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Biometric Authentication of PC by Using EEG Signals

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***Abstract*— Authentication plays an important role in security systems and security operations. In a general sense, there are three types of person authentication: something a person knows (password-based), something a person has (token based), and something a person is (biometric-based). Each has its own merits but also there are drawbacks which can cause vulnerabilities to security systems. Recently, technological advances make it easy to obtain Electroencephalography (EEG) signals. Moreover, the evidence shows that finding repeatable and stable brainwave patterns in EEG signals is feasible, and the prospect of using EEG signals for person authentication promising. An EEG-based person authentication system has the combined advantages of all three types of person authentication currently in use, yet without their drawbacks. Therefore, an EEG-based person authentication system should be suitable for especially high security systems. In this paper our aim to achieve strong and unbreakable authentication pattern is to be extracted for that we are applying four level signal/dataset decomposition to achieve reliable transformation. Based on the internal thresholding, a structural classification is performed on transformed signals to analyses signal spectrums in Alpha, Beta, Gamma, Theta and Delta of power to stabilize the mental status before authentication. The resultant is now computed with neural networking algorithm for pattern classification and decision making.**

***Index Terms*— Authentication, Biometric, Thresholding, Electroencephalography (EEG) signals.**

I. INTRODUCTION

Electroencephalography (EEG) is a monitoring system for analyzing and retrieving the electrical signals from brain activities. This is collected with slab wise placing of electrodes on human brain and skull for authentication. Using EEG the overall load in the system on processing is retrieved. The segmented reports are dividing into several epochs with same amplitude and frequency range. In general there are constant and stationary signals for computation

Concurrent EEG recordings and fMRI filters have been gotten effectively however fruitful synchronous recording requires that few specialized troubles be defeat, for example, the nearness of ball is to cardiographic antique, MRI beat ancient rarity also in the EEG ropes enlishment energetic streams goes inside the solid attractive ways to the MRI. At the time of testing, this can be overcome in various reviews effectively. These fields deliver conceivably hurtful radio recurrence warming and make picture antiquities rendering pictures futile. Because of these potential dangers, just certain restorative gadgets can be utilized as a part of a MR domain. Thus, documentation from both MEG and EEG which is in synchronous that contain likewise be led, that have a few focal points over utilizing either procedure alone:

EEG requires precise data about specific parts of the skull that must be assessed, for example, skull span, also carry out the different areas from skull. This problem will be not found in MEG, also it as to be adjusted for a synchronous examination enables.

Both MEG and EEG which identify action beneath cortex of the surface ineffectively, in the EEG, mistake increments of the level which profundity underneath cortex of the surface one endeavors near look at. Be that as it may, the mistakes are altogether different between the systems, and consolidating them along these lines takes into account remedy of some of this commotion.

MEG approaches for all intents and purposes no wellsprings of mind movement underneath a couple of centimeters under the cortex. EEG, then again, can get signals from more prominent profundity, but clamor at a high level. Less demanding will occur when joining this two in the direction figure out EEG flag surface at which it originates (analyzing signals from the surface of the cerebrum particularly accurate in MEG), from more profound in the mind what it originates, along these lines taking into account examination of more profound cerebrum signals than either EEG or MEG all alone.

A. EEG acquisition:

In normal the EEG data which is recorded by putting cathodes on the scalp with a conductive gel or glue, ordinarily in the wake of setting up the scalp range by light scraped area to diminish impedance because of dead skin cells. Numerous frameworks commonly utilize terminals, each of which is appended to an individual wire. A few frameworks utilize tops or nets into which terminals are inserted; this is especially normal when high-thickness varieties of anodes are required. Terminal areas and names are indicated by the universal 10 o 20 frameworks for most clinical and research applications (with the exception of when high-thickness clusters are utilized). This framework guarantees that the naming of anodes is predictable crosswise over labs. In most clinical applications, 19 recording terminals (in addition to ground and framework reference) are utilized. Fewer cathodes are ordinarily utilized whenever the neonates are used for recording EEG . For the standard set-up extra cathodes can be

added in the medical application requests the specific region of the cerebrum with expanded spatial determination. Clusters with high thickness (normally by means of top or net) can contain up to 256 terminals pretty much equitably dispersed around the scalp.

