ISSN: 2277-3754
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 1, Issue 4, April 2012

Eyebrow Sensing Wireless Mind Mouse

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Abstract— These Wireless Mind Mouse is designed to facilitate the Amyotrophic Lateral Sclerosis (ALS) patient to communicate. This paper include a Wireless Mind Mouse and the software is loaded on net book/Tablet PC with which the patients can express their daily needs and call at the time of help.

Index Terms— **Surface EMG Electrodes, RF Transmitting and Receiving Antennas, ALS (Amyotrophic Lateral Sclerosis), Tablet PC.**

I. INTRODUCTION

The design of a wireless mind mouse is almost similar to that of a wired mind mouse, except that instead of using a wired connection between modified mouse and tablet PC, an RF transmitting and receiving antenna is used. This design is useful for ALS patients. Amyotrophic Lateral Sclerosis (ALS) [1]-[2] is a disease which can begin from a small part of body like- a small finger of hand and start spreading to other parts. The muscle movement of such patients deteriorates continuously affecting the entire body. Hence gradually the patient looses the ability to talk and move. The last preserved movement in these cases is eyebrow movement [3].The idea is to design an aid [4] that can assist such patients to communicate with the outer world to meet their daily needs. Wireless mind mouse is designed to facilitate the patient to communicate. Software is loaded on the net book with which the patients can express their needs and call at the time of help.

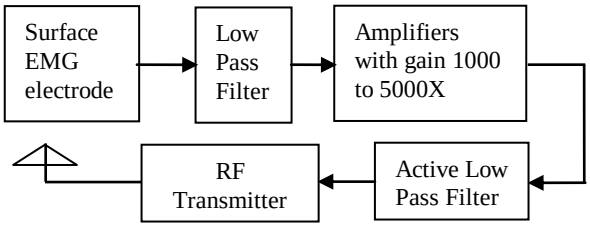

Fig.1 (a) - Transmitter part of wireless Mind Mouse.

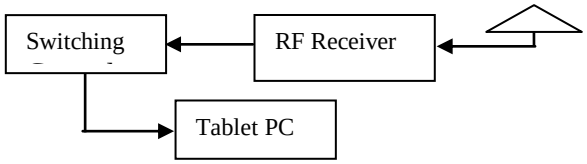

Fig.1 (b) - Receiver part of wireless Mind Mouse.

Firstly, the capturing of Electromyography (EMG) [5]-[6] signal from the eyebrow is done. This signal is processed and converted into the binary format that can resemble the clicking mechanism of normal mouse [7]. Many applications and the operating system of a tablet PC can be programmed to respond in different ways to different gestures created by the EMG signal in binary format. Then an RF transmitting and receiving antenna [8] is used to connect a tablet PC that has click-to-sound converting software. Standardized patients needs and queries are implemented in our document software, and the sound output has various options like- "water", "help ", "pain" , "food", "sleep", "medicine" and other daily needs. The basic practical implementation for wireless mind mouse is shown in Fig. 1 (a).

II. IMPLEMENTATION

The surface EMG electrodes [10] are placed on the eyebrow muscles .The movement of muscles is captured by the electrodes and transmitted to the circuit .The signal has minute amplitude (in mV or μV) and are not in a usable form. It is amplified with 10,000 gains in first level and 20,000 gains in second level .The amplified signal is filtered using an active low pass filter[11] to attenuate the high frequency noise that comes from subcutaneous muscle movements [12]. Then by using a comparator and common emitter NPN transistor circuit, a switching control signal is generated. This signal is sent as an input to the RF transmitter circuit. And it will transmit the signal through transmitting antenna. An RF receiver circuit receives the RF signal. It is processed and finally signal is sent to tablet PC or scanner which contains a voice recorder IC in which, the messages are recorded and played for the patient and also awakes the microcontroller programmed for timing of LED's. As the signal is received by the scanner, LEDs start blinking from one icon to another icon or in PC icons start blinking. Whenever the patient raises his/her eyebrow, the icon on which the cursor [13] currently points is clicked. Sound items specific to a particular icon are present, there so depending upon the icon selected, the sound output comes out.

