Human Identification Based on Color Stimuli

Md. Mahmudul Hasan[1], Nafiul Hasan[2], Md. Mohaiminul Islam[3], Mahozabin Suhi[4]
[1,2,3,4]*Department of Electrical and Electronic Engineering*
[1,2,3,4]*Bangladesh Army University of Engineering & Technology,*
Qadirabad, Bangladesh
[1]mubin.eee.kuet@gmail.com,[2]nafiulhasan71@gmail.com,[3]mohaiminulbauet@gmail.com, [4]mahojabinshuhi@gmail.com

***Abstract*—Human identification by using Electroencephalogram is becoming promising field and reliable to improve security systems. It is difficult to acquire EEG at a certain mental condition always such as concentration or relaxation. This paper represents a simple model to identify individuals and finding most effective primary color by using features of EEG by means of color stimuli. A comparison between primary and secondary colors for identification has also been made. Standard additive primary colors blue, green, red and one secondary color yellow were selected for experiment. Four neural networks were built by extracting various features of EEG in the domain of time and frequency. All artificial neural networks showed satisfactory performance with minimum mean square error for identification. Among the four selected colors blue color based ANN showed minimum mean square error of 6.238×10^{-08}.**

Keywords—Electroencephalogram (EEG), Human Identification, Color Stimuli, Artificial Neural Network (ANN), Biometrics.

I. INTRODUCTION

Human identification system uses identifier's features which makes it unique. Existing identification system are mostly either knowledge or possession based [1]. Password, PIN, fingerprint, voice etc. alike based database are very vulnerable in today. Facial recognition system is better but it also has been failed to complete reliability such as in the incident of Boston marathon bombing where the system fails to identify. Fingerprint can be stolen and all the data sets can be easily hacked. So human identification by using features of individual's brain wave becomes first choice for reliability [2-4].Biometrics uses special physiological or behavioral feature of individuals. As EEG consist of many features of brain, it is becoming a prominent research field [5].

Features of EEG due to different color stimuli is studied. Individual color stimuli has an effect on human emotion [6]. As EEG isn't constant and to reproduce subject need a specific environment such as concentration or relaxation, to make this system independent of hard experimental condition; the alternative method is to use color stimuli. Previous works shows that statistical and dynamic features gives best performance for human identification while using features of EEG [7]. So both domain's features is used in this proposed model.

The primary color red, green and blue are known as RGB colors. Primary colors are mixed together to generate secondary color. Researches shows significant effect of RGB on visual impact. A color theory namely opponent process describes the interpretation of color information with human visual system[8].

Practically most of the time the dataset have nonlinear relation. The dataset can be generalized by artificial neural network easily. Moreover ANN don't have input pre requisite. Besides theoretically ANN belongs to deep learning. To deal with the data complexity, volatility artificial neural network is chosen in this proposed work.

This paper presents a prominent methodology for human identification by using color stimuli. BIOPAC MP36, Acqknowledge 4.1 was used for acquiring EEG [9] and feature detection, MATLAB 2014a used for artificial neural network design.

The following sections of this article is described accordingly: section II represents the chosen methods, section III describes EEG processing and analyzing, section IV shows selection of features and comparison of colors. Section V and VI briefly discuss classification, experiment result and conclusion with future work respectively.

II. PROPOSED MODEL

A. Projected Model

The proposed model for identification of individual using color stimuli is visualized in Fig. 1 below. Having acquired EEG signal with BIOPAC with the assistance of MP36, features were taken out by Acqknowledge 4.1 and MATLAB 2014a which used to design artificial neural network. Deep learning with MATLAB leads to classification approach. By analyzing mean square error, regression, gradient, accuracy a decision is taken about whether the proposed model will work satisfactorily or not, which primary color is best and what type of color is better between primary and secondary.

