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Human Emotion Detection using Eeg Sensor

Meghana Gupta Arakere, Avik Seal, Rajarshi Karmakar, V. Nithya

Abstract*: This is a data visualization art piece using 10 seconds of mind waves recordings of the human, captured with EEG sensor.10 seconds of Alpha, Beta, Gamma & Theta brain waves while meditating are recorded, the different wave channels are categorized to state when the right brain representing artistic brain activity, isolating the ranges for each channel when the brain channels were more meditating and imaginative. Based on the waves of the brain obtained, we will be able to deduce few attributes such as attention span and mood. The moods we will be trying to assess and display here the level of happiness, sadness, anger along with attention span and meditation level (Concentration level).

Keywords: About four key words or phrases in alphabetical order, separated by commas.

I. INTRODUCTION

In this project we will be aiming to retrieve EEG waves from the brain and obtaining the alpha, beta, gamma. Delta and theta waves using an EEG headset. We will then be employing a MATLAB code to get the attributes required to point out the moods and also the attention span of the person. These attributes are measured and so displayed for therapists and caretakers for monitoring purposes. We will be converting alpha, beta, gamma and delta waves obtained from the brain into readable waves using various algorithms. These graphs are then read per second for obtaining the extent of concentration or level of attention. We will even be trying to devise an interactive application which can be used by caretakers and therapists to monitor the person's or the child's attention level and concentration level.

II. LITERATURE SURVEY

A. BCI based EEG Signals for Emotion Classification K. Saranya, S. Jayanthy.

Inference: The system is designed to classify the emotions into four classes (happiness, calmness, frustration/anger, depression).The main emotions were easily classified using the EEG signals and the sub classes of the emotions was obtained with the help of NLP.

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Meghana Gupta Arakere*, Student, Department of Electronics and Communications, SRM Institute of Science and Technology, Kattankulathur, Chengalpattu, Tamil Nadu, India.

Avik Seal, Student, Department of Electronics and Communications, SRM Institute of Science and Technology, Kattankulathur, Chengalpattu, Tamil Nadu, India.

Rajarshi Karmakar, Student, Department of Electronics and Communications, SRM Institute of Science and Technology, Kattankulathur, Chengalpattu, Tamil Nadu, India.

Dr. V. Nithya, Associate Professor, Department of Electronics and Communications, SRM Institute of Science and Technology, Kattankulathur, Chengalpattu, Tamil Nadu, India.

Emotions Detection based on a Single-electrode EEG Device Roylan Quesada-Tabares, Alberto J. Molina-Cantero, Isabel M. G´omez-Gonz´alez, ´ Manuel Merino-Monge, Juan A. Castro-Garc´ıa and Rafael Cabrera-Cabrera. Inference: The tool which was mathematically used to perform the analysis for the first time was ANOVA (Analysis of Variance) which was applied to each individual person and to the seven features which was ordered by a set of images, so as to check if any one sets of images significantly differs from the rest. The second analysis was performed using the classification algorithm C5.0, which generates a decision tree.

B. Recognizing the Degree of Human Attention Using EEG Signals from Mobile Sensors - Ning-Han Liu,Cheng-Yu Chiang,Hsuan-Chin Chu.

Inference: As electroencephalography (EEG) has been developed, the detection tools and brain-wave sensors have matured and have become affordable. In this study, the student's attention span – if they are attentive or not during the instruction were determined by seeing and observing their EEG signals.

C. Classifying Different Emotional States by Means of EEG-Based Functional Connectivity Patterns-You-Yun Lee,Shulan Hsieh.

Inference: The results of this study indicated that the rate of classification was better than the rate of chance. We can conclude from this paper that estimating the EEG based functional connectivity gives us a useful tool for observing the relationship between the brain activity and the emotional states of the person.

D. Review and Classification of Emotion Recognition Based on EEG Brain-Computer Interface System Research: A Systematic Review-Abeer Al-Nafjan , Manar Hosny , Yousef Al-Ohali and Areej Al-Wabil.