Every terminal is associated with one contribution of a differential speaker normal framework reference anode is associated with the other contribution of every differential enhancer. The electrical energy between the active electrode and the reference is enhanced by intensifiers (regularly one thousand–hundred thousand times, / sixty–hundred DB of electrical energy pick up). Afterword the Flag is moved (after that section) in the simple EEG, As the reroute of pens as paper goes beneath when the EEG flag is generated. Majority of EEG frameworks nowadays, notwithstanding, are advanced, and the opened up flag is digitized by means of an ADC in the wake of being gone through a hostile to –aliasing channels.

Simple to-computerized examining normally happens at two hundred fifty six to five hundred twelve hertz (256–512 Hz) EEG scalp in medical; inspecting till twenty kilohertz(20 kHz) are utilized as a part of some exploration applications. Amid the recording, a progression of actuation strategies might be utilized. These systems may actuate typical or unusual EEG movement that may not generally will see. Highly exposure to air , photic incitement , eye outcomes, psychological action, relax, deficient of sleep which include such techniques.An endivotes run of the mill seizure drugs might be pulled back is observed by amid epilepsy.

Electronically put away by computerized EEG flag which also be moved for show. For the high pass filer and low pass channel normal settings are 0.5Hz and thirty five to seventy hertz (35-70Hz) individually. In the commonly channels through moderate relic the high pass move, for example, EEG signs and development relic, while the low-pass sift channels through high-recurrence antiques, for example, electromyography. EEG flag is approximately ten microvolt (10 µV) to hundred microvolt(100 µV) for a run of the mill grow-up person which is measured through EEG scalp sufficiently, when it is measured through subdural terminals it is around ten to twenty millivolt(10–2mV).The difference between the voltages at two anodes which tells by the EEG voltage flag, For the perusing encephalographer of the EEG can be set up in one of a little ways. The portrayal EEG electrodes is alluded to as a montage.

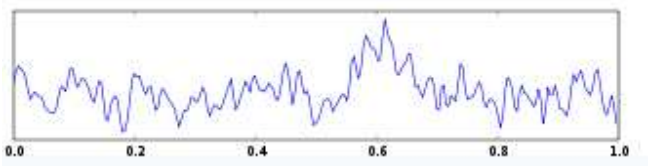


Fig: Normal EEG signal

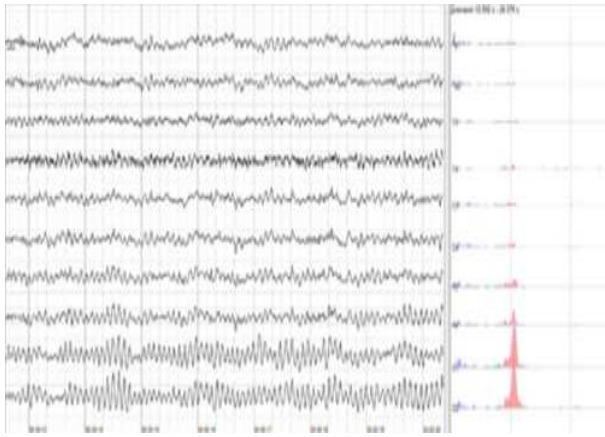


FIG: EEG sample with Alpha, Beta, gamma and theta sampling

II. RELATED WORK

Deon Garrett, David A. Peterson, Charles W. Anderson, and Michael H. Thaut [1], The paper describes that they have done EGG signal classification from linear (i,e. Linear discriminant study), non linear classifiers (i.e, SVM and neural networks) and feature extraction . due to high noises content in the EEG signal can limit the advantage of non linear classification above linear classification. This paper gives information about the results from both linear and non linear classification for the natural EEG signal with five mental tasks, finaly this paper reporting that non linear classifiers gives improved classification results. And also that feature selection of hand movement tasks can be done by using genetic algorithms.

Wahyu Caesarendra, Mochammad Ariyanto. Syahara U. Lexon, Elta D Pasmanasari ,Cindy R. Chang ,Joga D. Setiawan [2] The described paper they have recorded the EGG data from eight subjects from emotive EEG device with sixteen electrodes, feature extraction method comprising time field and numerical features are relevant to EEG signal. EEG data classification can done by using artificial neural network. This type of classification mainly to recognize the pattern for body prosthetic and disability person to wheelchair. This paper also reports the channels such as F7 and F8 are good in classification compare to all other 14 channels.

