

Hemispherical Potential Measurement of Brain using EEG Readings: A case study with innovative idea for more efficient medical equipments.

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Abstract:

So in this paper we will not only cover a measurement methodology involved in EEG and compare this result with a data set taken (from kaggle.com) and suggest idea also for improving the readings obtained from medical instrument involved in this diagnosis so that the disease can be cured more easily and as early as possible. We propose an idea of enhancing the performance of operational amplifiers inside the EEG Machine by adding a offset cancellation circuit and for lesser power dissipation, the amplifiers can be replaced with folded cascode operational amplifiers.

Keywords: Alpha, bipolar , potential, power dissipation, offset.

INTRODUCTION

Biomedical Engineering creates a bridge between medicine and diagnosis. It involves the concept of Science, Technology and mathematical calculations. To treat a disease with more accurate readings from the medical measuring instruments more efforts have to be done on technological part .To guide a doctor a medical measuring instruments plays a vital role e.g, ultrasound machine, X-Ray Machine, ECG , EEG etc. Since the industrialized nations gives importance to technology so much that their whole lifestyle accelerates on the improvement in technology. Medical care equipments came into existence in the beginning of 20th century before that the physicians were used to treat people with certain techniques. Earlier, midwives used to handle the pregnancy but today we have ultrasound machines for monitoring the child inside the womb of the mother. At the first end of this paper, we are intended to show the human brain and its various elements . Further in the second part, the EEG technique is explained. In the third part, the detail discussion about the EEG Recording is done . In the fourth part of this paper the comparison between the reference values of EEG Recordings and the

readings taken from [1] is elaborated. In the fifth part , the advantages of the offset cancellation circuit and folded cascode opamp is explained. Finally at the end the block diagram of proposed technique inside EEG recording machine is given.

I. THE CENTRAL NERVOUS SYSTEM

The central nervous system is shown below:

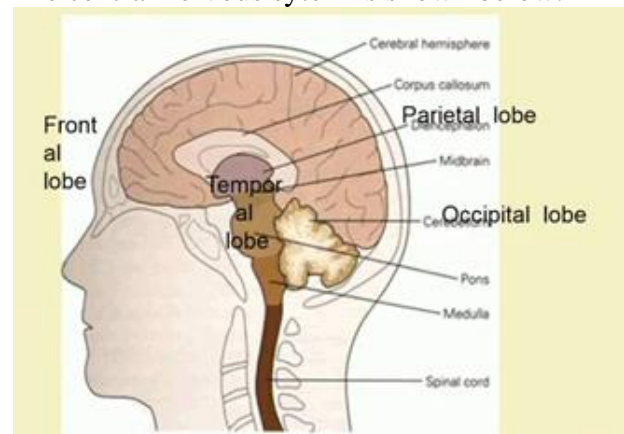


Fig.1: Central Nervous System

It consist of two parts:

1. The Brain
2. The Spinal Cord

This portion of the human body contains the maximum number of neurons. Out of 12 billion neurons, 9 billion neurons are present in the CNS.

These neurons are known as inter-neurons. Let's explain the different part of the brain

1. Frontal lobe: It is responsible for intelligence.
2. Occipital lobe: It controls the vision
3. Parietal Lobe: It's work is to control sensation
4. Temporal lobe: It's function is to monitor the emotions, language and response towards the external activity.

Neurons sense the outer environment and communicate the information to different part of the body. The brain is protected by the skull and the spinal cord is also protected by the bones as shown in Fig.1. The signal which originates from the working of different part of the brain is called EEG.

II. HEMISPHERICAL TOPOLOGY OF THE SKULL

It is peculiar that the measurement of this signal (which is generated due to the movement of the neurons) is done by taking the horizontal orientation as shown in Fig.2.