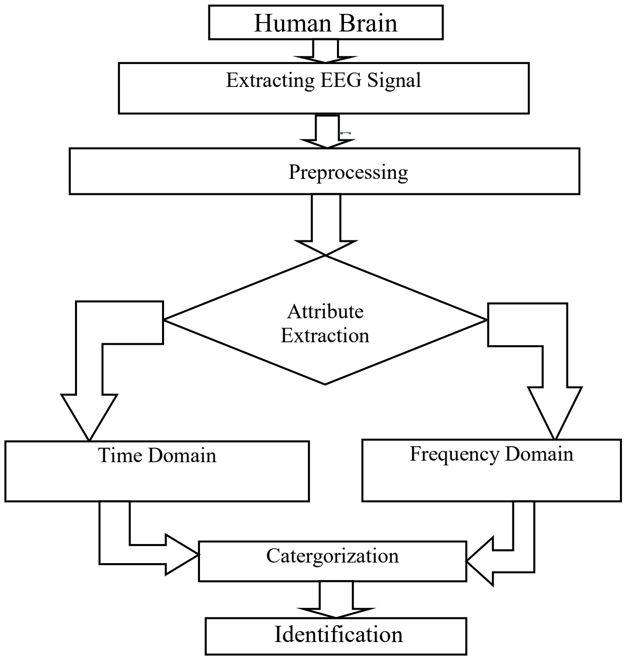

Fig 1. Flow chart of the planned approach for Biometrics using EEG

B. *Electroencephalography Acquiring and Exploratory Condition*

The test was conducted in Biomedical Engineering Lab of KUET (former BIT, Khulna), Bangladesh. Subjects were three male persons having no psychological and major visionary problem such as color blindness. Subjects were instructed to concentrate on colors. Total twenty individual trials were taken for each subject and color. Used two trials for testing purposes. Colors were shown in computer desktop screen.

C. *Experimental Setup*

1) Hardware description: BIOPAC data acquisition unit MP36 was used. Fig. 2 shows EEG signal acquisition system during the experiment.

2)Required software: Different softwares namely Acqknowledge 4.1 and EEGlab were used for signal processing approach. Relative waveforms is given by BIOPAC student Lab software after it's built in signal acquisition and processing system. Different features of signal were measured and analyzed in this platform.

Fig. 2. Pictorial view during experiment at BME, KUET.

III.SIGNAL PROCESSING AND ANALYSIS

A. *Filtering and Artifact Removing*

After acquiring the raw EEG signal it showed artifact and noise which due to EOG and EMG noise because of hand motion, eye blinking and line frequency (50 Hz). The raw EEG was filtered between .5 Hz to 44 Hz by band pass FIR.

B. *Smoothing*

Smoothing makes average and replace it with the real value. In words smoothing is averaging. Moderate smoothing (factor 5) was done. In (1) n, m are no. of points and samples respectively.

$$x_{output} = \sum_{r=m-\frac{n}{2}}^{r=m+\frac{n-1}{2}} \frac{x_{input}(r)}{n} \text{.......(1)}$$

C. *Domain analysis*

Standard deviation (STDDEV), Maximum value (MAX), kurtosis, skewness these statistical methods were measured in the study as time domain features. For measuring the overall power of EEG, Power Spectral Density (PSD) measures were used in frequency spectra and as a part of DFT, Fast Fourier Transform (FFT) was used as a parameter. Hamming window was used during FFT.

IV.EXTRACTED DATA

A. *Contrast of the EEG attributes of the individuals*

In time and frequency domain we used maximum, SD, skewness, kurtosis, PSD mean, PSD max, FFT mean, FFT max where the first four attributes are time domain and remaining fours are frequency domain features. The features of subject 1 in time domain while looking at blue color are illustrated below in Table I.

TABLE I. RESPONSE FOR BLUE COLOR OF SUBJECT 1

Trial	Maxm. (Micro-V)	Std. Dev. (Micro-V)	Skewness (Micro-V)	Kurtosis (Micro-V)
1	13.30831	5.79718	-0.0591	3.01581
2	8.776440	4.83765	-0.36379	2.19582
3	11.77697	3.59855	0.36564	3.68987
4	15.70188	5.25637	0.07720	3.26976
5	7.191940	3.88736	-0.1355	2.41993
6	9.168280	3.50900	0.10184	2.61476
7	7.122060	3.33194	0.10835	2.41100
8	10.48134	4.81770	-0.05164	2.35189
9	17.64717	4.89702	0.80992	4.74267
10	10.48335	4.36073	-0.23235	3.21103
11	11.19927	4.68437	0.46547	2.39521
12	9.036970	4.06186	-0.21058	2.64188
13	13.93632	4.75774	0.59110	3.15644
14	8.946480	4.73119	-0.41294	2.77898

15	9.362860	3.97022	-0.08332	2.75909
16	12.61301	4.51157	0.12616	3.52430
17	8.308320	3.74044	0.01996	2.66426
18	11.40869	3.42292	0.10140	3.87897
19	8.13347	3.42092	-0.06007	2.67656
20	8.43347	3.43864	-0.06569	2.85472

