The intelligent electronic system especially for quadriplegics wheelchair and blinds bicycle (New method in Paralympics)

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Abstract – **Quadriplegics and Blinds like other people are interested in life. We have designed an electrical system in order to make blinds able to ride bicycle alone without any others help that was not possible before! . This system can be applied as a smart power assistance module for manual wheelchairs or quadriplegics wheelchair. Also with this system, we can make a new method in Paralympics, and design a new cycling sport for blinds. We design an auditory guidance system for the blind using ultrasonic to audio signal transformation. The system derives visual information using infrared and ultrasonic sensors, and transforms it to binaural auditory information.**

The user can recognize the position of obstacles and the surrounding environment. It is grate! Today a blind who was not able to run a bicycle alone, can be winner in Paralympics

INTRODUCTION

Designing a bicycle for blinds or an obstacle avoidance system for Manual Wheelchairs in order to make a new method of sport is the main point in this project. Using microprocessor and ultrasonic devices, a new model for a mobility aid has been developed to enable visually impaired people to perceive their surroundings. In this kind of bicycle, a down swept frequency modulated ultrasound is emitted from a transmitter with broad directional characteristics in order to detect obstacles; Ultrasonic reflections from obstacles are picked up by a two - channel receiver. The frequency of the emitted ultrasound is swept from 70 to 40 kHz within 1ms, giving it almost the same characteristics as the ultrasound which an FM-bat produces for echo-location.

The frequency of the reflected ultrasound wave is reduced by about 50:1 by using a micro-processor with A/D and D/A converters. These audible waves are then presented binaurally through earphones. In this way, obstacles may be perceived as localized sound images corresponding to the direction and the distance of the obstacles, with this device, a visually impaired person could detect a 50 mm diameter wire at a distance of about 10 meter. This system complete with a line-tracking module which use IR and optical sensors. Also a main processor unit joins these units and sends auditory signals by RF transmitter to the cyclist.

METHODS

1- Sense of balance, Gravity and Angular Acceleration in human

The receptors for gravity in vertebrates Consist of two chambers of the membranous labyrinth called the utricle and saccule (fig. 1). Within these structures are hair cells. The hair like processes is embedded within a gelatinous membrane containing calcium carbonate crystals; this is known as an eolith *membrane,* because of its location in the inner ear (*oto* is derived from the Greek word for ear). Because the eolith organ is oriented differently in the utricle and saccule, the utricle is more sensitive to horizontal acceleration (as in a moving car).

When the head rotates, the fluid inside the semicircular canals pushes against the cupula and causes the cilia to bend. This bending either depolarizes or hyperpolarizes the hair cells, depending on the direction in which the cilia are bent. This is similar to the way the lateral line system hair cells in the vestibular pparatus of terrestrial vertebrates provide a sense of acceleration.

Because terrestrial vertebrates have two ears located on opposite sides of the head, the information provided by hearing can be used by the CNS to determine *direction* of a sound source with some precision. Sound sources vary in strength,

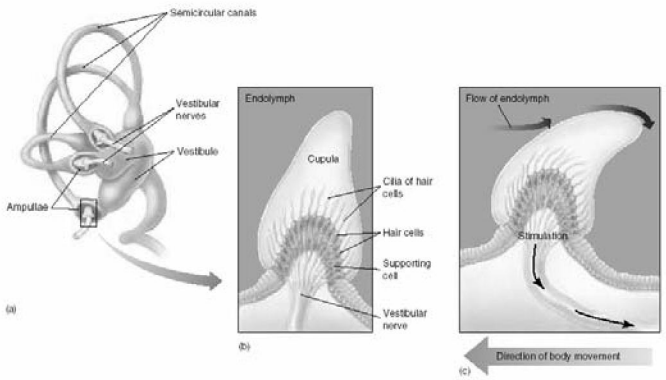

Fig. 1. The structure of the semicircular canals. (*a*) The position of the semicircular canals in relation to the rest of the inner ear. (*b*) Enlargement of a section of one ampulla's, showing how hair cell cilia insert into the cupula. (*c*) Angular acceleration in the plane of the semicircular canal causes bending of the cupula, thereby stimulating the hair cells.

however, and sounds are attenuated (weakened) to varying degrees by the presence of objects in the environment.

