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TONGUE CONTROLLED WHEEL CHAIR USING FSR SENSORS

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ABSTRACT

The Tongue Drive System (TDS) is a tongue-operated unobtrusive assistive technology, which can potentially provide people with severe disabilities with effective access and environment control. It translates user's intentions in to control commands by detecting and classifying their voluntary tongue motion by utilizing four FSR (Force Sensitive Resistor) which senses pressure of the tongue and is mounted on a headset outside the mouth in the vicinity of the tongue. A FSR sensor is a transducer that varies its output voltage in response to changes in applied pressure. In its simplest form, the sensor operates as an analog transducer, directly returning a voltage. With a known pressure of the tongue, its magnitude can be determined.

Keywords: FSR Sensors, Amyotrophic Lateral Sclerosis(ALS), Power Wheel Chairs, Arduino.

I. INTRODUCTION

The Tongue Drive Assistive technology for paralyzed persons using Atmega328P a microcontroller is anexclusive project that can move the wheel chair according to the instructions given by the above saidmicrocontroller.An embedded system is a combination of software and hardware to perform a dedicated task. Some of themain devices used in embedded products are microprocessors and microcontrollers[1].Microprocessors are commonly referred to as general purpose processors as they simply accept the inputs,process it and give the output. In contrast, a microcontroller not only accepts the data as inputs but also manipulates it, interfaces the data with various devices, controls the data and thus finally gives the result. The project consists ofthe FSR sensors, Atmega328P microcontroller, Dual H-Bridge driver (RKI-1004).

II. DESIGN AND METHODOLOGY

A tongue operated force resistive resistor based wireless AT has been developed for people with severe disabilities to lead a self-supportive independent life by enabling them to control their environment using their tongue.The analog outputs from the tongue are digitized, modulated and wirelessly communicated to the targeted devices in the user's environment. This technology works by tracking the pressure on FSR caused on the tongue. The signals received by the external controller unit are demodulated and de-multiplexed to extract the individual sensor outputs. By processing these outputs, the motion of the tongue within the oral cavity is determined[2]. Assigning a certain control function to each particular tongue movement is done in software. These control functions may then be used to operate a powered wheelchair.

Figure 1.1: Transmitter

Fig 1.2: Receiver

There are four FSR Sensors which are interfaced to the microcontroller as shown in the figure 1.1. FSR Sensors are transducers whose output voltage varies in response to the force on the sensor. We are using four FSR Sensors to control the direction of the powered wheelchair. When a force is applied on the particular Sensor, the sensor gets activated. When the force is removed, the FSR Sensor gets deactivated. Based on which FSR Sensor is activated, the microcontroller takes a particular decision regarding which direction the wheelchair should move. The RF transmitter sends that particular decision to the receiver circuitry.

The decision transmitted by the transmitter circuitry is received by the RF receiver which is interfaced to the microcontroller as shown in the figure1.2. The motors are connected to the microcontroller using anrelay motor driver. The motor driver is used to control the directions of both the motors used. Based on the decision transmitted, the wheelchair is moved in a specific direction by controlling the motor's direction. To prevent the wheelchair from ramming into obstacles such as walls, we have connected a

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proximity sensor to the microcontroller to detect the obstacles. Based on the proximity sensor output, the microcontroller takes decision whether or not to emergency stop the wheelchair.

a) Design of Wheel Chair

The design of wheelchair changing task wherein we have to consider all possible constraints of mechanics such as total weight on the wheelchair, torque required to rotate the wheels, thrust required to overcome the inertia.Figure 2.3 shows the dimensions of the wheels that which are necessary for design calculation.

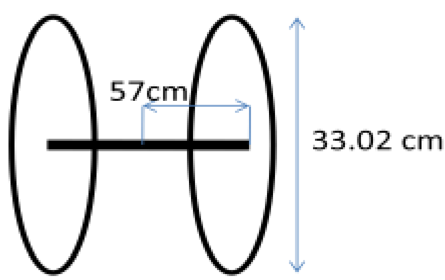

Figure 1.3 : Design of Wheel

Diameter of the wheel = 13 inches = 33.02 cm,

Distance between two wheels is 57 cm,

Total average weight = 100kg,

Weight on each wheel N = $\frac{100\ kg}{4}$ = 25kg,

Since we are powering only the two wheels,

Let us consider a weight of 50kg on each wheel,

Torque required is

$$T = W * d \qquad (2.1)$$

Where,

W= weight in kg,

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d = distance from center of the shaft connecting the two back wheel to the one of the wheel.

$$T = 50*\frac{0.57}{2} \quad (2.2)$$

$$T = 14.25kgm \quad (2.3)$$

There the power required is,

$$P = \frac{2\pi NT}{60} \quad (2.4)$$

Where,

N = Rotation/min of wheel,

T = Torque,

P = Power,

$$P = \frac{2\pi*25*14.25}{60}$$

$$P = 37.5 \text{ watts}$$

To determine the current I, we know that,

$$P = V*I \quad (2.5)$$

Therefore, current I written as,

$$I = \frac{P}{V}$$

$$I = \frac{37.5}{24} = 1.54 \text{ A}$$

III. FSR (FORCE SENSITIVE RESISTOR)

A force-sensitive resistor (alternatively called a force-sensing resistor or simply an FSR) has a variable resistance as a function of applied pressure as shown in figure 3.5. In this sense, the term "force-

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sensitive" is misleading – a more appropriate one would be "pressure-sensitive", since the sensor's output is dependent on the area on the sensor's surface to which force is applied.