Inference: In this study, we understood the trends in the electroencephalography (EEG) based emotion recognition system, which was used to provide the practitioners and researchers a view into the future of the systems for emotion recognition. This study was set out to review articles from different journals on emotion detection, recognition, classification.

III. SYSTEM MODEL -ARCHITECTURE

1. In the study of brain waves, till now the alpha,beta,gamma,theta waves have been identified and graphs have been obtained. In this project we obtain those graphs from the brain signals .We will be trying to show the person's attention level and concentration level based on the graphs readings.

We will be trying to show what the person wearing the EEG headset is imagining or thinking of. We will be obtaining a readymade EEG headset which is interfaced with MATLAB and Bluetooth for wireless and compact wave recording.

2. The characteristics which will be analysed and displayed are happiness, sadness, anger along with determining attention span and meditation level (concentration level)
3. We will be using a readymade headset to retrieve the brain waves from EEG using a software called NEUROVIEW and then interfacing it with MATLAB to display the characteristics.
4. The already present measurements with regards to EEG are the emotion quotients such as happiness, sadness, anger and frustration.
5. The Novelty of this project is to include characteristics such as Attention Span and Meditation level (concentration level).
6. MATLAB will derive the value graphs of alpha, beta, gamma, delta and theta waves and use algorithms such as ANOVA (analysis of varience) and find mean between different values of the obtained brain waves to measure various characteristics and display a corresponding value. Based on that value, we can determine the level of happiness or sadness or any other characteristic.
7. Values such as variance and arousal are measured and calculated using the algorithms, thus providing us the various percentages at which a person feels a particular emotion.

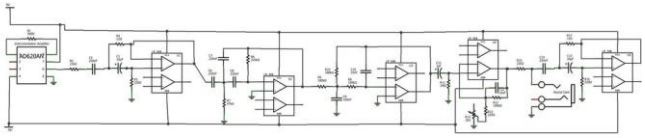

Figure I - Hardware Model

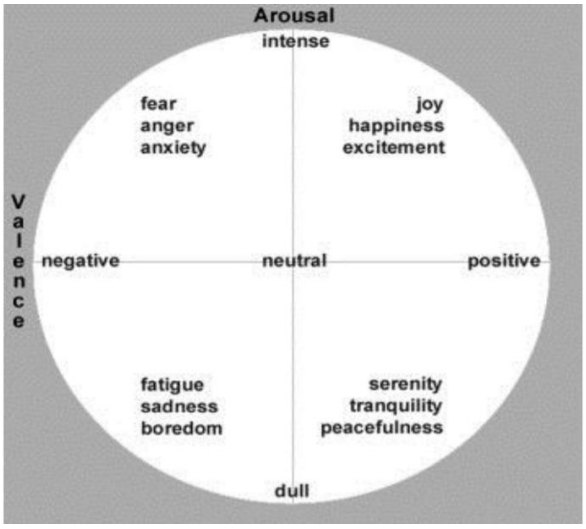

Figure II - Valence vs Arousal graph

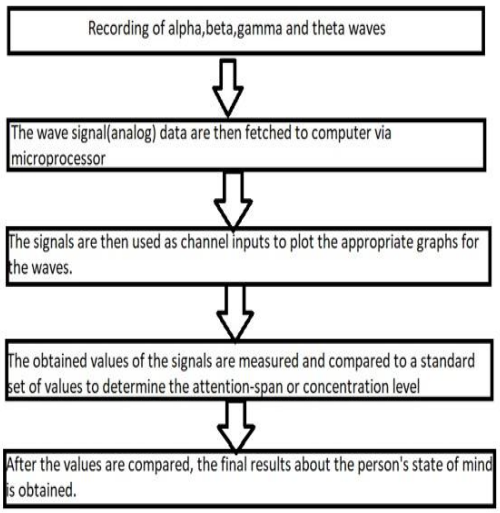

Figure III - Flow Chart

IV. SYSTEM DESIGN

Electroencephalography (EEG)

The brain produces different kinds of signals such as electrical and magnetic signals. The brain's activity can be viewed and recorded using various approaches, which are classified as invasive and non- invasive methods. In invasive methods, surgical procedures are used to implant a particular device in a certain part of the brain. In non-invasive type of procedures, there is no need for any kind of surgery. Amongst all the non- invasive forms of recording activity, Electroencephalography is the commonly used methods to record the signals from the brain. EEG is a direct and simple activity, which involves the measurement of voltage fluctuation, which is a result of the neurons flowing through the brain. The signals obtained can be represented as a signal over time and they can be measured using various electrodes, which are placed all over the scalp of the test person.

