International Journal on Recent and Innovation Trends in Computing and Communication ISSN: 2321-8169
Volume: 4 Issue: 3 540 - 542

EEG Based Color Impairment Detection

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Abstract:This study was designed to investigate the effects of colour in EEG signals as the subjects perceive different shades of colours. Color impairment may make it difficult or impossible for a person to engage in certain occupations. Drivers having color impairment may not be able to recognize the different traffic signals lights which may lead to severe accidents those questions the security of other road users. Persons with colour blindness may be legally or practically barred from occupations in which colour perception is an essential part of the job, or in which color perception is important for safety. Different shades of fundamental colours (Red, Green, Blue) were shown in randomized manner. The various colours show various effects in the energy band of the signal. Based on the data obtained from the experiment, we analyse the brain responses which come from color stimuli. The result gives us a measure to estimate the color stimulus.

Keywords—*ElectroEncephaloGram;Color Imapirment; Matlab; Labview*

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I. INTRODUCTION

The fundamental aspect of human perception is color, Also it has been known to affect the human's spirit. Trichromacy or normal colour vision requires three kinds of retinal photoreceptors having sensitivity in the different wavelength portion (L,M,S) of visible spectrum [1]. The type of the photopigment describes the spectral component. Anomalous trichromacy condition may occur when a photopigment which contains the natural variations of some proteins , shifts its sensitivity to a different band of spectrum. Further it can be classified in to protanomaly, deuteranomaly, or tritanomaly[2]. The absence of one of the photopigments caused due to Dichromacy. A very rare condition results from the existence of a single kind of photopigment or no photopigment at all called monochromacy is the worst condition[2].

Researches in different fields of color propose that the cognitive task performance is enhanced by red colour as compared to green and blue colour. The colours can change the moods and behaviour also. Different colors have been shown to have different associations within the cognitive domain as blue is associated with openness, peace and tranquillity whereas red is linked with hazards and also the highest level of compliance [3].

EEG or Electroencephalogram is the brain signal obtained from the scalp and it is unique to each persons. The EEG consists of mainly four waves, Alpha wave(α), Beta Wave(β), Delta Wave(δ), and Theta Wave(θ). Each signal varies uniquely according to different activities of the brain[4].

EEG Frequency Range	
Delta	1-3 Hz
Theta	4-7 Hz
Alpha	8-14 Hz
Beta	15-30 Hz

Table 1: EEG Frequency Range

Generally, the electrodes on our occipital regions (O1,Oz,O2) are used to get the brain activity. In this study, brain activities started after 1sec is concentrated. When people watch the colour, the power of the eeg signal varies which helps us to judge the color.

In this paper, the activities of the brain signals (EEG) when stimulus happened is analysed. The state of the brain activity, obtained after the subject gets the stimuli for a long time has been described and the result of the experiment will give us a method and guidance to conclude what color the people watched for using a simple experimental method.

II. EXPERIMENTAL SETUP

A. Subject

Three subjects including one female, aged between 21-23, participated in the experiment procedure. 12 different shades of 3 basic colours (Red,Green.Blue) where to be the stimuli. Out of the 12 shades the subject has to mark the matching colour of the test color shown according to the subject's visual perception.

 ISSN: 2321-8169
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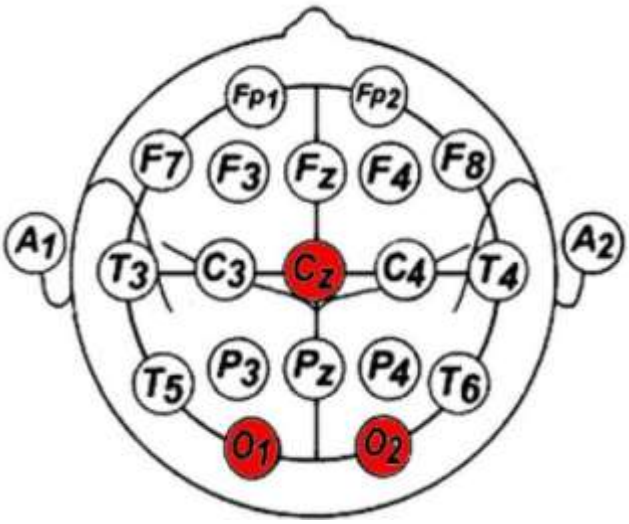

Fig 1: EEG Electrode Placement Position

B. Recordings

In this study, 4 Channels is used to capture the EEG signals from the brain from the regions Cz,O1,Oz and O2. A Reference signal from one of the ear is used to reject the common signals. The data is captured using NI6363 DAC card and using NI signal express. The signal is pre-processed using a band pass filter with cut-off frequency in the range of 0.3Hz and 40Hz and the signal is sampled at 256Hz. Each signal is captured at a frame length of 8sec.