Figure 1.4: FSR

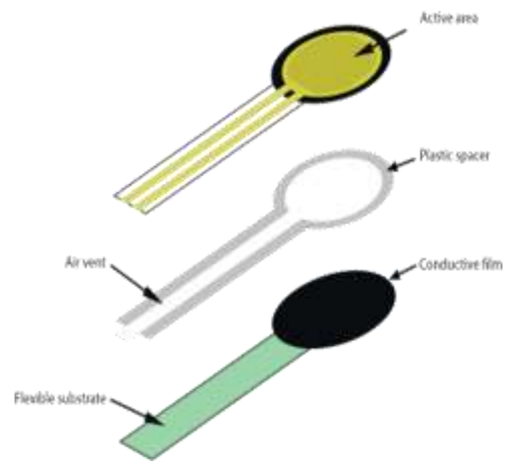

Figure 1.5: Layers in FSR

When external force is applied to the sensor, the resistive element is deformed against the substrate. Air from the spacer opening is pushed through the air vent in the tail, and the conductive material on the substrate comes into contact with parts of the active area as shown in figure 3.6.

- **Placing Of Force Sensitive Resistor**

The Tongue Drive System consists of Four FSR Sensors that can be placed outside the mouth. The FSR Sensors are interfaced to a microcontroller[4]. When the force applied by the tongue on a particular FSR Sensor, the microcontroller takes a decision to move the wheel chair in a particular direction which is sent wirelessly to another microcontroller to which motors are interfaced.

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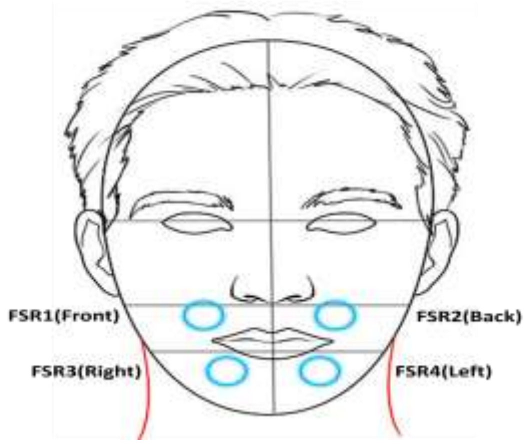

Figure 1.6 Sensor Placement

For example, when the magnet placed on tongue is moved towards sensor FSR1 as shown in the figure 1.6 , the wheelchair moves in the forward direction[6].

