFILE

M. Karthik graduated in Electrical and Electronics Engineering from Manonmaniam Sundaranar University, Tirunelveli, India and received the Master degree in Applied Electronics from Anna University, Chennai, India in 2004 and he was awarded PhD in Electrical Engineering in 2016 at Anna University, Chennai. He is currently with Kongu Engineering College affiliated with Anna University, Chennai. He has published and presented several papers in International journals and conferences respectively. He has also conducted several workshops and seminars in his research area. His research interest includes Fuel Cell Hybrid Electric Vehicles, Energy conversion/storage systems, Renewable Energy systems Modeling and Integration with Electric Grid.

S. Usha presently working in the department of Electrical and Electronic Engineering Department, Kongu Engineering College, Tamilnadu. She received her BE degree, in electronics and communication engineering in 1992 at Bharathiar University, Coimbatore. ME degree in Power Electronics and Drives in 2008 at Anna University, Chennai and awarded PhD in Electrical Engineering in 2015 at Anna University, Chennai. She has also conducted several workshops and seminars in her research area. Her area of interest includes network security, mobile Ad-Hoc networks and digital image processing.