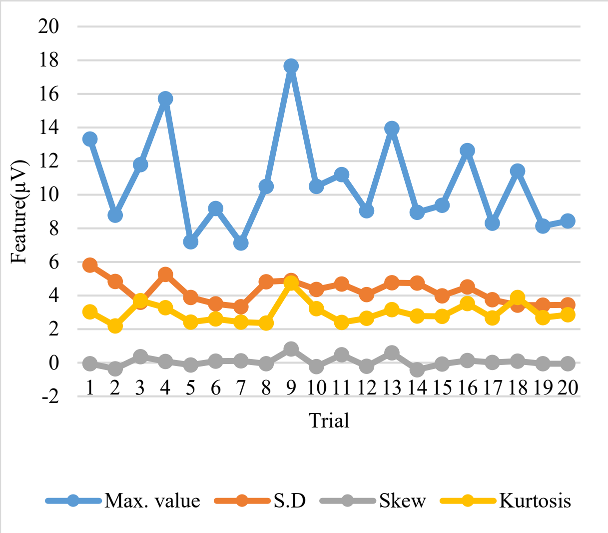

Fig. 3. Time domain features of subject 1 while looking at blue color.

Fig. 3 shows that the fluctuation of features of time series varies a little for subject 1 for blue stimuli in twenty different trials.

B. Comparisons of features for different individuals

After plotting definite feature of all subjects taken in twenty trials, it shows small variation of feature for same subject and comparatively more variation for different individuals. Fig. 4 shows the mean PSD for three subjects at twenty trial. Similar graphs are obtained for max PSD, mean FFT and max FFT.

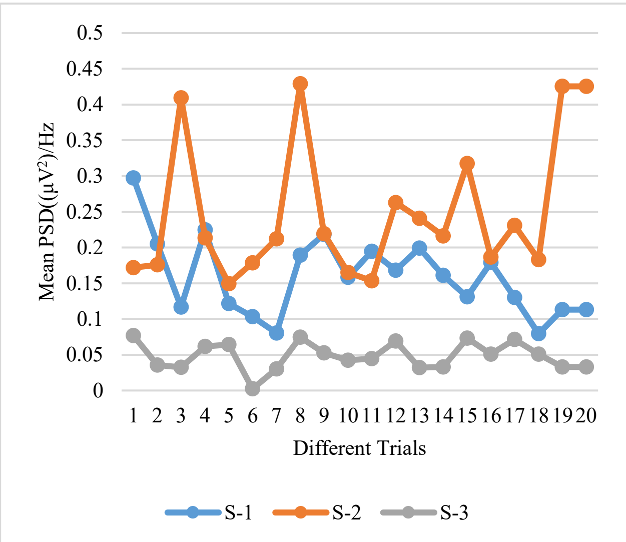

Fig. 4. Comparison of Mean PSD of different subjects.

V. Classification Results & Discussion

In this experiment we have used four color stimuli. So four neural network were built. MATLAB built in nntool GUI was used. Two layers feed forward back propagation ANN was used utilizing TANSIG transfer function and Levenberg Marquardt learning algorithm were used to design neural network.

A. Scenario 1: Yellow color

The ANN designed for yellow color showed mean square error of 0.22371 at epoch 1 with regression of 0.977 and successfully identified three different individuals with accuracy of 92.82%, 93.85%, 95.99% respectively. It gave the worst performance comparatively.

B. Scenario 2: Green color

The ANN designed for green color showed mean square of 7.7336×10^{-07} at epoch 24, overall regression 1 and successfully identified subjects with accuracy of 94.82%, 95.66%, 96% respectively. It showed good performance.

C. Scenario 3: Red color

The ANN designed for red color showed mean square error of 2.5798×10^{-07} at epoch 1, overall regression 1 and successfully identified all subjects with accuracy of 98.32%, 99.2%, 99.92% respectively.

D. Scenario 4: Blue color

The ANN designed for blue color showed mean square of 6.238×10^{-08} at epoch 5, overall regression 1 and successfully identified all subjects with accuracy of 99.98%,100%,100% respectively. Fig. 5 shows best validation performance of the neural network designed for blue color.

