CHAPTER 14

Implementation of Smart Wheelchair using Ultrasonic Sensors and Labview

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Abstract: The implemented patient-monitoring smart-wheelchair system is an ambulatory aid for specially-abled people along with continuous monitoring of the user's vital body parameters. In order to take into account different disabilities, four interfaces have been developed for wheelchair control namely eyeball control, gesture control, joystick control and voice control. A camera is used to capture the image of the eyeball. LabVIEW is used to take necessary decision depending upon the position of the eyeball. Remaining three modes also provide control over the wheelchair movement. Ultrasonic sensors are employed for implementing anti-collision mechanism. In the wheelchair body temperature and heart rate monitoring provision is made. This system will alert proper medical authorities and the wheelchair user's selected individuals if any parameter is out of safe range. The final project is an assistive technology with a difference which would make the life of its user easy and more stress free.

Keywords: msp430, patient monitoring, python, smart wheelchair

INTRODUCTION

There are specially-abled people throughout India. A major chunk of this population is physically disabled. Independent mobility is critical to individuals of any age. Children without safe and independent self-ambulation are denied a critical learning opportunity, which places them at a developmental disadvantage relative to their self-ambulating peers [1]. While smart wheelchairs are available in the market their costs are very high. The implemented wheelchair is an effort to make such modern assistive technology available at an affordable price. There are various types of disabilities like paralysis, paraplegia and muscular dystrophy.

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Depending upon the type of disability four modes has been provided and these are joystick mode, gesture control, eyeball control and voice control mode. Provision for monitoring the body temperature and heart rate has been made. Ultrasonic sensors have been mounted to provide obstacle detection which will ensure safety of the wheelchair user. GSM module has been added which will send an alert message to selected individuals whenever the body parameters of the individual are above certain specified threshold or the user presses the panic button so that they can take necessary actions.

SYSTEM OVERVIEW

The block diagram of the implemented system is shown in Fig. 1

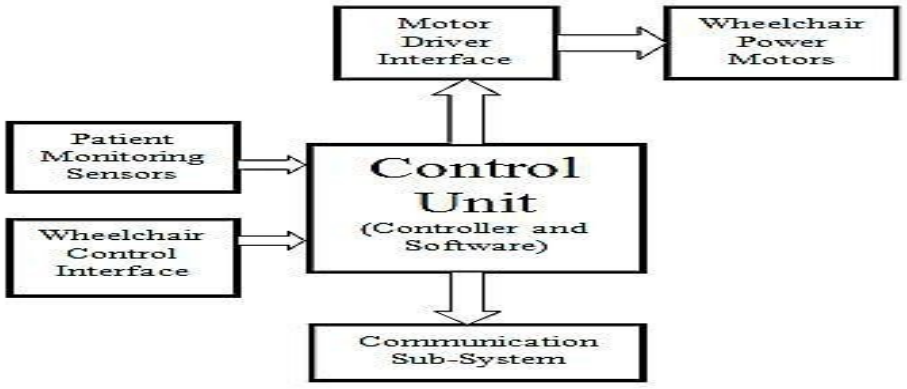

Figure 1: Block Diagram

System consists of following sub-blocks.

A. Control Unit

Control unit consists of msp430 microcontroller, python and LabVIEW software. All the decisions and data manipulation is done by control unit

B. Wheelchair Power Motors

DC motors are used for wheelchair movement. Since actual user will be sitting on the wheelchair, high torque motors that will be able to bear the load of person sitting on wheelchair are required.

C. Motor Driver Interface

The controller will not be able to drive those heavy motors. To drive those motors, a driver that will supply the necessary current for driving the same is required.

D. Patient Monitoring Sensors

Temperature sensor LM35 and TCRT1000 module are used to monitor the body temperature and heartbeat of the wheelchair user.

E. Wheelchair Control Interface

The implemented wheelchair has four different modes of control. These are eyeball control, audio control, gesture control and joystick control.

F. Communication Sub-System

This consists of the GSM module for sending alert messages to the appropriate authorities. SIM 900 module is used as for this purpose. It has serial interface for sending AT commands.

HARDWARE IMPLEMENTATION

G. MSP430 Microcontroller Series

The Texas Instruments MSP430 family of ultra-low-power microcontrollers consists of several devices featuring different sets of peripherals targeted for various applications. The architecture, combined with five low-power modes, is optimized to achieve extended battery life in portable measurement applications. The device features a powerful 16-bit RISC CPU, 16-bit registers, and constant generators that contribute to maximum code efficiency. The digitally controlled oscillator (DCO) allows wake-up from low-power modes to active mode in less than 1 μs.

H. DC Motor

The motors used are DC motors. The motors chosen are such that after using spur gear it is able to provide enough torque to move the wheelchair on load condition. Fig.2 shows the DC motor used and Table I shows the motor specifications.

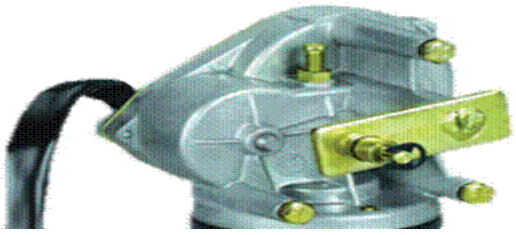

Figure 2: DC Motor

Figure 3: Motor Driver Module

Table I: Motor Specifications

Voltage Rating	17 NM
Power Rating	12 V
No Load RPM	60 rpm
On Load RPM	45 rpm
No Load Current	2.5 A
On Load Current	3.5 A

I. Spur Gear

Spur gears have been used to decrease the speed and increase the torque to achieve the desired torque value.Fig. 4 shows the spur gear assembly used. The gear ratio was calculated so that it can move the wheelchair at desired load.