For these reasons, auditory sensors do not provide a reliable measure of *distance.*

Some mammals emit sounds and then determine the time it takes for the sound to return, using the method of sonar to locate themselves and other objects in a totally dark environment by the characteristics of the echo. Bats are the most adept at this echolocation (fig. 2).

2- Design an electrical system based on natural creatures and phenomenon

Based on this grate phenomenon and other technologies in electronics and robotics we have designed a new bicycle for blinds which is equipped with new obstacle avoidance system (shown in Fig. 3).

Fig. 2. Sonar. As it flies, a bat emits high-frequency "chirps" and listens for the return of the chirps after they are reflected by objects such as moths. By timing how long it takes for a chirp to return, the bat can locate its prey and catch it even in total darkness.

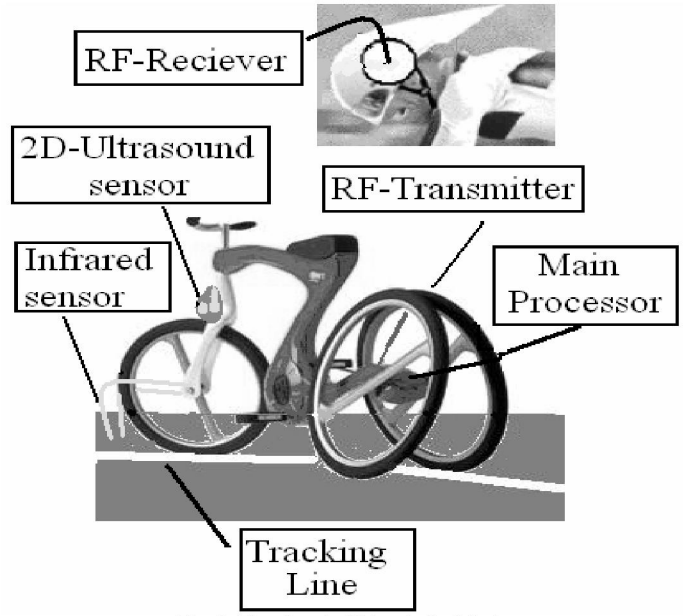

Fig. 3. The electrical bicycle for blinds

Also this system can be applied to manual wheelchair that provides independent mobility to Non-ambulatory individuals with visual impairments. (Shown in Fig. 4)

The concept of *power assistance* for a manual wheelchair is relatively new, and represents a viable alternative for individuals who are unable to generate sufficient propulsion force to use a manual wheelchair, but do not wish to use a traditional powered mobility device. In a power assisted manual wheelchair, the traditional rear wheel hubs are replaced with motorized hubs that serve to magnify or reduce (i.e., brake) the propulsive force applied to the rear wheel push rims by the user. We are using power assistance as the basis for a Smart Power Assistance Module for manual wheelchairs that provides independent mobility to non-ambulatory individuals with visual impairments. This system (shown in Fig. 4) uses sensors to detect obstacles near the wheelchair, and uses motorized hubs to modify the forces applied to each wheel to avoid obstacles.

The user population for this system consists of individuals with both a visual impairment *and* a mobility impairment that makes it difficult or impossible to ambulate independently using a white cane, guide dog, or other traditional mobility aid for the visually impaired. A large number of potential users are expected to be elderly, since visual and physical impairments often accompany the natural aging process.

People age 85 and older are the fastest growing segment of the world population. Leading medical causes of late-life disability include diabetes and stroke, both of which can produce a combination of visual and physical impairments.

This obstacle detector is designed to help blind or visually impaired person to safely navigate and quickly avoid obstacles and other hazards during riding bicycle. This device will have high quality and low production costs. It is designed to detect objects within a 17-foot range with Polaroid ultrasonic transducers.