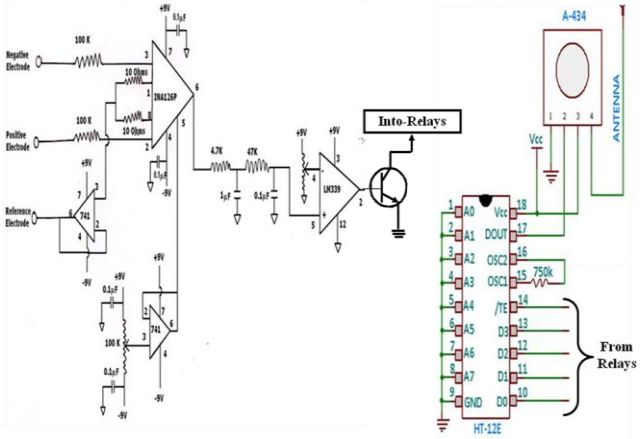

Fig. 2 (a) - Circuit Diagram for Transmitter Part of Wireless Mind Mouse.

ISSN: 2277-3754
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The tablet PC application helps the ALS patients for producing different sounds based on daily basic needs and improves the quality of care by effective patient monitoring and contributes to patients empowerment. In circuit shown in Fig .2 (a) the output from the three surface EMG electrodes is connected to the input of Transmitter section which consist RF transmitter which will transmit the control signal through its antenna. Similarly in Receiver section, signal is received through receiving antenna and after decoding process, RF transmitter generates a control signal which is sent as an input of Tablet PC.

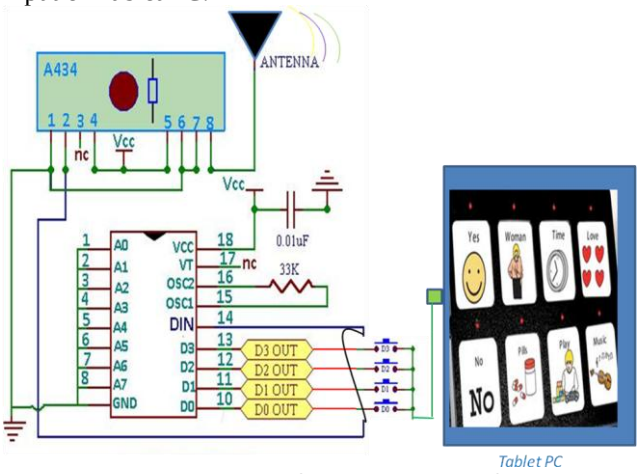

Fig .2 (b) - Circuit diagram for Receiver part of wireless Mind Mouse.

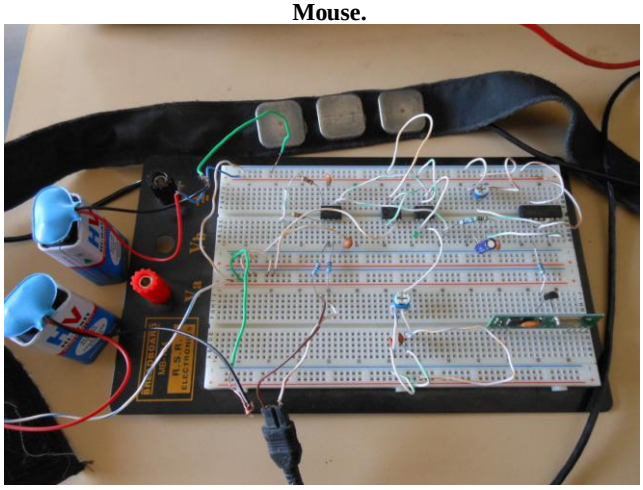

Fig.2. (C) - Picture of Bread Board Connection of Transmission Section for Wireless Mind Mouse.

The basic process that occurs in wireless mind mouse can be express by flow chart shown in Fig. 2 (d).