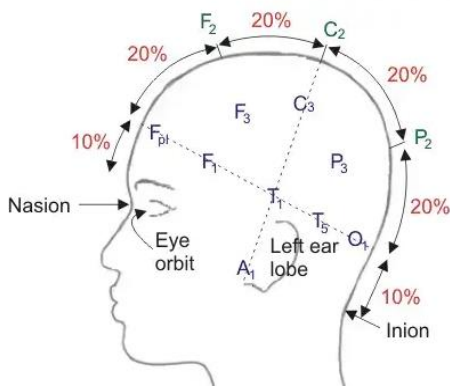


Fig.2: Hemispherical View of the Skull

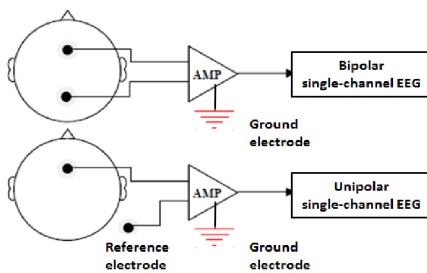


Fig.3: Types of Leads

The leads are of two types:

1. Unipolar Lead: In this , there are three electrodes placed over the head of human

body. Out of which one electrode behave as reference

2. Bipolar Lead: Only one electrode is placed over the head and another one is grounded as shown in Fig.3

Key-point: Electrode is defined as a metal rode or any conducting material which behaves as either cathode or anode as shown in Fig.4

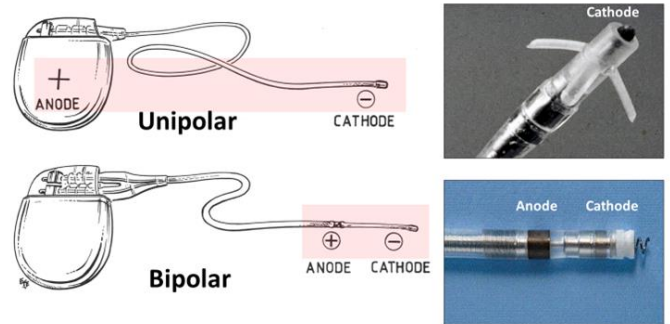


Fig.4: Types of Electrodes

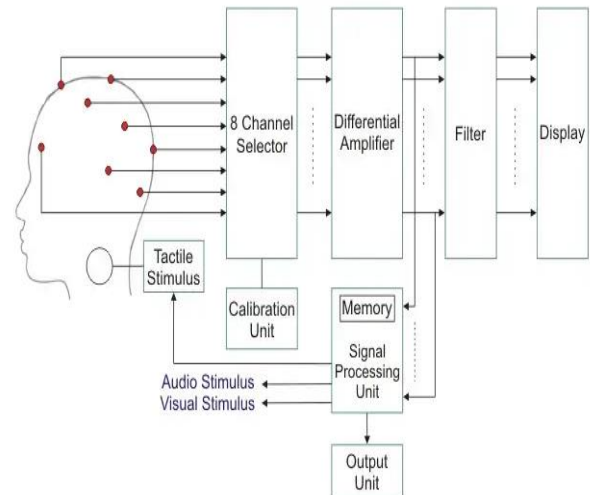


Fig.5: EEG Setup

A. Connection with respect to Fig.2

The various connections are shown in Fig.2

We have Nasion and Inion which are 180 degree part. So we take 10 degree shift and place one electrode. The sequence is such that next shift we take is of 20 degree. Similarly 20 degree shift is added for placing another electrodes. It should be noted that the inion is the position of the back of the brain specifically lower back of the brain (near neck).

B. Connection with respect to Fig.5

The electrodes are further connected to the 8 channel selector and further the output is taken to differential amplifier where the signal (which is the difference between the signal from any one electrode and the reference signal electrode).

C. Unipolar lead EEG Configuration(Fig.6)

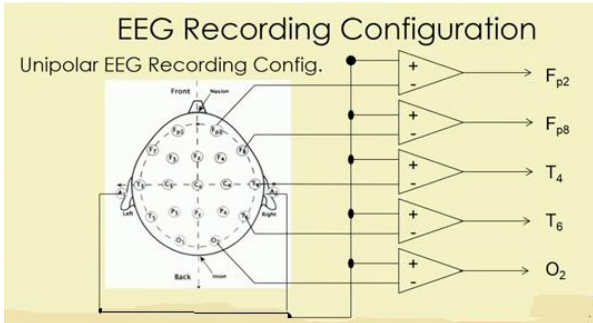


Fig.6: Unipolar EEG circuitry

In Fig.6 , the reference axis are :

1. Form left ear to right ear (Horizontal axis)
2. From back to front (vertically) as shown in Fig.6

There is a formation of grid where the both axes intersects. On those intersection, we place an electrode. Hence on the hemispherical orientation we have the electrode by keeping in mind the 10 degree angle and the 20 degree shift while rest of the portion of the skull is guided by the intersection of the axes.

