International Journal of Innovative Research in Computer Science and Technology (IJIRCST)
ISSN: 2347-5552, Volume-10, Issue-3, May 2022
https://doi.org/10.55524/ijircst.2022.10.3.69
Article ID IRPP1221, Pages 423-425
www.ijircst.org

Design of MEMS Sensor for Brain Wave Detection

N. Rambabu[1], Tammisetty Vyshnavi[2], Koppolu Padma Sai Tulasi[3], Inkollu Ajay Kumar[4], and Ganta Sai Krishna[5]

[1]Assistant Professor, Department of Electronics and Communication Engineering, PACE Institute of Technology and Sciences, Ongole, Andhra Pradesh, India
[2,3,4,5]UG Students, Department of Electronics and Communication Engineering, PACE Institute of Technology and Sciences, Ongole, Andhra Pradesh, India

Correspondence should be addressed to N. Rambabu; Rambabu_n@pace.ac.in

ABSTRACT- The human brain regulates bodily activities such as the heart, movement, speech, thinking, and emotion perception. Brain waves are electrical impulses generated by neuron communication. MEMS sensors can be used to monitor brain activity. MEMS, or Micro Electro-Mechanical Systems, is a chip-based technology [1] [2]. Sensors are made up of a suspended mass between two capacitive plates that create an electric potential differential to detect brainwaves. To capture and monitor brain signals, a MEMS electrode array was implanted in the brain. The basic idea behind this technology is to capture electric potential. Finally, a detection of brain wave signal analysis is performed to extract brain processing information and determine how this relates to abnormal brain processes.

KEYWORDS- MEMS Sensor, Brain Wave Detection, chip-based technology, Micro-Electro-Mechanical

I. INTRODUCTION

Micro-Electro-Mechanical Systems, is the technology is characterized electromechanical elements (i.e., devices) created utilizing micro manufacturing processes [3]. MEMS critical physical dimensions can range from far below one micron on the low end of the dimensional spectrum to several millimeters on the high end. Similarly, MEMS devices can be as basic as structures with no moving parts or as complex as electromechanical systems with several moving parts that are all integrated with microelectronics. Regardless of whether these parts can move or not, having at least some mechanically functioning elements is a prerequisite for MEMS. MEMS are referred to differently in the different parts of world. They are commonly referred to as MEMS in the United States, but "Microsystems Technology in other regions of the world.

While tiny structures and microelectronics are functional aspects in MEMS, the most notable elements are the micro sensors and micro actuators. Micro-actuators and Micro sensors are classified as "transducers," which are devices that transform their energies from one to one.

A wide range of micro actuators have recently been demonstrated by the MEMS research and development community, including: micro valves for liquid flows; optical switches and mirrors for redirecting light beams; Micro resonators for various uses, independently controlled micro mirror arrays for displays, micro pumps to provide positive fluid pressures, micro flaps to modify airflow on airfoils, and many more [4].

II. LITERATURE SURVEY

Emotions are crucial in everyone's existence. The brain waves tell us about the different emotions that a person is experiencing. This study looks at the alpha brain waves in happy and sad emotions. EEG machines are employed to conduct the research, and move clips are used to trigger joyful and sad emotions. The results demonstrate that the Alfa waves differ in happy and sad emotions.

A Brain Computer Interface allows electronics impulses from brain to be obtained. The non-invasive BCI research method used in this work to acquire brain signals was electroencephalogram. EEG detects signals from the surface of the skull, with the brain wave frequency being an important criterion. This document describes EEG measurements made with the EPOC headset and Emotive System uses. For describing brain waves by frequency, two types of measures were taken. The 2nd type is centered on resting the brain while listening to three different forms of peaceful music. The measurements' results were displayed as a representation of mind performance [5].

For highest signal quality Computer Interface, invasive Brain methods are used. These electrodes are used in cortical issues. These systems are used to help paralyzed persons or to restore vision was connecting by the brain for external cams. Although these BCI systems highest quality signals, they are susceptible to scar tissue buildup. Scar tissue causes a poor signal, which can potentially be lost.

