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Tongue Controlled Wheel Chair Movement In Tetraplegic Patients- An Innovative Prototype Model

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ABSTRACT:
Traumatic injuries, tumors, infections, or congenital malformations that cause spinal cord damage can render patients tetraplegic. Progressive diseases, such as multiple sclerosis and muscular dystrophy, and non-progressive disorders, such as cerebral palsy, can also cause many individuals to function as tetraplegics. As there is an increasing incidence of tetraplegia it has led to a greater concern to all workers in the health and rehabilitative sciences. This has led to the development of an innovative assistive appliance to help the tetraplegic individuals control their environment by enabling them to use the tongue muscle to operate the appliance. This article presents an innovative prototype model of a tongue controlled wheel chair movement in tetraplegic patients to cause a psychological benefit and improve their quality of life.

KEY WORDS: Tetraplegia, Assistive appliance, Headband, Feather-touch switches

I. INTRODUCTION:

Individuals who have sustained a major injury to the spinal cord in the cervical area may become tetraplegic[1]. Tetraplegia (Quadriplegia) is a complete or essentially complete motor paralysis for all extremities. The degree of paralysis depends on the extent of involvement and the level of the spinal cord injury[2]. In 1967 symposium on "The Cost of Life", Walsh suggested that the most common causes of this disability are automobile and diving accidents[3]. In addition, health professionals provide rehabilitative services for many patients who have varying degrees of function loss resulting from debilitating diseases such as poliomyelitis, spinal cord tumors, congenital anomalies, or cerebral palsy[2].This indicates a rehabilitation procedure whereby compensatory functions by the head and neck are made possible by the use of auxiliary prostheses[1]. A paralyzed person needs to depend on another person for carrying out their daily life task which makes their life miserable[4]. Therefore, it is of primary importance to rehabilitate them, at least to the extent of reducing their dependence on other people[5]. This can be easily accomplished by the use of assistive appliances. Assistive Technology provides disabled people with independence by enabling them to perform their daily life tasks by themselves[4]. Conventionally, various designs of mouthstick appliances were available to encourage a tetraplegic patient engage in some activity. With advancing technology, new innovative appliances are available that helps the tetraplegic patient in various activities such as mobility, hearing, vision, self-care, safety etc. This avoids the need for the support of an external person, such as a carer, and can lead a life more similar to physically able people[4].Assistive technologies help improving the quality of life for the tetraplegic patients by enabling them to pursue self-care, educational, vocational, and recreational activities. Tongue has a set of unique characteristics that makes it a suitable appendage for manipulating the environments of the tetraplegics through the use of tongue-operated assistive device[6].

This paper presents an innovative, non-invasive, cost effective prototype device that works on a motorized mechanism fortongue controlled wheel chair movement in tetraplegic patients and allows the tetraplegic patients a freedom of movement, thereby, reducing their dependency level on the caretaker, improving their quality of life and uplifting their psychosocial behaviour.

TECHNIQUE OF FABRICATION:

a. Fabrication of motorized prototype wheelchair
b. Fabrication of head band
c. Mechanism of action

a. Fabrication of Motorized Prototype Wheelchair: The prototype wheelchair is fabricated with two identical 12V, 100rpm, geared DC (direct current) motorized wheels connected at the back side and a castor wheel (has 360° rotation) at the front. The movements of the prototype wheelchair are controlled by the two wheels at the back side, not the front castor wheel. The motors are programmed to rotate in clockwise or anti-clockwise direction

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and in synchrony depending on the signal received. This rotation of motors causes movement of the prototype wheelchair, for e.g., when the right motor turns in a clockwise direction and the left motor turns in an anti-clockwise direction, the prototype wheelchair turns towards the right side and vice-versa for the left turn of the prototype wheelchair. The motor rotation is controlled through power supply by a battery. Motor speed i.e., speed of the prototype wheelchair is constant in this design. (Figure 1)