Materials

To get the EEG signals from the brain, we used a hardware obtained called the NeuroSky Mindwave. This hardware device has an electrode which is placed at Fp1 according to the standard 10-20 system. It also has a fixed sampling frequency of 512Hz along with a Bluetooth interface. The data we have obtained is read, saved and processed using the software Matlab 8.4.0.150421 (R2014b). To observe and study the features the IBM SPSS Modeller was used. This software consists of a set of tools of data mining that allows us to develop quick predictive models and also offers a wide variety of modelling methods which vary from automated learning, artificial intelligence to statistics.

Experimentation

For this project, a software combination of MATLAB and NeuroView have been used to record and read the data from the brain.

The software of NeuroView also provides us with a simple readable interface which can be used to combine the different waves from the brain. Another Application called Brain Wave Visualiser has been developed for a more interactive experience. It becomes easy for us to read the waves and also use it for children when it is attractive for the children. This application has been designed in a way that kids can happily sit down and be monitored for their attention span and concentration level because the app is bright and very fun to watch.

NeuroView and MATLAB

NeuroView is the software, which allows us to connect the Bluetooth module in the EEG headset to provide us with the various brain waves that can determine the thinking, emotional and other cortexes of the brain. This software collects all the data and is compiled using a MATLAB code to display the graphs as a combination of all the waves into one single wave. This wave can then be used to measure various characteristics such a concentration level and attention level.

Brain Wave Visualiser

Brain Wave Visualiser is the application, which has been developed by us to give the user a holistic and enjoyable experience while using the EEG headset. This application is an attempt to make the user enjoy his/her monitoring. It also makes it easy for caretakers to make their child concentrate easily without them having to nag. This application is a colourful setup. We are also trying to incorporate small games which will aid in the development of the brain and for cognitive development.

Signal Processing

The obtained EEG signal is segmented using 512 sample windows (1-s) which have a hop size of 64 samples (overlapping 87.5%). There has been a procedure which was developed for the automatic analysis of each epoch. It identifies if the sample contains a valid EEG signal or if it has any contaminants. These contaminants can have various sources such as blinks, winks, motion, eye movements or activity of muscles (EMG). In this case of our project, most of these contaminants have an ocular origin because of the position of the electrode. Yet, the electrical activity of the frontal and temporal muscles are important and these occur due to the movement of the electrode.

V. OUTPUTS AND RESULTS

NeuroView Results

We have been able to obtain the graphs for a sample value of data. The NeuroView and Matlab results are the following few images.