Nowadays, music plays a vital role in our lives. Music has the ability to alter emotions as well as brain activity, which may be evaluated using brain waves, which, when generated by neurons, carry electrical signals that carry sensory and cognitive information. In this study, brain waves from 10–12 average male undergraduate students who were not musicians were read using wireless electroencephalography on 14 channels.

III. PROPOSED DESIGN

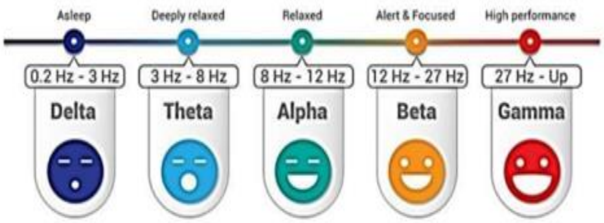

Figure 1: Block Diagram of Proposed System

In Figure 1 first step is let us take a chemical solution to analyze [6]. Next step is a chemical layer has to be applied on the sensor that reacts with our chemical solution. Whenever a chemical reaction is applied on a sensor a chemical reaction takes place between the solution and chemical layer. Due to chemical reaction on the surface of the sensor some chemical compounds are formed and due to this some force is applied on the sensor[7].

COMSOL Multiphysics could be a platform finite part analysis, convergent thinker and Multiphysics simulation computer code. It permits standard physics-based user interfaces and paired systems of partial differential equations .It provides associate degree IDE workflow for electrical, acoustics and chemical uses. Beside the wide selection of classical issues that may be with efficiency self-satisfied with precise usage modules, the core Multichemistry weightage are often accustomed solve broad vary of PDEs in weak type.

Table 1: Assembly Level Optimizing Data

Selection

Geometric entity level	Domain
Selection	Domains 1–2

Material parameters

Name	Value	Unit
Relative permittivity	2	1

Basic Settings

Description	Value
Coefficient of thermal expansion	{{100e-6[1/K], 0, 0}, {0, 100e-6[1/K], 0}, {0, 0, 100e-6[1/K]}}

The versatile nature of the COMSOL setting facilitates more analysis by creating "what-if" cases straightforward to set up and run. You'll be able to take your simulation to the assembly level by optimizing any side of your model as shown in the above table 1.

IV. RESULTS

We present the results obtained from our research and the evaluation of the MEMS (Micro-Electro-Mechanical Systems) sensor designed for brain wave detection. The primary objective of this study was to develop an innovative MEMS-based sensor capable of accurately detecting and capturing brain wave signals for various applications in neuroscience and medical diagnostics.

COMSOL Metaphysics additionally has many problem-solving advantages [8]. Once beginning a new project, victimization COMSOL helps you perceive your drawback. You are able to test out numerous geometrical and physical characteristics of your model, so you can really home in on the necessary style challenges as shown in Figure 2.