A. Surface EMG Electrode

EMG stands for electromyogram, which the measurement of electrical potentials [14]-[15] is created by the contraction of muscles. The human body as a whole is electrically neutral. It has the same number of positive and negative charges, but in the resting state, the nerve cell membrane is polarized due to difference in the concentrations and ionic composition across the plasma membrane.

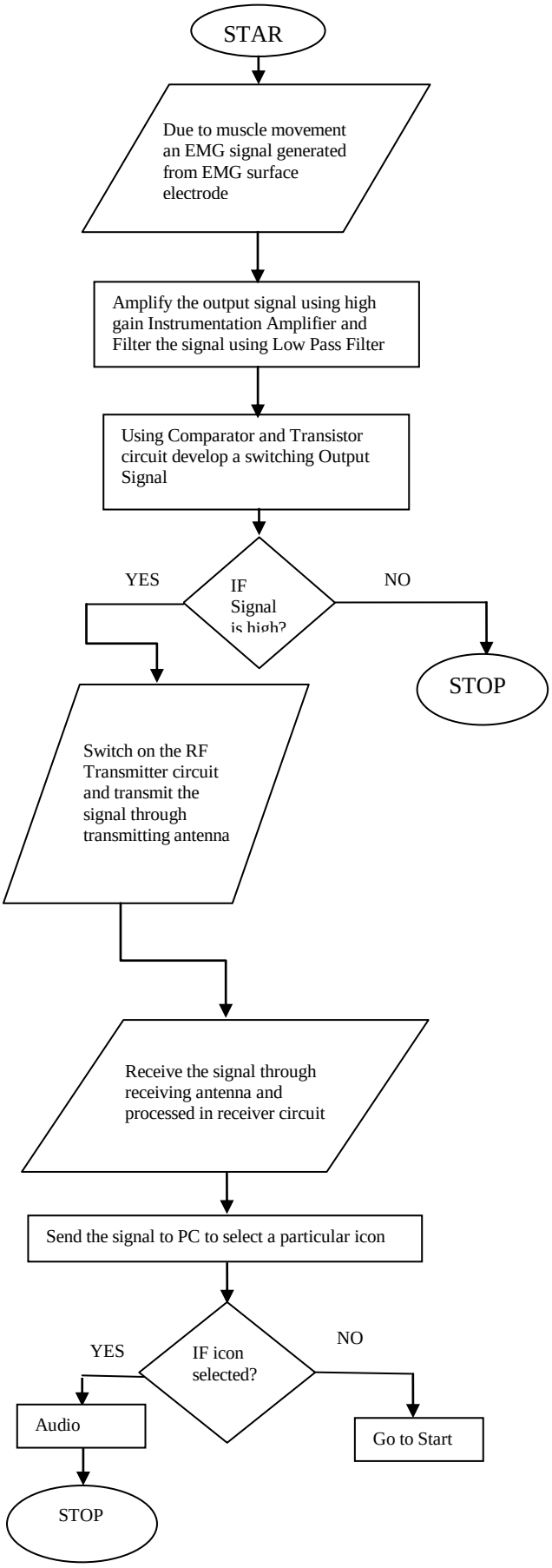

Fig. 2(d):- Flow Chart for Mind Mouse.

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A potential difference exists between the intra-cellular and extra – cellular fluids of cell. in response to stimulus from the neuron, a muscle fiber depolarizes as the signal propagates along its surface. This depolarization accompanied by a moment of ions, generates an electrical field near each muscle fiber. And finally muscles generate a voltage of amplitude ranging from mV to a few micro volts. It contains frequencies of higher or lower than 10Hz.The EMG bioelectrical signals are typically very-very small in amplitude and so, amplifier circuit is required to accurately record, display and analyze the EMG. A typical EMG waveform measured during a brief muscle contraction is shown in Fig. 2 (e).