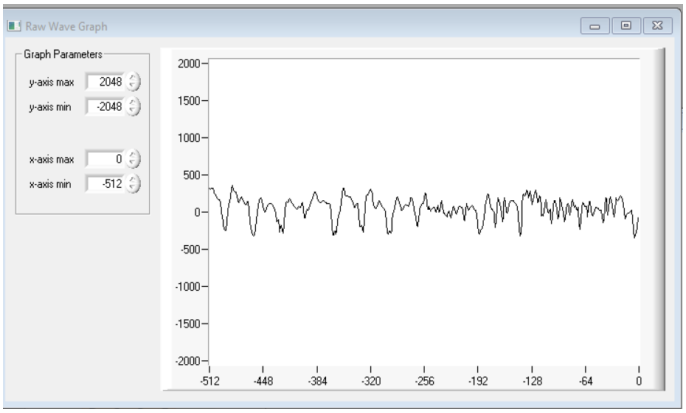

Figure IV - Raw wave

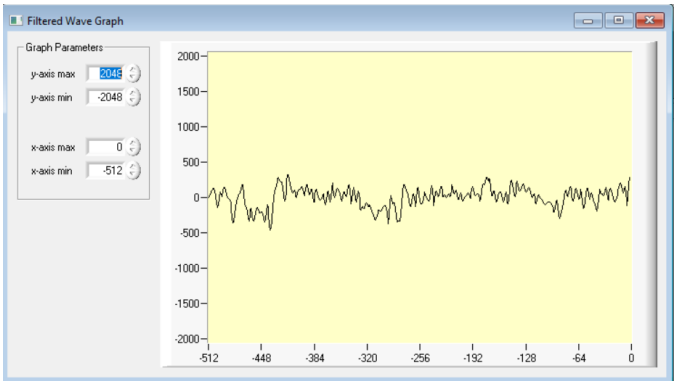

Figure V - Filtered wave

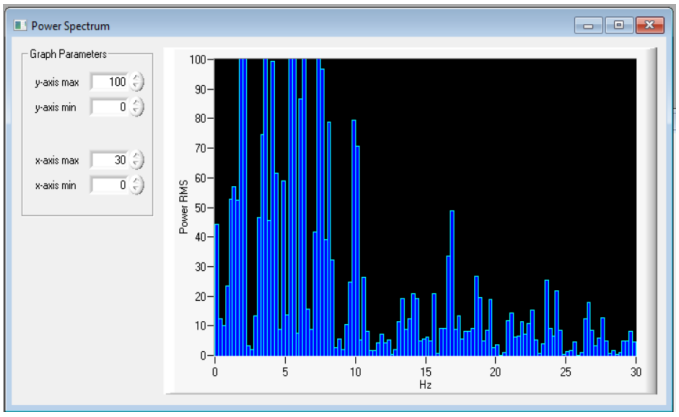

Figure VI - Power Spectrum

Figure VII - Output of NeuroView

Table I - Measured values for the NeuroView Graphs

Time	PoorSigna	Attention	Meditation
17:34:50	0	43	40
17:34:51	0	51	24
17:34:52	0	40	41
17:34:53	0	34	48
17:34:54	0	38	53
17:34:55	0	38	67
17:34:56	0	30	50
17:34:57	0	57	50
17:34:58	0	43	51
17:34:59	0	43	43
17:35:00	0	29	41
17:35:01	0	17	43

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Brain Wave Visualizer Output

The following figure shows a snap of the app we developed.

Figure VIII - Brain Wave Visualiser Output

To test the variation of values in different people, we have taken values from 5 different test subjects and have measured the averages of their concentration and attention (meditation) levels.The following images show the averages of different people:

