INNOVATIVE TECHNIQUES USING WIRELESS SENSORS IN DESIGNING SMART SYSTEM FOR DISABLED PATIENTS

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ABSTRACT

Physically challenged persons find their movements very tough with the existing assistive devices (Joysticks in cases of higher disability. Though there are many methods available in recent times to enable their motility they require fine and precise control which is most of the times not possible. In recent times there have been various control systems developing specialized for people with various disorders and disabilities. This paper reports the preliminary work in developing a robotic wheelchair system that involves the movement of eyeball and head kinematics in directing the wheel chair. The system enables the patient to have command over the chair, its direction of movement and will also sense and alarm the user about the obstacles in the path to avoid collision. This wheelchair helps the patient to move in environments with ramps and doorways of little space. Generally an automated wheelchair must be highly interactive to enable the system to work most efficiently.

Keywords : Wireless sensors, PIC Microcontroller, LabVIEW.

I. INTRODUCTION

Several studies have shown that both children and adults benefit substantially from access to a means of independent mobility, including power wheelchairs, manual wheelchairs, scooters, and walkers. Now the aging in the world is progressing .

For example, if older people find it increasingly difficult to walk or wheel themselves to the commode, they may do so less often or they may drink less fluid to reduce the frequency of urination. If they become unable to walk or wheel themselves to the commode and help is not routinely available in the home when needed, a move to a more enabling environment (e.g., assisted living) maybe necessary. To accommodate this population, several researchers have used technologies originally developed for mobile robots to create "smart wheelchairs." A smart wheelchair typically consists of either a standard power wheelchair to which a computer and a collection of sensors have been added or a mobile robot base to which a seat has been attached. New Smart wheelchairs have been designed that provide navigation assistance to the user in a number of different ways, such as assuring collision-free travel, aiding the performance of specific tasks (e.g., passing through doorways), and autonomously transporting the user between locations. A recent clinical survey [13] indicated that 9%–10% of patients who received smart wheelchair training found it extremely difficult or not viable to use it for their activities of daily living, and 40% of patients found the steering and maneuvering tasks difficult or impossible. The annual report of the Ministry of Public Health and Welfare states that 0.73 million people have a motor disability on the legs and arms [11]. For people with these disabilities, many different kinds of electrical and robotic wheelchairs have been designed. It will increase the number of the person who use a wheelchair and/or the person who are related to it. Several modes of control for powered wheelchairs exist, including joystick [9], chin, and sip-and-puff controllers. However, each of these systems has specific disadvantages and their "choice" is often the only option, given the extent of the user's limited abilities**.** There are many systems like video oculography systems, infrared oculography, eyeball sensing using electro oculography are available and much more. There are even systems based on voice recognition too [2]. The basic assisting using voice control is to detect basic commands using joystick [7-8] or tactile screen. These applications are quite admired among people with limited upper body motility. There are certain hitches in these systems. They cannot be used by people of higher disability because they require fine and accurate control which is most of the time not possible. To improve quality of life for the elderly and