Inan Gu¨ler and Elif Derya U¨ beyli [3], Paper consists of they have done multiset classification by support vector machine among correcting error output codes used for multiset electroencephalogram data classification difficulty. The algorithms like probabilistic neural network and multilevel preceptron neural network are also been tested and performance of classification of EGG signals are compared with this algorithms. wavelet coefficients and lyapunav exponents are the features which signifiy the EEG signals and the this features have been trained in svm and pnn to achieve maximum classification accuracies.

Arun Chavan, Dr. Mahesh Kolte [4], In this paper , feature extraction of EEG signal can be done using different wavelets and appropriate wavelet are chosen which give best result, from this feature extraction of EEG signals , by using neural network algorithm the EEG signals are classified into normal and abnormal class. The EEG dataset which is composed through online, first the pre processed technique is done by passing the EEG data to high pass and low pass filters and to

identify and correct the noise content as much as possible the signal has to be represent in time domain. In order to remove unwanted noise from the signal the filtering methodology has to be applied to the EEG signal. The wavelet transform are applied to EEG signal recorded from each of electrodes, this wavelet transform are used as pre processing. Finally by using artificial neural network the EEG data are classified.

M. Z. Ilyas, P. Saad and M. I. Ahmad, A. R. I. Ghani [5], Paper includes, the classification of EEG signals for brain computer interface is campared, one of the major task is that how to extract the significant EEG signals from data with poor quality and also with noise content.in order to get strong BCI system it is necessary to choose useful classification technique for classifying EEG signal. In this paper classification technique such as support vector machine, multilayer perceptron artificial neural network, k-nearest neighbour, logistic regression are assessed. In this paper dataset 1 from BCI competition 4 which is used for testing the classifiers, classifier such as logistic regression and support vector machine most capable classifiers with high accuracy.

Umer I.Awan, U.H Rajput, Ghazaal Syed, Rimsha Iqbal, Ifra Sabat , M.Mansoor [6], Paper consists of feature extraction and classification of EEG signals with different facial expressions. The EEG data which is recorded from non invasive electroencephalogram device. The EEG data which is acquire from ten subjects, with age group between eighteen to fourtyfive. the feature vectors are extracted for EEG actions by using segmentation and selection with root mean square value. K nearest neighbour algorithms are used for the classifications.

Yulianto Tejo Putranto, Mohammad Hariadi, Tri Arief Sardjono, Mauridhi Hery Purnomo [7], in this paper the classification of EEG signals for motor imagery task has done. The EEG signals are acquire from two class motor imagery data, this signal are used for feature extraction and classification. for feature extraction the power of EEG signals, absolute mean wavelet coefficient, wavelet coefficient with average power, coefficients with standard deviation are used. Finally classification can be done by using k nearest neighbour, support vector machine, linear discriminant analysis. Finally linear discriminant analysis gives much accuracy compare to two classifiers.

Anjum Naeem Malik, Javaid Iqbal and Mohsin I. Tiwana [8], Paper has the EEG signal with several combinations of features and classifier are used in order to acquire highest classification correctness for 4 set EEG based BCI system. Subjects as to perform knee and ankle joint movements during which EEG data are recorded from sensorimotor cortex from 4 subjects. After eliminating artifacts, the feature such as average band power, peak,kurtosis,mean and skewness this features were calculated. Finally classification can be done using k nearest neighbour, support vector machine, linear discriminant analysis. This paper reports that linear discriminant analysis which gives better accuracy compared to other classifiers.

III. PROPOSED SYSTEM

In the proposed system, EEG is a major conceptual entity for evaluation. In this system, EEG is acquired using a sophisticated hardware unit with electrodes and series value recording system.