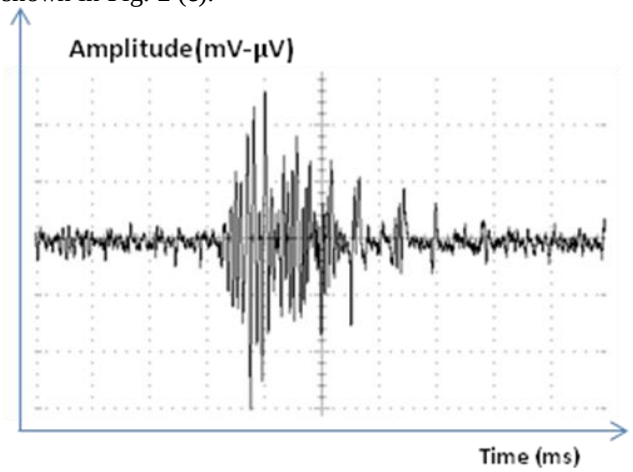

Fig. 2 (e): Typical EMG waveform during a brief muscle contraction.

The EMG signal recorded during voluntary dynamic contraction [16] may be consider as a zero. Mean Gaussian process

$s(t) \in N(0,\sigma_s)$ Modulated by the muscle activity and corrupted by an zero-mean Gaussian additive noise $n(t) \in N(0,\sigma_s)$.

if the probability of detection is p_d .Then the double-threshold method is by equation:-

$$p_d = \sum_{k=r_0}^{m} \binom{m}{k} P_{dk}^{k} (1-P_{dk})^{m-k}$$

Where P_{dk} is probability of detection in single threshold method. $= \exp\left(\frac{\ln P_y}{1+10^{SNR/10}}\right)$. P_y is probability of noise sample above the threshold 'y'. r_0 is the threshold parameters, and 'm' is the length of the observation window.

B. Instrumentation Amplifier

The instrumentation amplifier is a closed-loop adjustable gain block that allows the amplification of low-level signals in the presence of common-mode error and noise. Most common op-amps such as LM741 and LM324 have bipolar transistor (BJT) as input device. This leads to input current of 100-500nA with very high gain.

C. Low pass filter

To attenuate the high frequency noise that comes from subcutaneous muscle movements. In a simple resistive/ capacitive low pass filter the cutoff frequency is given as:-

$$f_{cutoff} = \frac{1}{2\pi RC}$$

D. RF transmitter and receiver

The RF module, as name suggests, operates at radio frequency. The corresponding frequency range varies between 30 KHz to 300GHz.Signals through RF can travel larger distance making it suitable for long range application. An RF transmitter receives serial data and transmits it wirelessly through RF through its antenna connected at pin4. The transmission occurs at the rate of 1Kbps-10Kbps.The transmitted data is received by an RF receiver operating at the same frequency as that of receiver and receives the signal through receiving antenna and after decoding process it will give a suitable output.

E. Relay

A relay is an electrically operated switch. Relays are used where it is necessary to control a circuit by a low power signals (with complete between control and controlled circuits), or where several circuit must be controlled by one signal.

III. RESULT AND DISCUSSION

i. Simulation and hardware implementation result.

The EMG signal [17] is a biomedical signal that measures electrical signal generated in muscles during its contraction representing neuromuscular activities [18]. This signal is normally a function of time and is describable in terms of its amplitude, frequency and phase. The output electrical signal by two different surface EMG electrodes [19] is shown in fig.3 (a).

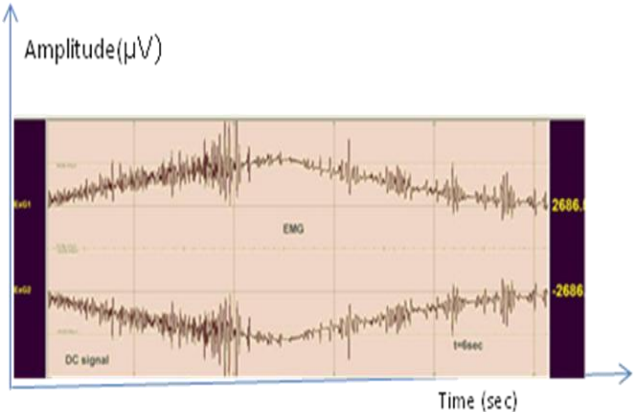

Fig.3 (a) - Output electrical signal by two different surface EMG electrodes.