Fig 2: NI6363 DAC Card

C. Environmental Setup

The experiment is conducted in room insulated from high intensity lights and noise, only moderate lights are used. Care is taken to reduce the effects of external noises like daylight breaching and power line interferences etc. The display is put on a screen with required brightness so that the subject can visualise the color without any hindrance. The entire procedure is explained to the subject clearly before the experiment starts andthe colour in the display is set to change every 8 sec.

Fig 3: Experiment Color panel in LabVIEW

D. Procedure

Electrodes were placed on the scalp on positions Cz, O1, Oz and O2 according to the 10-20 international system of electrode placement. To make it stick firmly, it has been attached to a cap and a conductive gel is used. After the subject is set to relax, the experiment system developed in LabVIEW is started in which the subject has to choose the given test color from the displayed 12 shades of colors. Each 12 shade is created in such a way that one or more component deficient from the test color. Similarly 36 different test colors are there in the experiment. Simultaneously the EEG is recorded and the data of each frame is exported to excel file. The data obtained is then analysed using MATLAB. The experiment is repeated for different trials.

Fig 4: Subject Undergoing Experiment

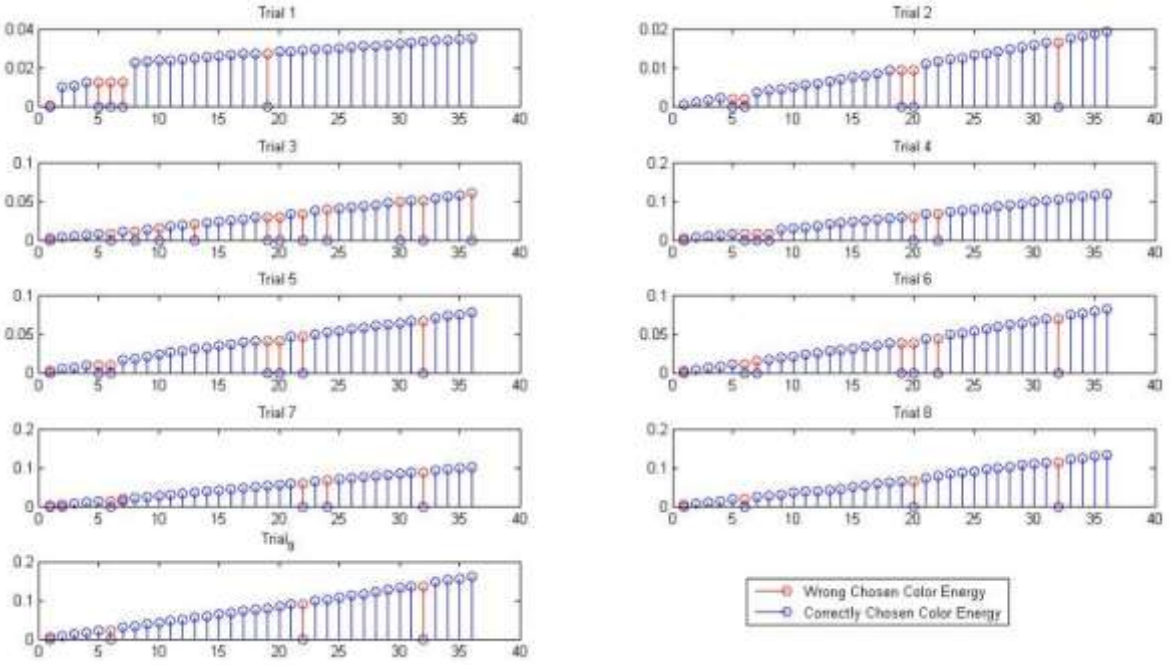

Fig 5: EEG Energy Graph of different trials

III. ANALYSIS

The uncorrelated linear components of data obtained are found using the Principal component analysis in MATLAB. The signal is passed through Band pass filter having lower cut-off frequency of 4Hz and higher cut-off frequency of 40Hzand then separated in to alpha, beta and theta waves. The energy of each signal is calculated for each channel and averaged to obtain the energy per each colour fordifferent subjects. The Fast Fourier Transform is then applied and the entropy of the signal is also calculated..

IV. RESULT

Energy of each EEG signal is calculated for different subjects during the performance of the experiment. The obtained result is shown in figures 5. From the experiment, a change is observed, when the subject chooses more wrong color;more dips in the energy is observed while when the subject chooses the right color the energy tends to increase giving a ramp like structure. The red component in the figure indicates a wrong choice and blue color indicated a right choice of color.

V. CONCLUSION

In this paper, the Energy difference between eeg signals of different subjects during the color stimuli experiments is investigated. The results shows that the energy of right chosen color tends to increase linearly and that of wrong color, more dips are observed. This result can be further applied to detect the color blindness in persons and for eeg based authentication purposes.

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