Key-point: Here the term axes is used because there are parallel horizontal and parallel vertical axes are present in the rest part of the brain to form a grid of intersection

In unipolar the signal is taken from any of the electrodes as shown in Fig.6 and fed to the operational amplifier(inverting terminal) while the non inverting terminal is fed from the reference signal. This reference signal originates due to the potential difference between the two ear lobes. So we obtain a globsl scitivity of the brain which varies point to point.

D. Average EEG Configuration(Fig.7)

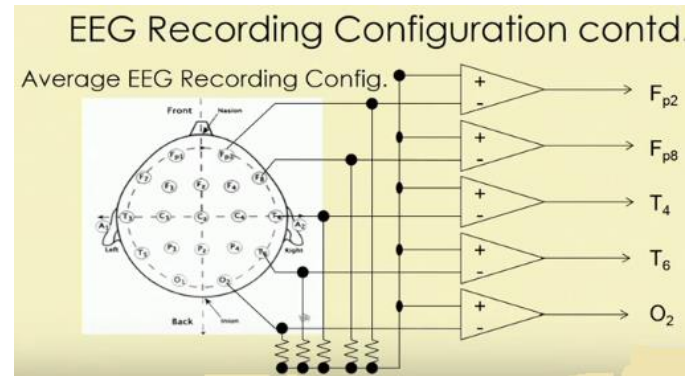


Fig.7: Average EEG Recording circuitry

In this case, the resistors are added to the input of the operational amplifiers so as to increase the input impedance. The signal at the inverting terminal would be calculated from taking into consideration the mid point reference resistance and by considering the potential at individual point as shown in Fig.7 such that $V=IR.....(1)$

$$I=V/R.....(2)$$

And at the end the output is obtained by taking individual potential at the non inverting terminal.

E. Bipolar EEG Configuration(Fig.8)

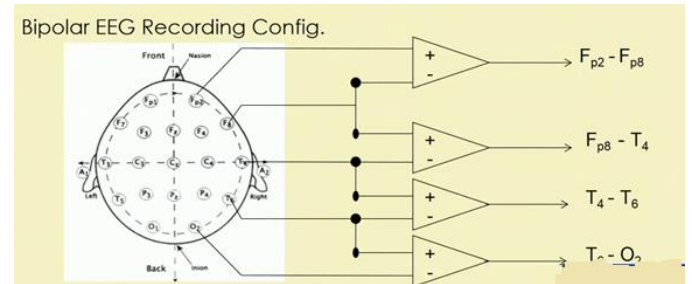


Fig.8: Bipolar EEG circuitry

In this case, the potential is calculated between individual points by taking one point signal at inverting terminal and in second case , it is taken at the non-inverting terminal as shown in Fig.8

It is useful for detecting the local activity of the brain. For example , there is tumor in the brain which is present in a very small area of brain. It can bed detected by pointing two electrodes small distance apart and can be judged by taking the signal from those two electrodes.

II. NATURE OF THE OUTPUT SIGNAL AND OBSERVATIONS.

In this part ,we are going to look into consideration of the nature , shape of the EEG signal. Actually the output received from the operational amplifier is fed to the filter

say(bandpass filter) and then is taken to the display unit as shown in Fig.5. Now in Fig.9, we have the signal and observation drawn from it,