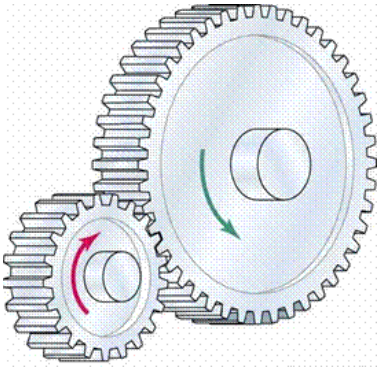

Figure 4: Spur Gear

J. Motor Driver Module

This is the drivér that is used to control the DC motors. Microcontroller output is used to control the motors and in turn the wheelchair via this module.Fig. 3 shows the driver used.Fig. 5. Shows the LCD used to display body temeperature.

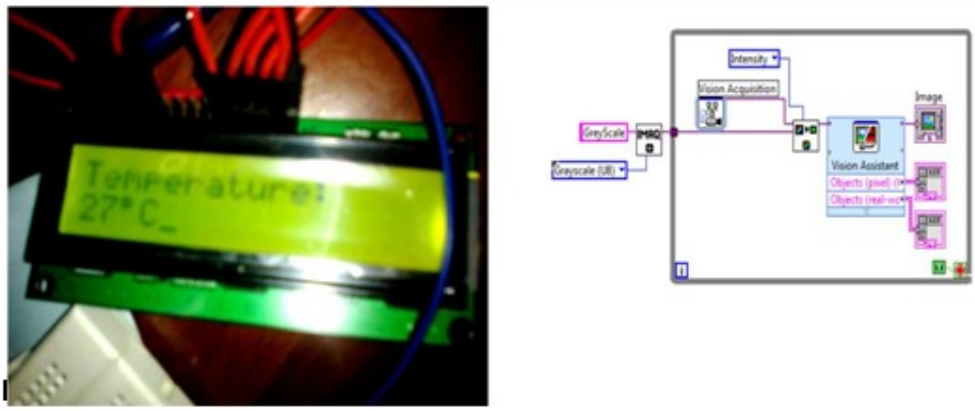

Figure 5: Body Temperature Display

K. Implemented Wheelchair

Fig. 6 shows the implemented wheelchair. In this model the gears as well as the motors and the battery and control box has been fitted. The user can use the controls provided for controlling the wheelchair. The wheelchair is foldable and thus can be transported conveniently.

Figure 6: Implemented Wheelchair

HARDWARE IMPLEMENTATION

L. Eyeball Control

The User's eye ball movements are used to guide the wheelchair in this mode. This is achieved through pattern recognition technique. Vision Assistant is used for pattern recognition. Template images are matched with the image of user. User's eyeball captured in real time. Depending upon the matched image microcontroller guides the wheelchair in appropriate direction.

M. Audio Control

User's voice commands are used to guide wheelchair. Command spoken by user is processed using python. Recognized command is used to control wheelchair. Commands used are forward, backward, left, right and stop.Fig. 7 shows the graphical user interface (GUI) created for the voice control mode. It will give a visual indication to the user which command has been detected.

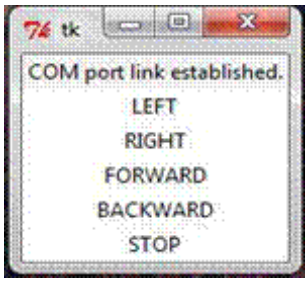

Figure 7: Audio Control GUI

N. Joystick Control

This mode is provided for people who are paralyzed below waist but are able to use their hands properly. Normal joystick operation is used to direct the wheelchair.

O. Gesture Control

For those people who are paralyzed below neck and are able to use their neck properly this mode is incorporated. In this mode a capacitive accelerometer is used to detect the head gestures and ADC is used to convert the analog values to digital values. Microcontroller takes the necessary action.

SOFTWARE IMPLEMENTATION

P. Python

Python is an open source programming language. Speech module has been used for voice control. A GUI has been created using Tkinter module. Serial communication is done using pyserial. Whenever a particular command is

detected a particular character is transmitted serially to the microcontroller. The microcontroller takes the necessary decision depending on the character received.

Q. LabVIEW

LabVIEW (Laboratory Virtual instrument Engineering Workbench) is a system design platform and development environment for a visual programming language from National Instruments. This software is used to implement eyeball control mode. Machine Vision module has been used for eyeball tracking and VISA is used for serial communication.

CONCLUDING REMARKS

The designed and implemented final wheelchair is a cost effective solution to the society's need for modern smart assistive technology. In the implemented system there are four modes of wheelchair control namely eye-ball control, voice control, joystick control and gesture control. Ultrasonic sensors have been used for implementing obstacle avoidance and anti-collision mechanism. Body temperature and heart rate of the wheelchair user is monitored and if the values exceed a particular specified normal threshold a warning message will be sent to individuals specified by the user. There is also a panic button provided which when pressed will trigger an alarm as well as send a message.

CONFLICT OF INTEREST

None Declare

ACKNOWLEDGEMENT

None Declare

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