Electronic Braille Reader

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Abstract— Most of the assistive tools present in the market currently, designed for the people who have blindness are very costly, not easily repairable and even if available, are not easily accessible by them, the vast majority of which is economically weak. Apart from this, the number of books printed in braille is very limited. In general, new commercially available assistive technologies are far too expensive for them to afford. Our device uses the novel technology which employs electro-tactile stimulations to create perception of Braille characters. The proposed model is designed to target persons with blindness so that they can learn independently and to give them new perspective in literacy. The missing sense of sight in them leads them to perceive the world in a different manner. This served as an inspiration to us to use haptics as a tool to help them interact with the environment.

Key words: Braille Reader

I. INTRODUCTION

The concepts at work behind electro tactile stimulation for sensory substitution are complex, and the mechanics of implementation are no less so. The idea is to communicate non-tactile information via electrical stimulation of the sense of touch.

In practice, this typically means that an array of electrodes receiving input from a non-tactile information source (a camera, for instance) applies small, controlled, painless currents (some subjects report it feeling something like soda bubbles) to the skin at precise locations according to an encoded pattern.

The encoding of the electrical pattern essentially attempts to mimic the input that would normally be received by the non-functioning sense. So patterns of light picked up by a camera to form an image, replacing the perception of the eyes, are converted into electrical pulses that represent those patterns of light. When the encoded pulses are applied to the skin, the skin is actually receiving image data.

According to Dr. Kurt Kaczmarek, Brain Port technology co-inventor and Senior Scientist with the University of Wisconsin Department of Orthopedics and Rehabilitation Medicine, what happens next is that "the electric field thus generated in subcutaneous tissue directly excites the afferent nerve fibers responsible for normal, mechanical touch sensations."

Those nerve fibers forward their image-encoded touch signals to the tactile-sensory area of the cerebral cortex, the parietal lobe.

II. OBJECTIVE

According to a Times of India (TOI) study published in 2007, India has the largest population of persons having blindness in the world. In India, out of the two million such children, only three percent receive education.

Many tend to fall out of school due to various socio-economic factors. Our aim is to increase literacy among the younger generation as well as the old, so that they can contribute their intelligence to the society and have better chances of employment.

Remember it’s not we that are disabled its technology that is disabled we can cure disabilities by using technology, so the advances in technology can be used to cure disabilities. This device is also for other people having blindness wanting to read text from e-books and documents present in computers and low-cost smart phones.

III. PROJECT OVERVIEW

SKIN PHYSIOLOGY: The skin is the body’s largest organ. Its functions include:

1) Protecting the body against injury, heat and light radiation,
2) Helping the penetration of chemical agents,
3) Preventing the invasion of microbes and microorganisms,
4) Regulating the body temperature,
5) Eliminating harmful substances resulting from the metabolic activities, Secreting hormones and enzymes
6) Playing an immunological role, cooperating with Langerhans cells and
7) Acting as an external sensory organ having several kinds of sensors.

This last function of the skin is the one exploited in tactile interfaces. Unique from other senses the tactual sense is providing information to individuals and primarily to the visually and sensory impaired about such physical world qualities as temperature, perception of texture, position and motion.

In order to guide the design for better interfaces a thorough understanding of the several modalities of the skin’s sensors and nerves and their response to external stimuli is essential.

The surface of the skin is made of a conglomeration of dead cells. Underneath the surface, there are very thin and distinct layers, which are called: the Epidermis which has a thickness that varies from 0:4mm to 1:6mm, the Dermis which is 5 to 7 times thicker than the Epidermis, lying below the epidermis and is linked to it by the basement membrane and the Hypodermis the skin's third and the last layer, which binds the skin with the muscle tissues.

This layer is highly elastic and has fat cells acting as "shock absorbers", thereby supporting delicate structures such as blood vessels and nerves.

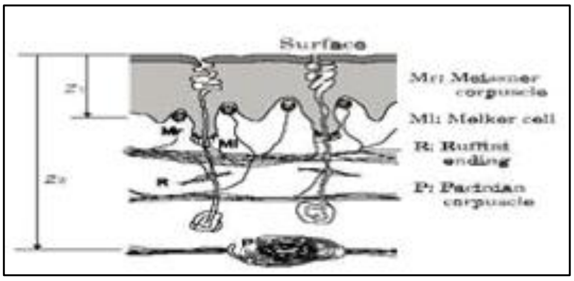

Fig. 1: Skin Anatomy

Receptor	Sense modality
Meissner Corpuscle	Stroking, fluttering
Merkel Disk Receptor	Pressure, texture
Pacinian Corpuscle	Vibration
Ruffini Ending	Skin stretch
Hair follicle	Stroking, fluttering
Hair	Light stroking
Field	Skin Stretch

Table – 1: Human Mechanoreceptors and Corresponding Sensory Modalities

IV. LITERATURE SURVEY

On 18 September 2014, we visited National Association for Blind (NAB) at Worli. We wanted to know about how tactile response of visually impaired people. We saw making of the Braille and how visually impaired people are trained. We also saw Electronic Braille Reader of freedom scientific company which cost over 1 lakh for 40 cells.