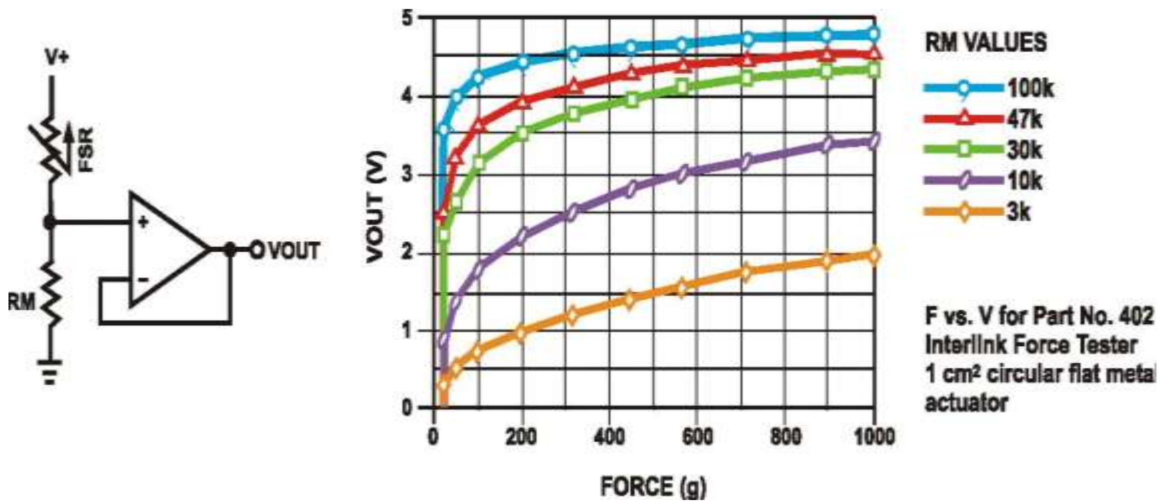

Figure 1.7: Force vs. V_{out} Characteristics with Different R_M

- **Operation FlowChart**

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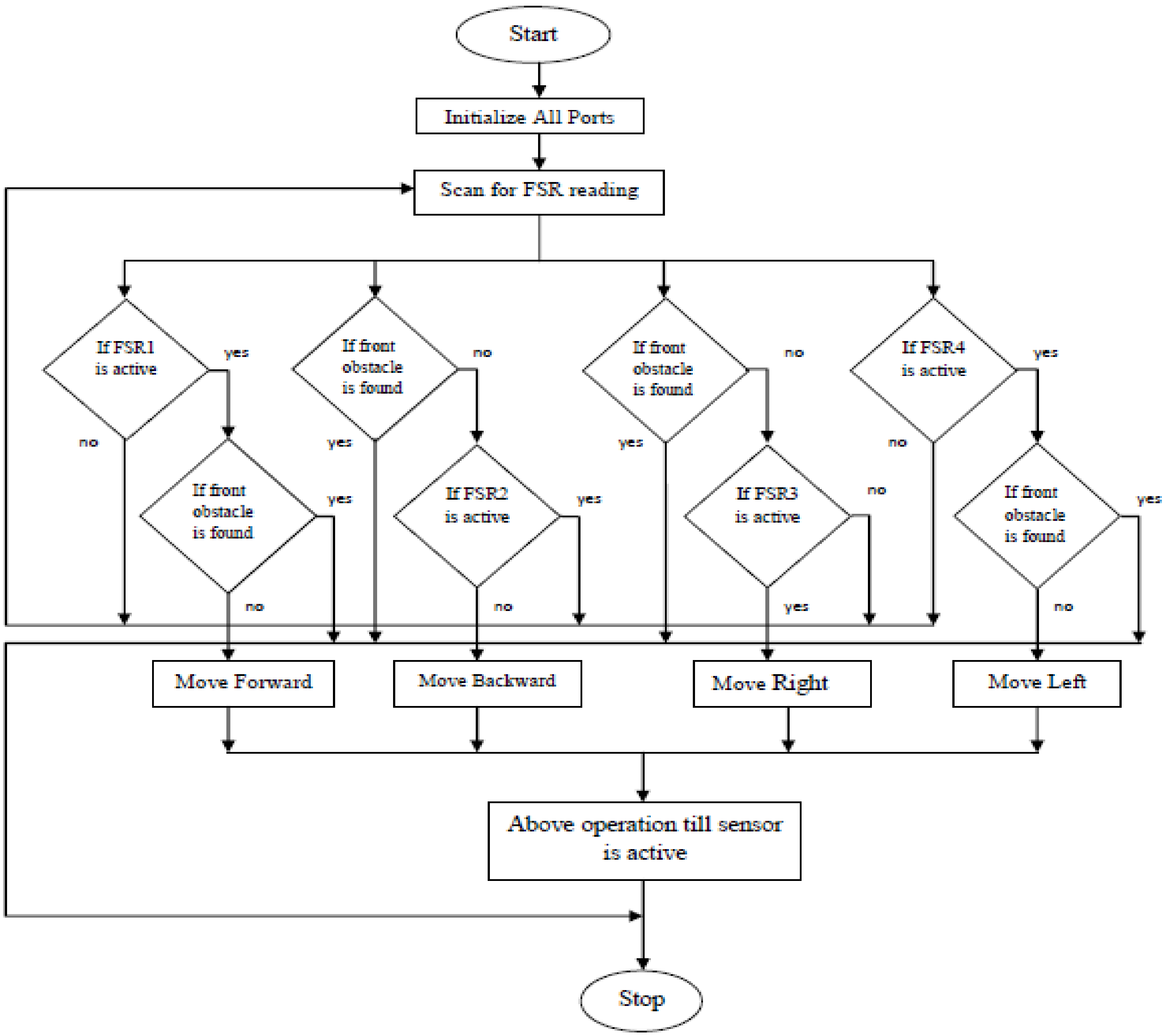

IV. EXPERIMENTAL RESULTS

Figure 1.8(a) : Transmitter (b) Wheel Chair (c) Receiver

V. CONCLUSION AND FURURE SCOPE

This work "Tongue Drive Assistive Technology for paralyzed persons" is mainly intended to design a wheelchair which can be controlled by movement of tongue, which is very useful for handicapped and paralyzed persons. This system consists of FSR sensors and a Wheelchair interfaced to microcontrollers. This device could revolutionize the field of assistive technologies by helping individuals with severe disabilities such as those with severe high level spinal cord injuries return to rich, active, independent and productive lives. Also this FSR sensor can be used to control different devices basing on the force applied on the tongue

There are plenty of scopes to upgrade this EWC prototypeby adding features like Voice & Gesture recognition which provides ease of operation in the system that will be more user friendly. Heart beat monitor which can detect the heart beat rate of the user as well as the sign of heart attack GPS tracker to find out users exact location; and many more optional features can be added according to user's need.

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