A. Data Acquition

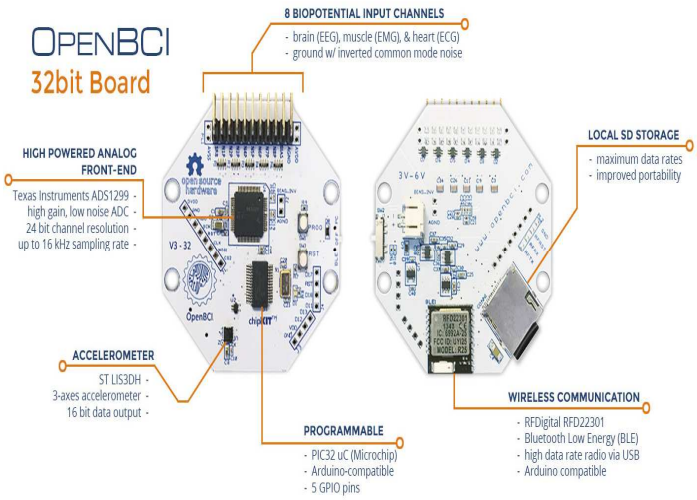
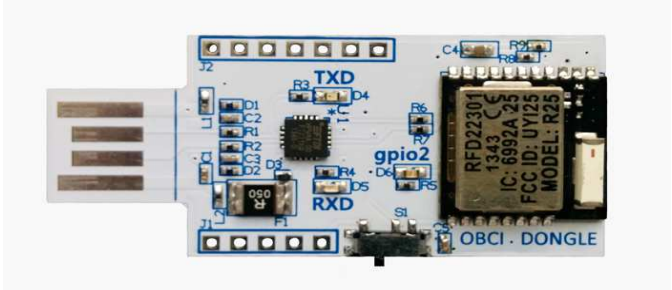


Fig : Open BCI 32 bit board.

B. Open BCI dongle

RFduio pins are softened out up an indistinguishable request and format from the shields and RFduio radio. RFdunio GPIo2 is linked with blue LED. Earnings from FTDI chip is linked with TXD [Red] and RXD [insatiability] LEDs.

Dongle will have 2 positions in slide switch[it is noted on base silk screen].At point when the switch is on GPIo6 side, the FTDI- DTR stick will be directed to the RFduino stick six(6)and prepared for information deliver to and from the Open BCI board. The setup will be called as "ordinary" mode and furthermore takes into consideration program the Open BCI board on air. When the switch is on the reset(RST) side, the FTDI- DTR stick directed to the RFduino reset stick. Thus reprogramming the RFduino on Dongle is taken into account for this mode.



C. Feature Extraction:

Power Spectral Density (PSD) is a measure of a flag's energy force in the recurrence area. By and by, the PSD is registered from the FFT range of a flag. The PSD gives a helpful approach to describe the adequacy versus recurrence substance of an arbitrary flag. In the Random Control System, PSDs are utilized to speak to the control and information channel signals. Arbitrary vibration is encountered each day in this present reality. The movements experienced, on the back of a truck, the hold of a plane or ship, the bed of a flatcar

amid travel are all arbitrary vibration. It is movement at numerous frequencies in the meantime. The sufficiency at these frequencies changes haphazardly with time. The typical approach to depict arbitrary movement is as far as its Power Spectral Density.The example of power spectral density ,from the figure we can analyze that signal x contains 4Hz & 7Hz sin wave, so there are two peaks at 4Hz & 7Hz.

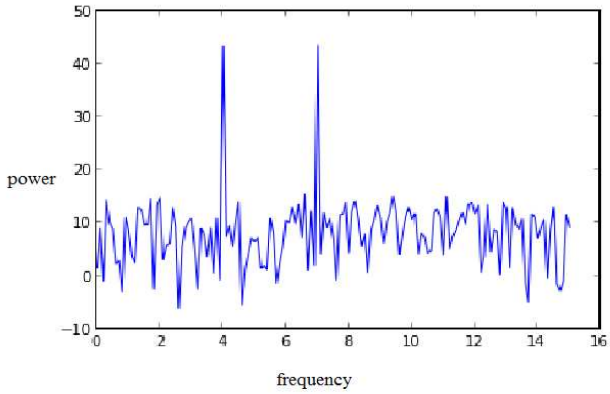


Fig: signal x contains 4Hz & 7Hz sin wave, so there are two peaks at 4Hz& 7Hz.