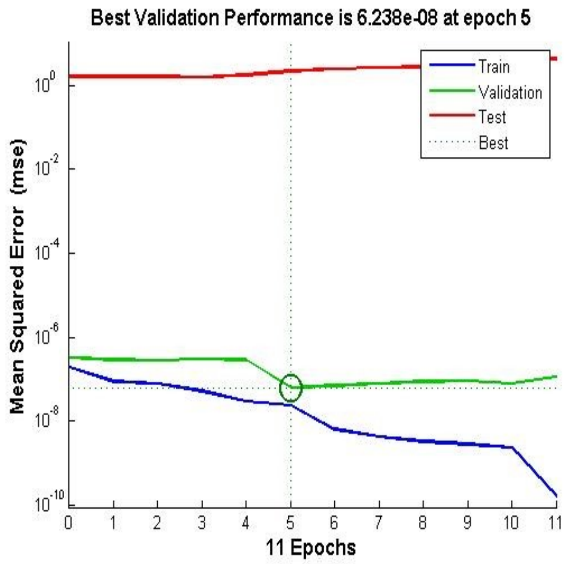

Fig. 5. Performance of neural network designed for blue color.

TABLE I I. COMPARISON DESIGNED NEURAL NETWORKS

Attributes	Yellow	Red	Green	Blue
Mean Square Error	0.223	2.579×10^{-07}	7.733×10^{-07}	6.238×10^{-08}
Overall Regression	0.977	1	1	1
Accuracy (Average)	94.22%	95.49%	99.14%	99.99%

The above table shows a comparison among ANN designed for different colors. So now the results clearly signifies that the ANN built for blue color gives best performance with 99.99% identification accuracy. Mean square error is an effective parameter for evaluating the performance of any ANN model. Lower mean square error signifies better efficiency of the designed ANN and vice versa. The value of regression varies from zero to one. Having unity or near to unity regression represents a greater efficiency and vice versa. Accuracy is measured by comparing the output and target value in terms of percentage.

VI.CONCLUSION

After the subsequent steps of EEG signal processing, it is to confirm that human identification can be done easily by means of color stimuli and EEG analysis. ANN for blue color gives lowest error of 6.238×10^{-08} whereas ANN designed for yellow color gives the highest error of 0.22371. Being primary color, blue provides best performance as it shows mean square error illustrating better performance of the network.

Development of an efficient online EEG analysis system for real application is under progress. SVM analysis of proposed model is under consideration.

REFERENCES

[1] C. Ashby, A. Bhatia, F. Tenoreb, and J. Vogelstein , "Low-Cost Electroencephalogram (EEG) based Authentication", Proceedings of the 5th International, IEEE EMBS Conference on Neural Engineering, Cancun, Mexico, April 27 - May 1, 2011.

[2] M. M. Hasan, M. H. A. Sohag, M. E. Ali, and M. Ahmad, "Estimation of the Most Effective Rhythm for Human Identification using EEG Signal", 9th International Conference on Electrical and Computer Engineering (ICECE),2016.

[3] A. Riera, A. Soria-Frisch, M. Caparrini, C. Grau, and G. Ruffini,"Unobtrusive biometric system based on electroencephalogram analysis," EURASIP J. Adv. Sig. Proc., 2008.

[4] C. R. Hema, M. P. Paulraj, and H. Kaur, "Brain signatures: A modality for biometric authentication," International Conference on Electronic Design (ICED), pp. 1–4, December 2008.

[5] Q. Gui, Z. Jin, W. Xu, "Exploring EEG-based Biometrics for User Identification and Authentication," IEEE conference on Signal Processing in Medicine and Biology Symposium (SPMB), pp. 1-6, Dec. 2014.

[6] D. Zakzewski, I. Jouny, and Y. C. Yu, "Statistical Features of EEG Responses to Color Stimuli", 40th Annual Northeast Bioengineering Conference (NEBEC), 2014.

[7] M.M. Hasan, M. M. A. Sohag, and M. Ahmad, "EEG Biometrics Based on Small Intra-individual and Large Inter-individual Difference of Extracted Features", International Conference on Electrical, Computer & Telecommunication Engineering (ICECTE), 8-10 December 2016, Rajshahi-6204, Bangladesh.

[8] D.Q. Ultama, T.L.R. Mengko, R.Mengko,M.N. Aulia, " Color blind test quantification using RGB primary color cluster", International Conference on information Technology Systems and Innovation(ICITSI),2016.

[9] Reference manuals of AcqKnowledge software guide and MP system hardware guide. (2008). BIOPAC Systems Inc., 42 Aero Camino,Goleta, CA – 0067, USA.