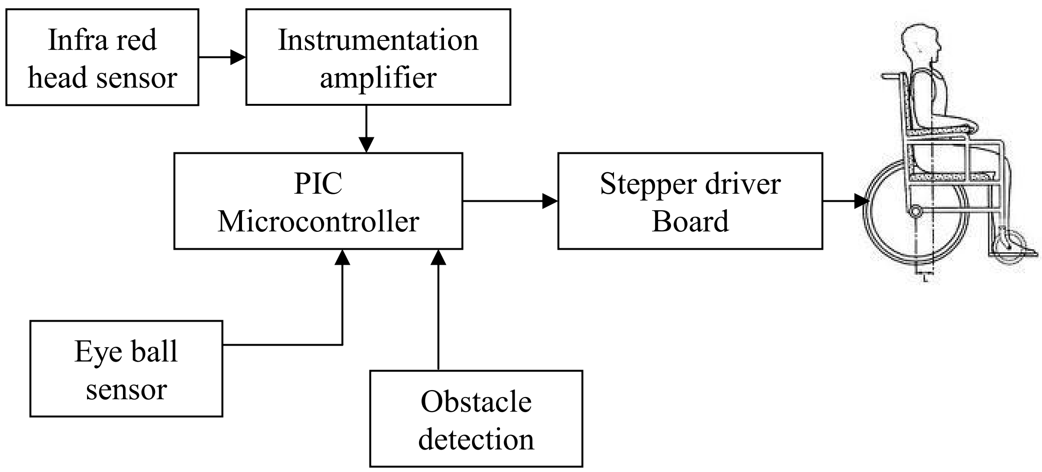

Fig.1 Overall Block diagram of the Proposed Smart wheel chair System

disabled people, electric-powered wheelchairs (EPWs) have been rapidly developed over the last 20 years. Most of current EPWs are controlled by users' hands via joysticks, and are very difficult for elderly and disabled users who have restricted limb movements. The main performance of a Smart wheel chair includes the autonomous navigation capability for good safety, flexibility, mobility, obstacle avoidance and the intelligent interface between the users and the smart system, including hand-based control (joystick, keyboard, mouse, touch screen), voice-based control (audio), vision- based control (cameras, etc.). Thus, we concentrate on the human- interface issue in our research and implement conventional autonomous capabilities with necessary modifications to realize an actual working system. Our proposed work eliminated the physical constraints caused by other conventional wheel chairs by detecting the basic left-right – front-back movements using head gesture recognition and for diagonal movements using eye ball sensing.

The whole paper is divided into the following sections. Section 2 depicts the principle behind the head gesture recognition, Section 3 about eye ball sensing, Section 4 describes the programming unit and Section 5 violates the obstacle sensing mechanism. The eye ball sensing mechanism was tested using LabVIEW.

II. HEAD GESTURE RECOGNITION

The first stage entails the position determination of the head using Infrared sensors placed behind the head of the user. This way the user's field of view is not limited by the position sensing equipment. Further more the sensors are positioned in a way that does not pull out the physical dimensions of the wheelchair. In order to be in charge of the wheelchair the head positions have to be converted into movement orders for the wheel motors. For this purpose the area of possible head positions has been divided into five sectors as shown in Figure 2, and the actual head position detected is classified into one of these sectors. The control scheme for the wheelchair is basically that the way the head is moved that way should the wheelchair move, i.e. bending the head forward increases the speed, and sloping the head to the left make the wheelchair turn left. A state machine is used to change the linear speed (forward/backward speed) of the wheelchair, based on the sector in which the head currently is.

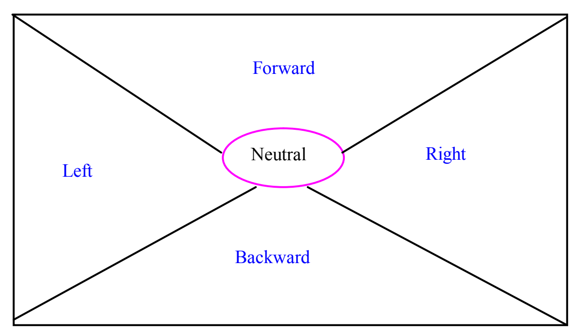

Fig.2 Head Position determination

III. EYE BALL SENSING

Earlier methods of eye ball tracking include a USB web camera which is mounted on a cap worn by the user [1] .This camera is adjusted so that it lies in front of one of the eye of user. The camera has inbuilt light source, so that it can capture bright images if darkness appears under the cap. The drivers of the camera are installed in a PC to which the camera is plugged in. The software module for image processing works on three different modules: video capturing, frame extraction and pixel color detection. When the user is looking straight in font, the pixels on both the vertical lines are black. This is interpreted as the "center" direction of the user's eye. When user looks towards left, the pixels on the left vertical line are black, but the pixels on the right vertical line are white. The closed eye condition is also recognized by the software. This condition is then used to determine the blinking of the eye. The natural blinks of eye are distinguished from the unnatural blinks. The user has to blink his eye for a second if he wants to start moving or stop moving the wheelchair. But a wheel chair with a camera, PC and image algorithms makes the system tedious.

The basic principle of our proposed method of eye ball sensing involves the direction sensing in the colour of the eyes. There are two main colour pigments in the human eyes. i.e., black and white. The colours show different wavelengths in the spectrum. White being the farthest colour in emits the lowest wavelength. So the wavelength of white light is chosen as the standard parameter. The infrared light ray measures and reflects the wavelength emitted by the white portion and based on that the eyeball sensor is constructed.

The Eye ball sensors are placed on either side of the eyes fixed in goggles. The whole circuitry is fitted inside a table-top instrument which is connected to the spectacles through a long flexible cable which performs the analysis, processing and amplification of the signals derived from the sensor's eye-ball movements. Both eyes are lit up by the energy from the Infrared Light-Emitting Diode (IRLED) sections. The silicon phototransistors and the IR sources are mounted in front of the eyes so that the obstruction of the field of view is minimized and the capability to accurately monitor the position of the eye is maintained. The eyeball sensor is fitted on to the patient and the wavelength of white portion is recorded. Then when the patient wants to move right side, his left eye shows no variation in wavelength but in the left eye the black portion is sensed by the sensor which leads to decrease in the wavelength which automatically indicates to the wheel chair the direction it has to in. the same mechanism happens in the right eye too.