D. Classification:

Classification process is initiated from the random training set processing and thus classifies data based on the training set obtained from EEG data acquisition hardware unit and then process the signal in classifying new data. Classification algorithm which takes two EEG data from different users and gives an binary output 0 or 1, where Output 0 indicates that the not authenticate and Output 1 indicates that the authenticate.

E. Methodology for Processing

This informational index of EEG information was recorded from a few solid subjects. The prompt based BCI parameter comprised of two/three engine symbolism assignments, to be specific the creative energy of development of the left- hand [LH], right- hand [RH] and the both F (feet). Different session was recorded for few subjects on various days and the information of each and every session were put away into an one information document individually. The subjects were sitting in an agreeable easy chair before a PC screen. Toward the start of a trial, the screen is clear. Following two seconds (t=2s), a sign as a bolt guiding either toward the left, right or down (comparing to three classes of LH, RH and F) showed up and remained on the screen for a particular length (3-10 sec). This provoked the subjects to play out the coveted engine symbolism assignment. The subjects were asked for to complete the engine symbolism assignment until the signal vanished from the screen and attempt to dodge the eye squinting or eye developments amid the creative energy. A 2 seconds break took after when the prompt is vanished. This system is rehashed 30-100 times for each keep running with the arbitrary signal succession. The worldview is delineated in Figure 1. For each subject, the main run is called introduction strategy which just exhibits the signs with no input. In view of the online BCI classifier prepared on the EEG information recorded from the introduction run, the framework can display the framework criticism online by a few red bars speaking to the characterization yield for left hand, right hand and feet summons. Then, the EEG information with class names are recorded. The tests directed in various days for a similar subject are called distinctive sessions.

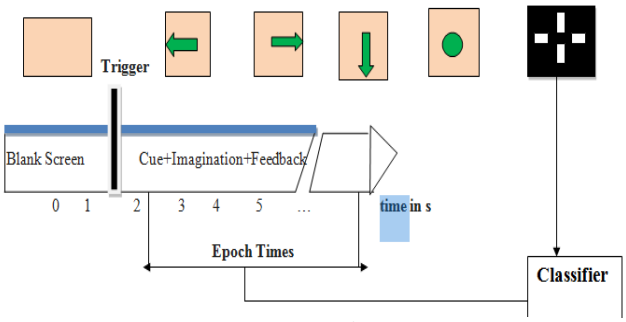


Fig: Queue based BCI method for Signal acquisition

IV. Results And Analysis:

The proposed system is built with a moral for designing and delivering an authentication system for PC using EEG signal study and processing. The detailed view on the study with respect to methodology and signal acquisitions is studied in precious chapters. In this chapter, a brief overview on result and its discussion is studied.

Typically, the system is designed on inter domain environment with raw signal collection from hardware and software for processing. The system uses, MATLAB as its fundamental and principle software for processing and justification. In general, the system acquires signals from Hardware using electrodes and fed into the system for processing, training and classification. In this project, Classification plays an important role under decision making for authentication.