Table II- Average values for test subject 1

Time	PoorSignal	Attention	Meditation	Time	PoorSignal	Attention	Meditation	Time	PoorSigna	Attention	Meditation	Time	PoorSignal	Attention	Meditation
15:43:24	0	13	48	15:43:52	0	27	54	15:44:20	0	69	74	15:44:48	0	54	100
15:43:25	0	16	51	15:43:53	0	41	53	15:44:21	0	66	69	15:44:49	0	48	100
15:43:26	0	16	61	15:43:54	0	51	61	15:44:22	0	67	77	15:44:50	0	51	97
15:43:27	0	14	70	15:43:55	0	70	83	15:44:23	0	56	78	15:44:51	0	47	81
15:43:28	0	23	66	15:43:56	0	67	81	15:44:24	0	60	81	15:44:52	0	50	78
15:43:29	0	34	61	15:43:57	0	47	66	15:44:25	0	41	83	15:44:53	0	61	63
15:43:30	0	57	64	15:43:58	0	38	61	15:44:26	0	51	70	15:44:54	0	67	80
15:43:31	0	74	70	15:43:59	0	44	60	15:44:27	0	54	67	15:44:55	0	80	90
15:43:32	0	87	81	15:44:00	0	35	53	15:44:28	0	51	61	15:44:56	0	83	100
15:43:33	0	54	100	15:44:01	0	35	70	15:44:29	0	64	51	15:44:57	0	74	100
15:43:34	0	47	96	15:44:02	0	26	81	15:44:30	0	35	43	15:44:58	0	61	100
15:43:35	0	44	84	15:44:03	0	34	74	15:44:31	0	48	50	15:44:59	0	53	91
15:43:36	0	54	84	15:44:04	0	38	69	15:44:32	0	64	51	15:45:00	0	54	69
15:43:37	0	47	70	15:44:05	0	41	67	15:44:33	0	74	74	15:45:01	0	56	50
15:43:38	0	48	90	15:44:06	0	63	67	15:44:34	0	74	74	15:45:02	0	47	44
15:43:39	0	53	78	15:44:07	0	51	63	15:44:35	0	63	74	15:45:03	0	50	37
15:43:40	0	41	81	15:44:08	0	57	61	15:44:36	0	48	81	15:45:04	0	51	35
15:43:41	0	50	97	15:44:09	0	60	63	15:44:37	0	29	61	15:45:05	0	41	40
15:43:42	0	57	70	15:44:10	0	48	34	15:44:38	0	35	80	15:45:06	0	48	34
15:43:43	0	57	93	15:44:11	0	40	44	15:44:39	0	35	63			48.63107	67.728155
15:43:44	0	64	78	15:44:12	0	34	60	15:44:40	0	43	61				
15:43:45	0	66	63	15:44:13	0	35	64	15:44:41	0	53	77				
15:43:46	0	51	54	15:44:14	0	43	96	15:44:42	0	50	63				
15:43:47	0	47	43	15:44:15	0	43	94	15:44:43	0	48	53				
15:43:48	0	30	47	15:44:16	0	40	74	15:44:44	0	37	27				
15:43:49	0	29	50	15:44:17	0	51	63	15:44:45	0	40	30				
15:43:50	0	30	60	15:44:18	0	54	63	15:44:46	0	50	38				
15:43:51	0	13	50	15:44:19	0	66	63	15:44:47	0	53	74				

Table III- Average values for test subject 2

Time	PoorSignal	Attention	Meditation	Time	PoorSignal	Attention	Meditation	Time	PoorSignal	Attention	Meditation
15:55:20	0	61	30	15:55:43	0	40	16	15:56:07	0	74	14
15:55:21	0	53	27	15:55:44	0	56	8	15:56:08	0	64	27
15:55:22	0	80	27	15:55:45	0	56	14	15:56:09	0	61	38
15:55:23	0	70	47	15:55:46	0	66	20	15:56:10	0	67	51
15:55:24	0	81	44	15:55:47	0	74	24	15:56:11	0	69	66
15:55:25	0	87	64	15:55:48	0	54	37	15:56:12	0	70	67
15:55:26	0	67	51	15:55:49	0	53	34	15:56:13	0	74	56
15:55:27	0	74	29	15:55:50	0	43	24	15:56:14	0	67	34
15:55:28	0	77	26	15:55:51	0	57	16	15:56:15	0	66	34
15:55:29	0	78	1	15:55:52	0	63	4	15:56:16	0	78	20
15:55:30	0	81	13	15:55:53	0	75	1	15:56:17	0	75	30
15:55:31	0	78	21	15:55:54	0	81	1	15:56:18	0	77	47
15:55:32	0	84	27	15:55:55	0	96	8	15:56:19	0	74	30
15:55:32	0	78	37	15:55:56	0	100	14			70.70492	33.032787
15:55:33	0	67	41	15:55:57	0	94	11				
15:55:34	0	75	50	15:55:58	0	81	30				
15:55:35	0	54	60	15:55:59	0	56	47				
15:55:36	0	57	81	15:56:00	0	57	41				
15:55:37	0	75	66	15:56:01	0	50	50				
15:55:38	0	81	61	15:56:02	0	64	44				
15:55:39	0	91	57	15:56:03	0	75	23				
15:55:40	0	81	40	15:56:04	0	74	27				
15:55:41	0	78	38	15:56:05	0	83	27				
15:55:42	0	67	34	15:56:06	0	74	8				