A brief description of the design is that an ultrasonic transducer first emits a pulse and then receives an echo to detect obstacles in the user's path. Logic system will determine whether the time lapse between the transmission of the ultrasonic pulse and the first received echo indicates the presence of an object within some preset distance. This will trigger one of the three modes of output to indicate the specified distance. With decreasing frequency for closer distance, three different sounds will correspond to the object's

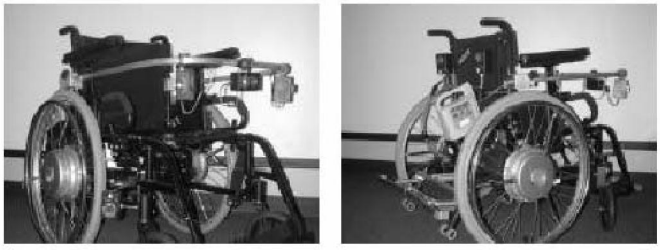

Fig. 4. The obstacle avoidance system for Manual Wheelchairs

distance from the user within 9 feet, 13 feet and 17 feet respectively.

Fig.5, .6 below show the block diagrams of the obstacle detector, which consists of an ultrasonic unit, an integrated logic system and an audible output circuit shown in Fig.7.

In this project we exchange CPU in robots with CNS (center nerve system) in human. Here human brain must receive auditory signals, process, decide and control limbs in order to maintain balance and equilibrium, so a successful cycling.

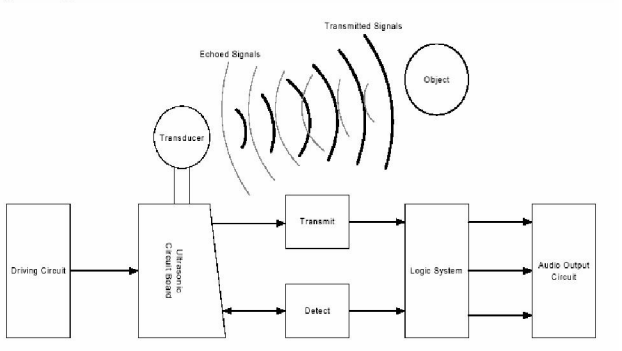

Fig. 5. Obstacle Detector Block Diagram

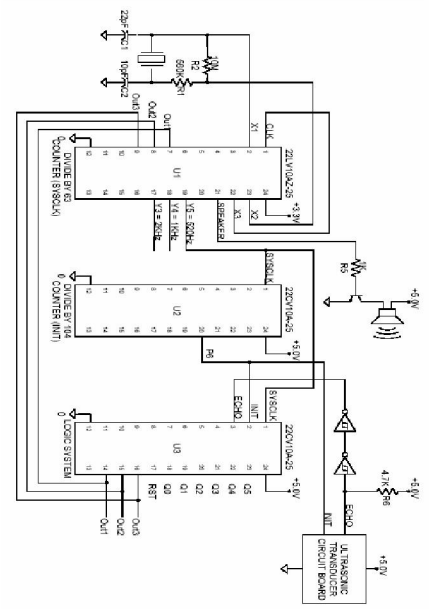

Fig. 6. Schematic Circuit of the Obstacle Detector system

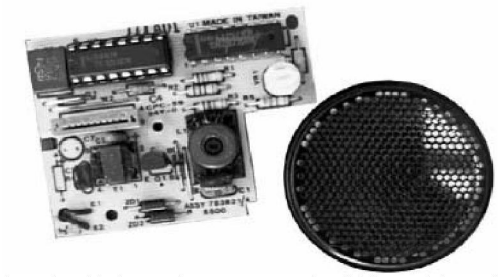

Fig. 7. The Polaroid ultrasonic range sensor is widely used for mobile robot obstacle avoidance.

Another system which is used to make guidance for blind cyclist is line-tracking module that its block diagram is shown in fig.8.this line-tracking module is very common in line tracking robots. But here is a main difference, here again CPU is exchanged by human CNS.

Using an infrared (IR) light emitting diode (LED) a phototransistor and optical sensors to measure how much light is reflected from the surface, to detect the presence of a line. This unit help Blind cyclist to track lined course or road, shown in Fig.9.

There is an important point. Blind cyclist must ride in cycling area which are lined and protected under the law special to this kind of bicycles.

RESULTS

The block diagram of the completed system is shown in fig.10.In this system per unit processes its own signals and makes an auditory signal depended on tracking line and obstacles.

Auditory signals are transmitted by RF transmitter and receiver units. Receiver unit is fixed into a head phone that is used by cyclist this auditory signals are the main information used by cyclist to maintain balance and tracking the course.