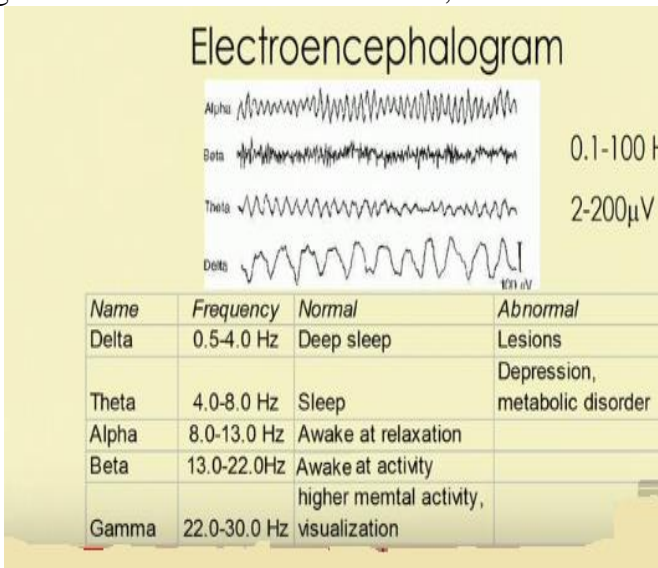


Fig.9: EEG Signals

It is peculiar to note that, the EEG signal is a micro volt signal (2-200 μ V) and exist between the range of (0.1 to 100Hz) bandwidth. The various signals are

1. Delta Signal: It is between the range of (0.5 to 4.0)Hz, the in case of normal brain , the state of the brain is deep sleep while in case of patient , it can be injury.
2. Theta Signal: It occurs between the range of (4-8)Hz frequency range and in this case, the person is in sleep, It means if a person is taken under EEG consideration and this wave is detected (person is in sleep mode), while in case of abnormal brain the state of depression or any metabolic disorder is detected..
3. Alpha Signal: If it is between the range of (8-13) Hz , the for a normal brain , it would be the state of awake with relaxation.
4. Beta Signal : If it is between the range of (13-22) Hz, then for normal brain , it is the state of awake at activity.
5. Gamma Signal: It exist in between (22-30)Hz for normal brain , which means that brain is doing higher mental activity like memorizing or visualizing.

III. COMPARISON BETWEEN THE READINGS BETWEEN THE NORMAL BRAIN HUMAN BODY AND STUDENT BRAIN WITH MENTAL DISORDER

TABLE I
DATA SET TAKEN FROM[1]

Signal	EEG RECORDINGS		
	NORMAL BRAIN READINGS	BRAIN WITH MENTAL DISORDER	RESULTS
Delta (0.5-4)Hz			>4 Hz
Theta (4-8) Hz			>8 Hz
Alpha (8-13) Hz			>13Hz

IV. FOLDED CASCODE TECHNOLOGY AND OFFSET CANCELLATION CIRCUITRY

In this part, we are explaining the advantages of offset cancellation circuitry and folded cascode technology [2]

A. Offset Cancellation Circuitry

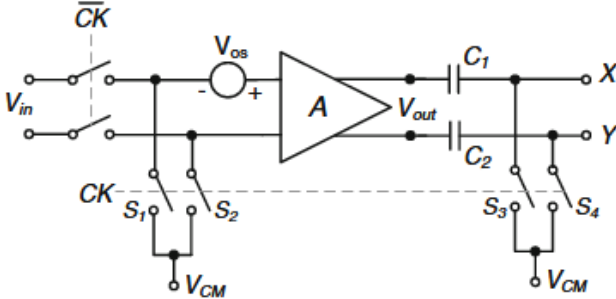


Fig.10:Offset Cancellation Circuit

In this cancellation circuit, the offset or residue or error signal of the operational amplifier is reduced with the help of capacitors and clock as shown in Fig.10

Steps are as follows:

1. When clock is high, the circuit is in auto zeroed form. In this case both the inputs are shorted together, which means gain of the amplifiers is given as $A = V(out)/V(os)$.
2. This voltage $V(out)$ will be stored in capacitors at the output. ($C(1)$ and $C(2)$),
3. When clock is low $V(os)$ is amplified and stored in $C(1)$ and $C(2)$.
4. Already $V(os)$ is stored in $C(1)$ and $C(2)$, it gets cancelled.