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The signal is picked up at the electrode and amplified typically; a differential amplifier is used as a first stage amplifier. Then the signal can be processed to eliminate low frequency or high frequency noise or other possible artifacts [20]. This process is done by using an filter circuit and final output from filter circuit is shown in Fig.3 (b).

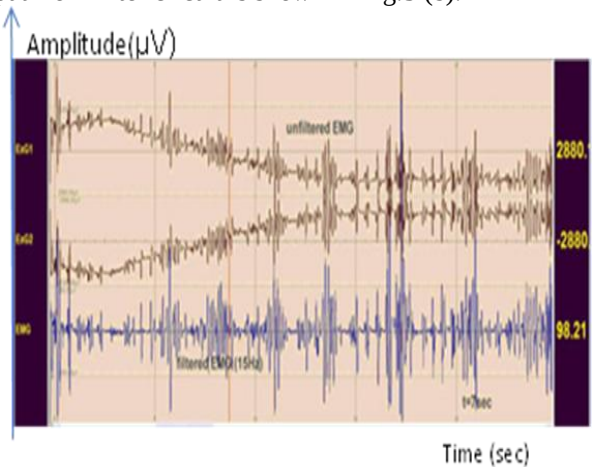

Fig 3(b): Output from Filter Circuit.

Frequently, the user is interested in the usable amplitude of the signal. So signal is further rectified and averaged in some format to indicate EMG amplitude and by using an suitable amplifier circuit an amplified amplitude is obtained and by using an comparator circuit and a CE transistor circuit an switching signal is generated as a output which is shown in Fig.3 (c).

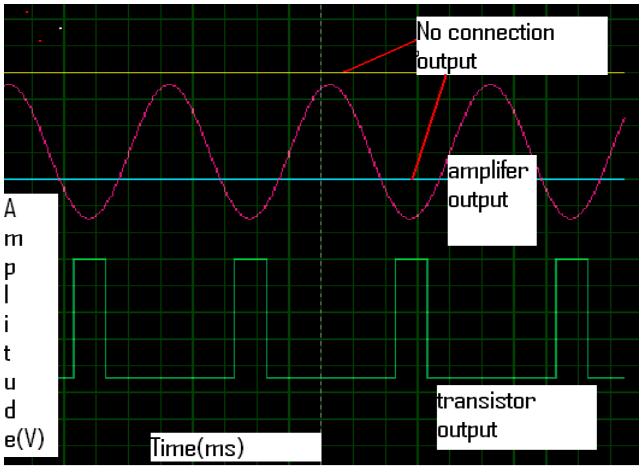

Fig.3 (c) - Output Wave Form of Final Stage Amplifier and Transistor Circuit.

ii. Handi-Talk:

It is software that has picture of daily activities and necessities and letters from A to Z icon with the cursor moving automatically from one icon to the other. With a click, the required icon is selected and the respective sound comes out or the letter is typed on the screen.

IV. CONCLUSION

Amyotrophic Lateral sclerosis (ALS) patients will not be able to express their needs due to the non-functioning of vocal cords and arms. The mind mouse aids such patients to be able to communicate. A mind mouse performs click operation on the screen of the tablet PC (or net book) where the Handy-talk software is installed. The cursor moves automatically on the icons that represent pictures related to daily activities and alphabet. The movement of eyebrow will select the highlighted icon and the corresponding sound comes out which alerts the other people of the patient's needs. A mind mouse helps in communication for ALS patients. It can be used by any patient who unable to move, speak provided some part of their body has little movements.

In future Improvement of necessary software and computers can enable the ALS patients to be able to control the computer completely. The patient will be able to play games on computer that requires only click mechanism. The patients can send emails; write books etc. using this device.

ACKNOWLEDGEMENT

We pay our sincere thanks to BVRIT College for providing funds to our project and ATL for the technical support. NK is especially indebted to Hardware Design Engineer, ATL for his support during the design of the project. NK, also, expresses his deep gratitude towards LLK Singh, N. P. Maity and Reshmi Maity from Mizoram University for their kind help whenever required.

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