IV. PIC16F877 MICRO CONTROLLER

The PIC16F877 Microcontroller shown in Fig3 includes 8kb of internal flash Program Memory, together with a large RAM area and an internal EEPROM. An 8-channel 10-bit A/D converter is also included within the microcontroller, making it ideal for real-time systems and monitoring applications. All port connectors are brought out to standard headers for easy connect and disconnect. In-Circuit program download is also provided, enabling the board to be easily updated with new code and modified as required, without the need to remove the microcontroller.

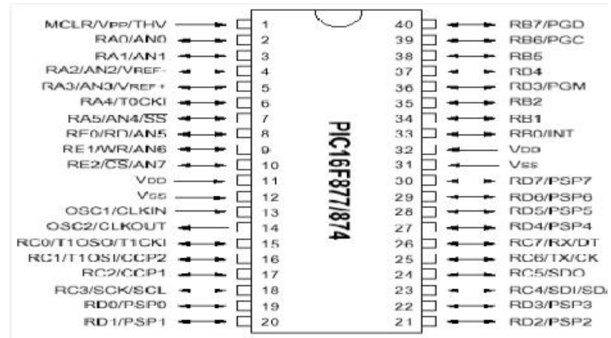

Fig.3: Pin details of PIC16F877

V. OBSTACLE DETECTION AND STEPPER DRIVER CIRCUIT

Ultrasonic sensor is another way to make non-contact distance measurements. It works by the principle of measuring the time a sound wave takes to disseminate from the sensor, to an object and back to the sensor. They are generated by a transmitter and reflected by the target. The returning waves are detected by a receiver. The time hindrance is used to measure the distance to the object. This sensor senses the obstacle in the way and stops 30 cm before it. So the wheel chair is fool proof against obstacles on the way of the wheel chair. This enables the disabled person to move freely around in the environment without any dangers.

An Opto coupler is needed to isolate the Interface Board form the Stepper Motor to restrict any high voltage to the Interface board. And this board also contains stepper Driver circuit to amplify the Voltage and to withstand high current because the pulse coming out from the Interface is not tough enough to drive the Motor. **Software Driver in Hitech C** is used to control the angular position i.e., to send specified pulses with controlled timing to vary the speed as when and where required.

VI. RESULTS AND DISCUSSION

LabVIEW (short for Laboratory Virtual Instrumentation Engineering Workbench) is a platform and development environment for a visual programming language from National Instruments. Eye tracking can be tested in many ways. Simulation of eye tracking for smart wheel chair system is done in LabVIEW tool to check the feasibility of the project. LABVIEW is a widely used graphical programming environment which allows designing systems in an intuitive block-based manner in shorter times as compared to the commonly used text-based programming languages.

LabVIEW is commonly used for data acquisition, instrument control, and industrial automation.The amplitude of the signal obtained from the eye ball sensor is very less. An bio amplifier is used to achieve the required gain. The moment of eye found can be clearly understood by looking at the output difference between the figures 4and 5**.** Figure **4** shows the signal when there is no movement as the signal is plain. The figure **5** shows the output of EOG when moment of eyes is present which can be observed by looking at the peaks

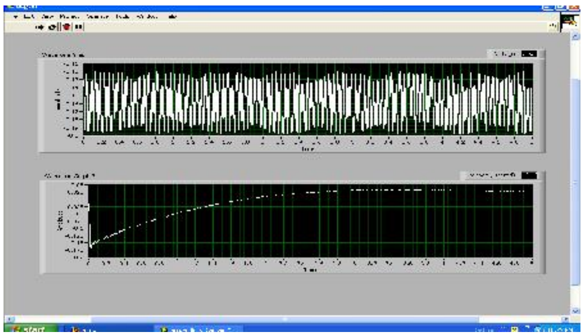

Fig.4 . Results without movement of eye

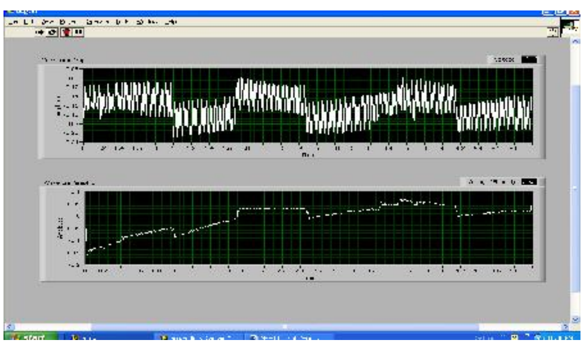

Fig.5. Results with the movement of eye

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