B. Folded Cascode Circuitry

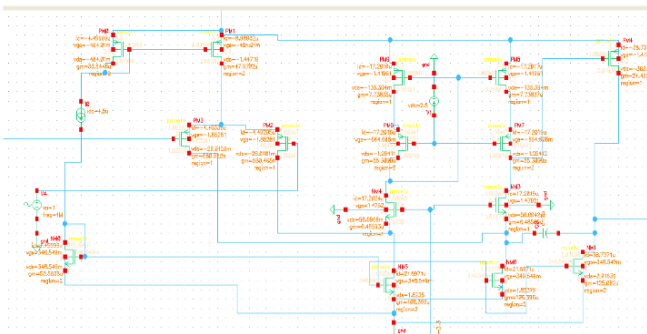
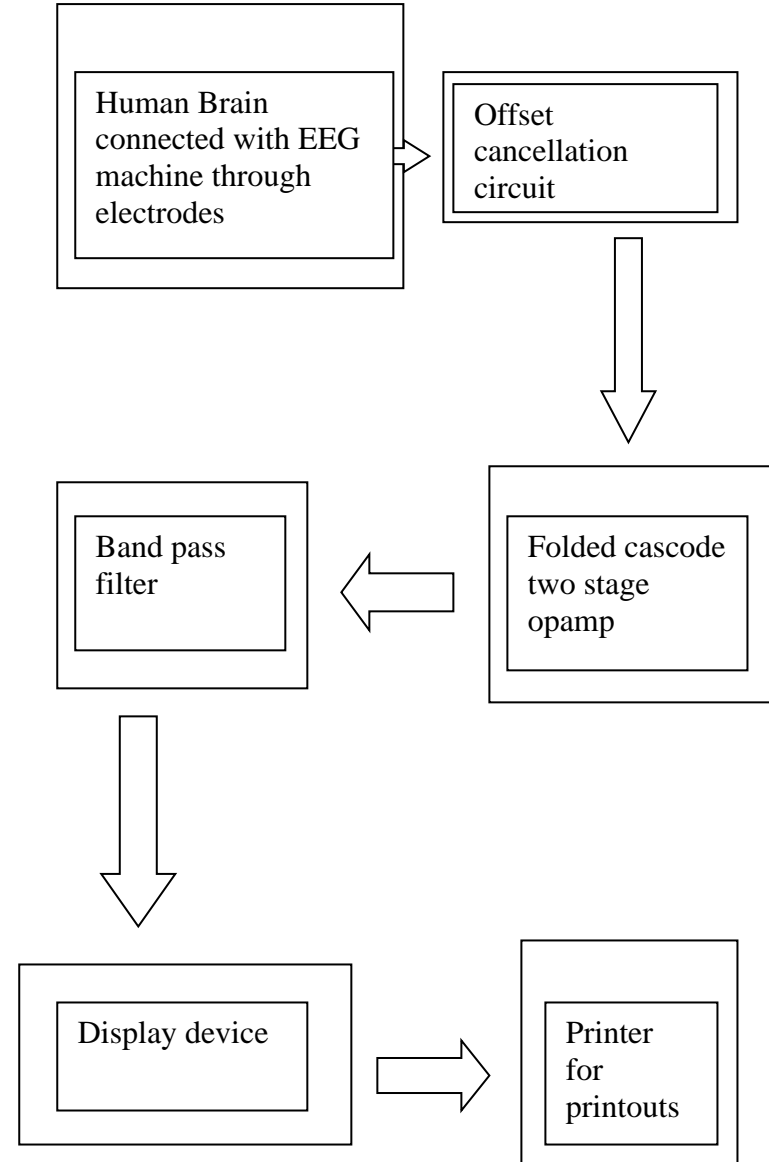


Fig.11:Folded cascode topology[2]

Advantages are

1. Power requirement is low
2. Gain is high

V. FLOW CHART FOR THE DESIGN OF INTERNAL EEG MACHINE CIRCUITRY



VI. CONCLUSIONS

The main idea behind in this paper is to develop an EEG machine which consists of both the technologies (folded cascode and offset cancellation). Since operational amplifiers are the most versatile amplifiers which are used in various electrical machines and VLSI is a branch which works over the integration of various IC's of operational amplifier on a single silicon chip. From the block diagram, it is clear that these technologies will improve gain and more accurate

readings can be obtained from EEG. Hence, the medication can be provided further on the basis of the accurate results.

Hence Biomedical engineering is the heart of the diagnosis and they should move hand in hand.

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