Table IV- Average values for test subject 3

Time	PoorSignal	Attention	Meditation	Time	PoorSignal	Attention	Meditation	Time	PoorSignal	Attention	Meditation	Time	PoorSignal	Attention	Meditation
16:01:54	0	78	30	16:02:17	0	47	100	16:02:41	0	41	77	16:03:05	0	26	17
16:01:55	0	93	41	16:02:18	0	50	100	16:02:42	0	40	69	16:03:06	0	50	23
16:01:56	0	87	60	16:02:19	0	61	94	16:02:43	0	43	67	16:03:07	0	30	38
16:01:56	0	78	41	16:02:20	0	61	96	16:02:44	0	44	56			58.04	67.76
16:01:57	0	69	38	16:02:21	0	74	84	16:02:45	0	48	54				
16:01:59	0	88	29	16:02:22	0	69	78	16:02:46	0	53	81				
16:01:59	0	91	40	16:02:23	0	67	74	16:02:47	0	51	80				
16:02:00	0	84	41	16:02:24	0	66	56	16:02:48	0	51	80				
16:02:01	0	93	48	16:02:25	0	77	63	16:02:49	0	48	93				
16:02:02	0	84	66	16:02:26	0	78	63	16:02:50	0	41	91				
16:02:03	0	57	51	16:02:27	0	81	63	16:02:51	0	51	100				
16:02:04	0	56	75	16:02:28	0	74	63	16:02:52	0	41	100				
16:02:05	0	61	77	16:02:29	0	74	63	16:02:53	0	53	100				
16:02:06	0	69	48	16:02:30	0	63	80	16:02:54	0	60	97				
16:02:07	0	100	56	16:02:31	0	81	70	16:02:55	0	61	88				
16:02:08	0	100	51	16:02:32	0	40	70	16:02:56	0	81	75				
16:02:09	0	100	60	16:02:33	0	37	77	16:02:57	0	75	87				
16:02:10	0	84	80	16:02:34	0	35	56	16:02:58	0	69	91				
16:02:11	0	74	88	16:02:35	0	13	54	16:02:59	0	47	88				
16:02:12	0	56	84	16:02:36	0	24	69	16:03:00	0	41	75				
16:02:13	0	43	93	16:02:37	0	24	48	16:03:01	0	24	64				
16:02:14	0	53	100	16:02:38	0	29	48	16:03:02	0	21	40				
16:02:15	0	41	100	16:02:39	0	40	61	16:03:03	0	47	24				
16:02:16	0	47	100	16:02:40	0	47	66	16:03:04	0	38	34				

Table V- Average values for test subject 4

%Time	PoorSignal	Attention	Meditation	%Time	PoorSigna	Attention	Meditation
1.58E+09	26	23	24	1.58E+09	0	43	61
1.58E+09	0	44	24	1.58E+09	0	51	70
1.58E+09	0	61	13	1.58E+09	0	60	100
1.58E+09	0	53	21	1.58E+09	0	47	100
1.58E+09	0	75	57	1.58E+09	0	34	100
1.58E+09	0	63	77	1.58E+09	0	23	100
1.58E+09	0	53	87	1.58E+09	0	41	100
1.58E+09	0	70	100	1.58E+09	25	41	100
1.58E+09	0	80	75	1.58E+09	0	54	91
1.58E+09	0	69	53	1.58E+09	0	56	88
1.58E+09	0	60	43	1.58E+09	0	67	91
1.58E+09	0	47	13	1.58E+09	0	44	80
1.58E+09	0	37	35	1.58E+09	0	43	74
1.58E+09	0	43	29	1.58E+09	0	64	80
1.58E+09	0	38	10	1.58E+09	0	78	74
1.58E+09	0	56	40	1.58E+09	0	84	77
1.58E+09	0	57	43	1.58E+09	0	88	74
1.58E+09	0	63	34	1.58E+09	0	81	56
1.58E+09	0	94	75	1.58E+09	0	57	74
1.58E+09	0	78	38	1.58E+09	0	63	67
1.58E+09	0	75	37	1.58E+09	0	60	69
1.58E+09	0	51	41	1.58E+09	0	50	90
1.58E+09	0	38	29	1.58E+09	0	53	77
						56.73913	62.8478261