Fig. 2: Some Braille Books and Display

V. BLOCK DIAGRAM

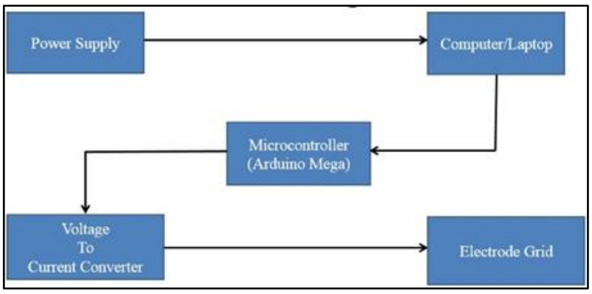

Fig. 3: Block Diagram of Electronic Braille Reader

The Electronic Braille Reader consists of following blocks, as shown in the block diagram.

1) Power supply & Computer
2) Microcontroller (Arduino)
3) Voltage to Current Converter
4) Electrode grid

In this section we will emphasize on detailed overview of each of the block shown in previous block diagram. In every description of the block respective schematics and working is explained.

A. Power supply & Computer

The uniqueness of this design is that it eliminates the need for physically moving pins (and designing ways to move them independently), by using electrical stimulation via electrodes to produce a similar perceptual effect and bringing down the cost of the device by fifty times. The only power requirement is to drive the Computer and Arduino and Voltage to Current Converter Circuit via the Computer or laptop which is being used to transmit the letters via the Arduino Software.

B. Microcontroller (Arduino)

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button.

It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip.

Instead it features Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter. We have used this board because it is simple, compact and have enough pins required for our project.

C. Voltage to Current Converter

The only power requirement is to drive the transformer circuit and the microcontroller, which is as low as nine volts. The current required for the pins are generated via this circuit which is connected to the Arduino board and the output generated can be felt by the visually disabled person on the finger. The feeling of the current is very low and can be compared to the tingling of soda bubbles.

D. Electrode grid

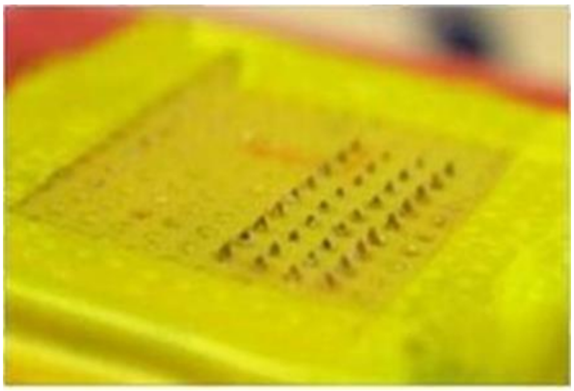

Fig. 4: Miniature Stimulators

The quality of the stimulation depends upon the type of electrodes used, the pulsed waveform used for stimulation and the relative placement of the electrodes.

We are using a grid of copper electrodes, with <1 mm tip diameter to produce localized stimulation. Also extensive testing was done to optimize the intensity of shocks.

VI. PROPOSED SOFTWARE ALGORITHM

The Arduino integrated development environment (IDE) is a cross-platform application written in Java, and derives from the IDE for the Processing programming language and the Wiring projects. It is designed to introduce programming to artists and other newcomers unfamiliar with software development. It includes a code editor with features such as syntax highlighting, brace matching, and automatic indentation, and is also capable of compiling and uploading programs to the board with a single click. A program or code written for Arduino is called a sketch.

VII. PROBABILITY

The device is divided into three layers, the lowest layer consisting of the motion sensor and the corresponding circuit, the next layer has a microcontroller and the topmost layer is the multiplexing circuit. The end product can be plugged into any computer or Smartphone and can be kept on any available surface thus making the entire device extremely compact, compatible, and lightweight, user friendly and safe.

In the manufacturing phase, the optical sensor circuitry, the microcontroller, the stimulation and multiplexing units will be printed on a single printed circuit board, thus further reducing the space and bulkiness of the device.

VIII. RESULT & CONCLUSION

The perception of sequence was felt through the electrodes. This gave the sense of directionality in spatial and temporal domain, hence enabling the person to perceive data.The design of the prototype is such that it is not only portable but also easy to use. Also, from the commercial point of view, the design is feasible as it uses inexpensive and easily available components that make the device low cost, hence giving it an edge over the other similar products in the market. The present prototype can further be molded to suit user's requirements. For example, a memory chip can be included in it to store any text file or any other data that the user wants to retrieve.

IX. FUTURE SCOPE

The scope of this project is very large and can be integrated into a variety of applications. Java software can be developed to read each character in the given text one by one and send it serially to the microcontroller which will be programmed to actuate the respective electrodes which form a sensible Braille character. The device can be integrated with a small camera underneath to capture text from any book, newspaper, article or any surface, and then do image processing and present it on the electro tactile display screen. Apart from that, the prototype can be used to know about various surface textures.

One of our long-term goals is also to have real-time power generation in the device by integrating small wheels beneath the device, which rotate inbuilt motors when the device is in motion, generating enough power to run the circuit hence making it independent of the battery source.

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