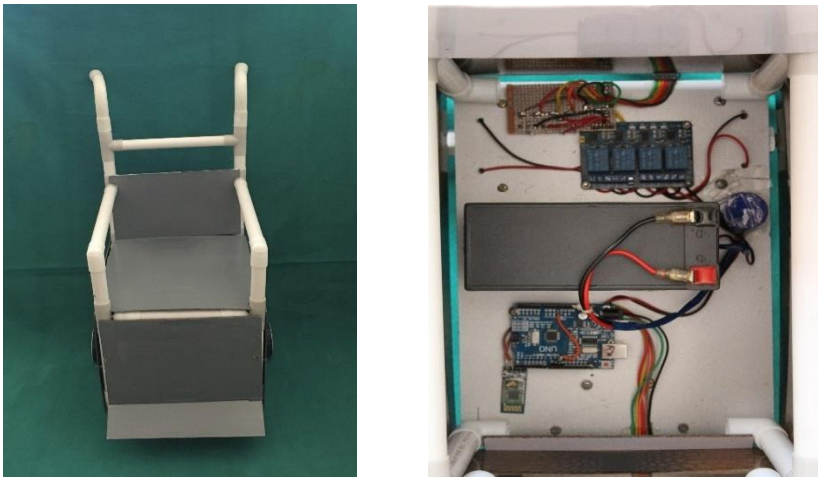

Figure 1: Prototype Motorized Wheelchair

b. Fabrication of Head Band: A head band made of a biocompatible plastic, in front of the ears at the side of the cheeks is custom fabricated according to the width of the patient's face. There are four feather touch (on-off) switches placed on the inner-side of a head band against the cheek, two on right side and two on left side. All these four switches are connected to a switching four channel relay circuit unit. By the selective switching of the relay through the diode circuit unit, the movement of motors and therefore of the prototype wheelchair is controlled. (Figure 2)

Figure 2: Head Band

The switches are positioned on the inner side of the head band in a manner to correspond with the region of buccal vestibules of the oral cavity i.e.

i. Right upper switch – at the region of maxillary right buccal vestibule.
ii. Right lower switch – at the region of mandibular right buccal vestibule.
iii. Left upper switch – at the region of maxillary left buccal vestibule.
iv. Left lower switch – at the region of mandibular left buccal vestibule.

c. Mechanism of Action: Here, the switches are burnt for the following movement of the prototype wheel chair:

i. Right upper switch when activated by taking the tongue intra orally to the maxillary right buccal vestibule, the prototype wheelchair moves in a forward direction.
ii. Right lower switch when activated by taking the tongue to the mandibular right buccal vestibule, the prototype wheelchair moves in the right direction.
iii. When the left upper switch is activated by taking the tongue to the maxillary left buccal vestibule, the prototype wheelchair moves in a backward/reverse direction.
iv. When the left lower switch is activated by moving the tongue to the mandibular left buccal vestibule, the prototype wheelchair moves in a left direction.

With this non-invasive innovative appliance, tetraplegic patients will have freedom of movement with less dependency.

II. DISCUSSION:

Assistive technologies are critical to lead a self-supportive independent life for people with severe disabilities[7]. Jamie Bell[8], had suggested five most innovative appliances for patients with tetraplegia. It included a tongue- controlled wheelchair, where-in, tongue was pierced with a magnetic stud that gave the patients more independence, as they were able to execute commands quicker and more easily.

Jeonghee Kim et al.[9]had suggested a tongue-drive system that enables people with severe disabilities to control their computers, wheelchairs, and smartphones using voluntary tongue motion. For this, a small magnetic tracer on the tongue either glued to the tongue for short-term temporary use (a few hours) or embedded in a titanium tongue stud for attachment to the tongue via a piercing for medium- to long term use was done.

Venkata Ramudu P and Prasanna Murali Krishna P[7]suggested a tongue operated magnetic sensor based wireless assistive technology for people with severe disabilities to lead a self-supportive independent life enabling them to control their environment using their tongue. Tongue drive system consist of a small permanent magnet secured on the tongue by implantation, piercing or tissue adhesive is used as a tracer, the movement of which is detected by an array of magnetic field sensors mounted on a headset outside the mouth or on orthodontic brace inside.

Mallika et al.[10]suggested a tongue controlled wheel chair and device switching wirelessly using RF technology. This device is portable and this system operation is entirely driven by wireless technology. The user can control the wheelchair directions with the simple tongue movement and he can also request the basic needs like water, food or medicine using voice module.

Above mentioned techniques were invasive as they involved piercing of the tongue for placement of an activating component of the appliances. Whereas the innovative technique of tongue controlled wheelchair movement presented in this paper is non-invasive involving activation of feather touch switches placed extraorally near the four buccal vestibules by near tongue movement to the respective buccal vestibules intraorally.

As mentioned, the earlier assistive technologies for controlling wheelchair movements in tetraplegic patients are either invasive or of high precision to be learnt by patients or expensive or technically difficult to fabricate. Henceforth, this paper presented an innovative prototype model of wheelchair movement control to overcome these disadvantages as this technique is non- invasive, cost effective and can be easily learnt and controlled by the tetraplegic patient.

III. CONCLUSION:

A tongue controlled assistive technology has been developed for people with severe disabilities to lead a self-supportive independent life by enabling them freedom of movement. This innovative technology is non-invasive, cost effective, self-sufficient and easily learnt by patient for controlling wheelchair movements.

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