Table VI- Average values for test subject 5

Time	PoorSignal	Attention	Meditation	Time	PoorSignal	Attention	Meditation	Time	PoorSignal	Attention	Meditation
16:07:28	0	47	67	16:07:52	0	83	88	16:08:16	0	87	74
16:07:29	0	50	69	16:07:53	0	74	97	16:08:17	0	80	91
16:07:30	0	51	66	16:07:54	0	43	91	16:08:18	0	63	100
16:07:31	0	63	75	16:07:55	0	44	77	16:08:19	0	53	100
16:07:32	0	61	80	16:07:56	0	64	77	16:08:20	0	60	100
16:07:33	0	66	75	16:07:57	0	69	74	16:08:21	0	63	96
16:07:34	0	75	77	16:07:58	0	70	90	16:08:22	0	93	84
16:07:35	0	80	66	16:07:59	0	81	96	16:08:23	0	100	70
16:07:36	0	80	69	16:08:00	0	61	96	16:08:23	0	100	66
16:07:37	0	83	83	16:08:01	0	63	94	16:08:25	0	100	56
16:07:38	0	87	80	16:08:02	0	69	80	16:08:25	0	80	61
16:07:39	0	80	81	16:08:03	0	67	84	16:08:27	0	53	60
16:07:40	0	69	83	16:08:04	0	77	96	16:08:27	0	51	51
16:07:41	0	64	78	16:08:05	0	61	88	16:08:28	0	56	54
16:07:42	0	51	74	16:08:06	0	54	84	16:08:29	0	53	53
16:07:43	0	51	75	16:08:07	0	43	88	16:08:30	0	64	69
16:07:44	0	64	77	16:08:08	0	34	81	16:08:31	0	53	63
16:07:45	0	63	84	16:08:09	0	37	87	16:08:32	0	43	63
16:07:46	0	75	93	16:08:10	0	60	93	16:08:33	0	50	63
16:07:47	0	64	81	16:08:11	0	63	93			66.73134	79.373134
16:07:48	0	57	81	16:08:12	0	75	93				
16:07:49	0	70	78	16:08:13	0	87	84				
16:07:50	0	81	78	16:08:14	0	78	77				
16:07:51	0	87	100	16:08:15	0	93	66				

VI. HELPFUL HINTS

A. Abbreviations and Acronyms

1. EEG – Electroencephalography
2. BCI – Brain Computer Interface

VII. APPLICATIONS

1) This project gives a perspective for caretakers to understand the mood of people, especially children.
2) It helps therapist to understand the mood of patients.
3) It can be used to understand the attention span and concentration level in people which helps in bringing about necessary help and assistance required for such people by therapist and caretakers..

VIII. CONCLUSION

This project is a useful contribution to the field of psychology and also for general caretakers and therapist.If we are able to obtain the brain waves and determine certain behavioural aspects missing within an individual , then this project will make a huge change in the treatment of mentally challenged individuals as well as help in the mental growth of children.

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AUTHORS PROFILE

Meghana Gupta Arakere, Pursuing final year BTech in Electronics and Communications in SRM Institute Of Science and Technology.
Published two research papers:

1. Location guidance of robots using local positioning system published in Institute Of Physics, Bristol-http://iopscience.iop.org/article/10.1088/1757-899X/402/1/012040
2. Smart Irrigation System using IoT published in Asian Journal Of Science and Technology - https://www.journalajst.com/archive/201906

Avik Seal, Pursuing final year BTech in Electronics and Communications in SRM Institute Of Science and Technology.
Published one research paper on **Smart Irrigation System using Iot** in Asian Journal Of Science and.Technology
https://www.journalajst.com/archive/201906

Rajarshi Karmakar, Pursuing final year BTech in Electronics and Communication in SRM Institute Of Science and Technology.

Dr. V. Nithya, Associate Professor in SRM Institute Of Science and Technology.

Area: Wireless Communication, Wireless sensor networks P.HD in Wireless sensor networks M.E in Communication Systems B.E in Electronics and Communications engineering Published 11 research papers and conducted multiple conferences and seminars in SRM Institute of Science and Technology.