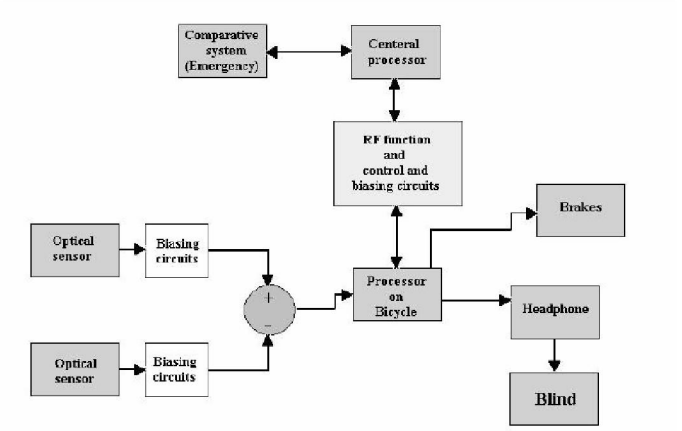

Fig. 8. Block diagram of optical sensors

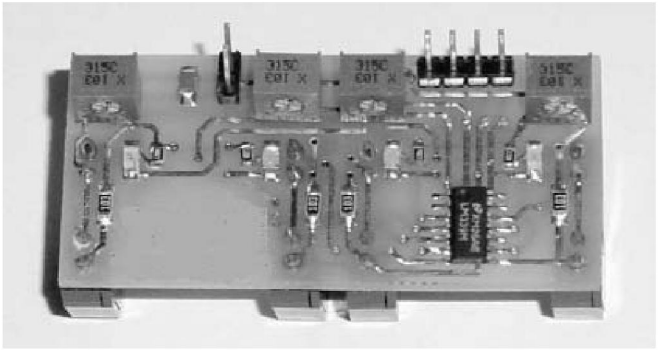

Fig. 9. A line-tracking module (IR sensors).

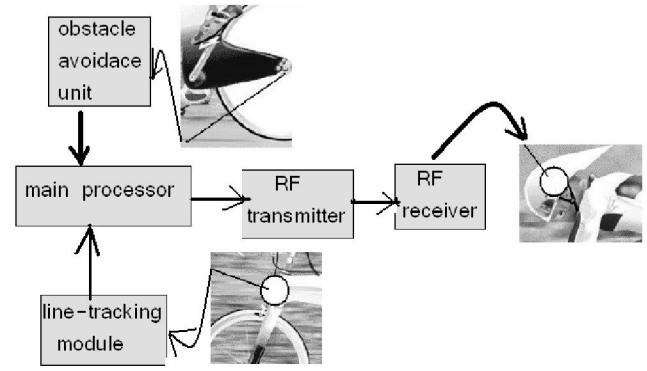

Fig.10. Completed block diagram of the electrical bicycle for blinds

Experimental results

This system tested with 5 quadriplegics and 32 blinds in the laboratory and real condition in the Islamic azad university science & research branch and the results are shown in Table1.

DISCUSSION

Here is a limit in high speed cycling and racing. The bicycle must be equipped with protective tools such flat wheels or axillary's wheel and other tools that support cyclist balance. In some condition and courses using three wheel bicycles is so useful to increase cyclist balance we call it triad cycle. There is no problem about wheelchairs because of its own low speed.

CONCLUSION

Currently, the majority of non-ambulatory visually-impaired individuals are seated in a manual wheelchair and pushed by another person. Depending on the extent of useful vision remaining, individuals with low-vision can operate an unmodified manual wheelchair, powered wheelchair or scooter, but the risk of an accident obviously increases with increased visual impairment. There are reports of individuals using a white cane or guide dog along with a wheelchair, but this is not common practice.

Quadriplegia disabilities and Blindness are kinds of disability that makes lots of problems in life .this new system can brings Independence for peoples with this kind of disabilities and can solve some of their life problems in order to improve life way.

Today, Paralympics sports, have an important place in the entire world. One of the branches of these sports is the sport for quadriplegics and too blinds. Now this method can be a new branch of sport in Paralympics son!

TABLE 1
SOME PARAMETER IN EXPERIMENTAL CONDITION

Kind of disability / parameter	Accuracy %	Trust %	Safety sense %	Enjoy sense %
Blinds bicycle	71.2	82.2	85.3	72.3
Quadriplegics wheelchair	85.6	99.5	98.9	99.1

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