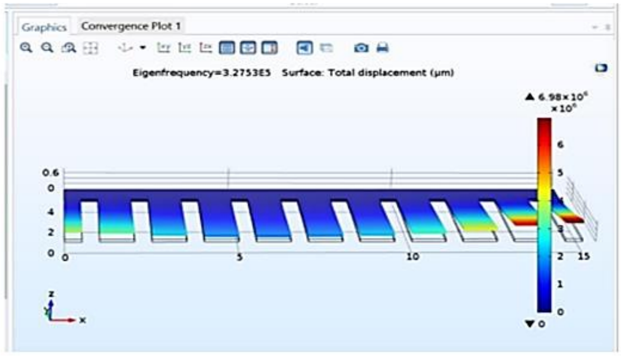

Figure 2: Displacement of Model at F=3.2753E5

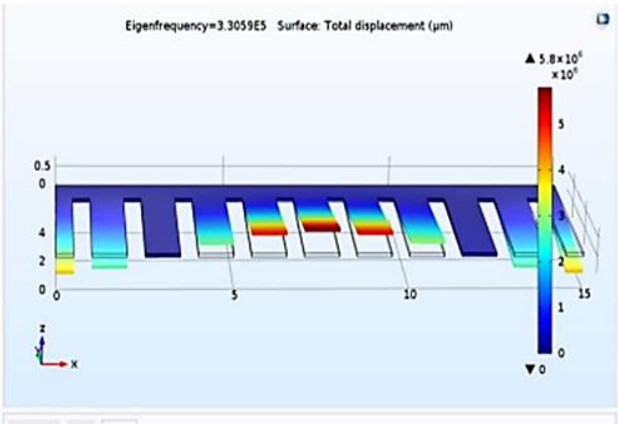

Figure 3: Displacement of Model at F=3.3059E5

From Figure 3 we investigated MEMS sensor with different materials and dimensions which is more suitable for detecting chemical reaction rate. By using different kind of materials like Silicon (Si), Zenite5145L and with different dimensions, we designed a sensor in COMSOL Multiphysics Software. We evaluated the Eigen Frequency vs. Displacement of the sensor structure with the aid of COMSOL Multiphysics Software. By plotting the graph between Eigen Frequency and Displacement; we came to know that there is an inversely proportional relation between those two variables. We have used Silicon for the base structure because of its high tensile-strength and low Spring Constant (K) which gives rigidity and increases lifetime of the sensor [9].

The results obtained from the evaluation of the MEMS sensor for brain wave detection demonstrate its excellence in capturing brain wave signals accurately and reliably. This innovative sensor holds great promise for applications in neuroscience research, medical diagnostics, and brain-computer interfaces, offering a compact and high-performance solution to advance the understanding of brain activity and improve healthcare outcomes.

V. CONCLUSION

A novel sensor model sensor design based on MEMS technology. This MEMS technology offers numerous advantages in terms of design and operation. When compared to the other sensor, this design has some new features. A new pressure sensor model for detecting human brain waves has been developed using MEMS technology and a capacitive construction that provides excellent sensitivity. The medium conductivity material is investigated in COMSOL multi physics by determining the relationship between Eigen frequency and displacement. For an Eigen frequency of 3.27*106 HZ, the maximum displacement is 7.28*1066, and the minimum displacement is 5.16*10-6m for a frequency of 3.39*106 HZ.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

REFERENCES

[1] Koudelková, Zuzana & Strmiska, Martin, Introduction to the identification of brain waves based on their frequency. MATEC Web of Conferences. 210, (2018). 05012. 10.1051/matecconf/201821005012.

[2] Emotions and Brain Waves, Ahmed, Mohammed Abdul, Brain Waves Classification toward Human Emotion Based on EEG signal. Master's thesis, University Technology Malaysia, Faculty of Computing, (2013)

[3] A. Ito and A. Zhu, "A Study to Use a Low-Cost Brainwave Sensor to Detect Dementia," International Conference on Computational Science and Computational Intelligence (CSCI), Las Vegas, NV, USA, 2019, pp. 999-1002, 2019, doi: 10.1109/CSCI49370.2019.00190.

[4] Jacobs, G.D., Friedman, R. EEG Spectral Analysis of Relaxation Techniques. Appl Psychophysiol Biofeedback 29, 245–254 (2004). https://doi.org/10.1007/s10484-004-0385-2

[5] Banquet, J. P. (1973). Spectral analysis of the EEG in meditation. Electroencephalography and Clinical Neurophysiology.

[6] Nithya, V. & Kumar, P. & Juliet, Vimala, Design of a MEMS sensor for sleep apnea detection, 1-5. (2016). 10.1109/ISCO.2016.7726966.

[7] S. S. mader, M. Windelspecht, Human biology, 12th ed., (New York, NY: McGraw-Hill, (2012), ISBN.

[8] H.S. Anupama, N.K. Cauvery, G.M. Lingaraju, International Journal of Advances in Engineering & Technology.

[9] Oken, Barry & Chiappa, Keith, Statistical issues concerning computerized analysis of brainwave topography. Annals of neurology. 19. (1986). 493-7. 10.1002/ana.410190511.