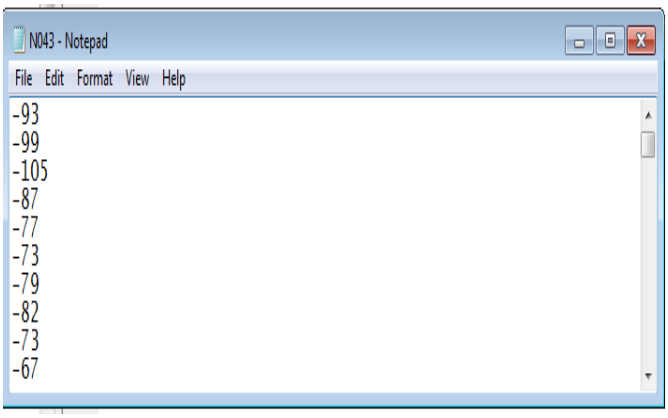


Fig : *.TXT file for acquired signals of EEG for processing

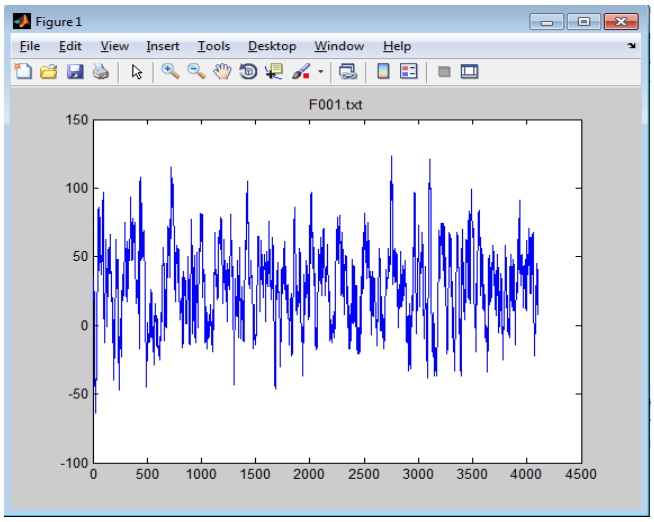


Fig: EEG Signal for processing as Input

The above graph demonstrates, input signal for processing into the system, the signals are retrieved from text file of acquired EEG samples from the hardware unit using electrodes. In this phase, the input is plotted with respect to amplitude v/s time slots for detailed segmentation and processing. This improves system dependency in overall management for signal processing under neural networking.

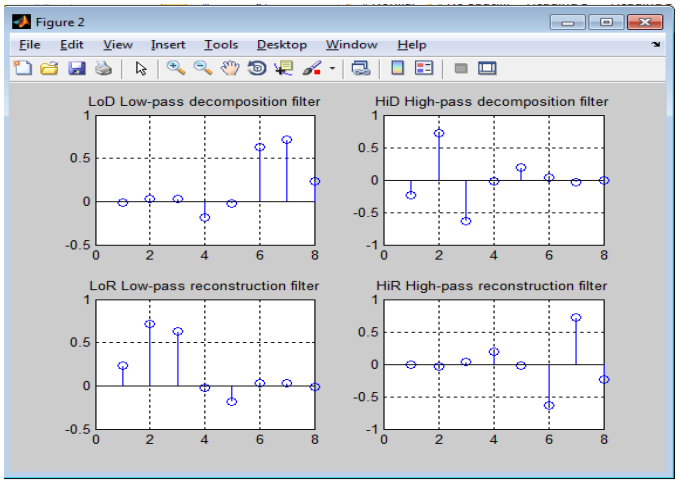


Fig : Signal Processing under Low and High pass filters.

For feature smoothing and attribute pattern extraction and dominance, the system is processed with low pass decomposition filter and low pass reconstruction filter and same with respect to high pass filters. This gesture of processing, improves overall benefit of processing and attribute extraction.

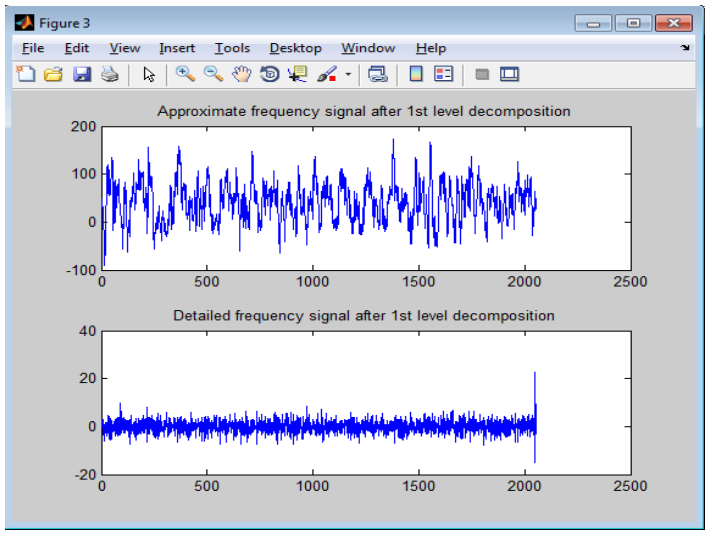


Fig : Frequency based EEG signal processing in Level1

The graph is plotted for frequency decomposition at 1st level of digitalization and the same is processed and shown in fig 5.4, in fig 5.4 (Above) demonstrates detailed approximation of signal frequency plotting. And in fig 5.4 (Below) demonstrates exact plotting of signal frequency after 1st level of decomposition.

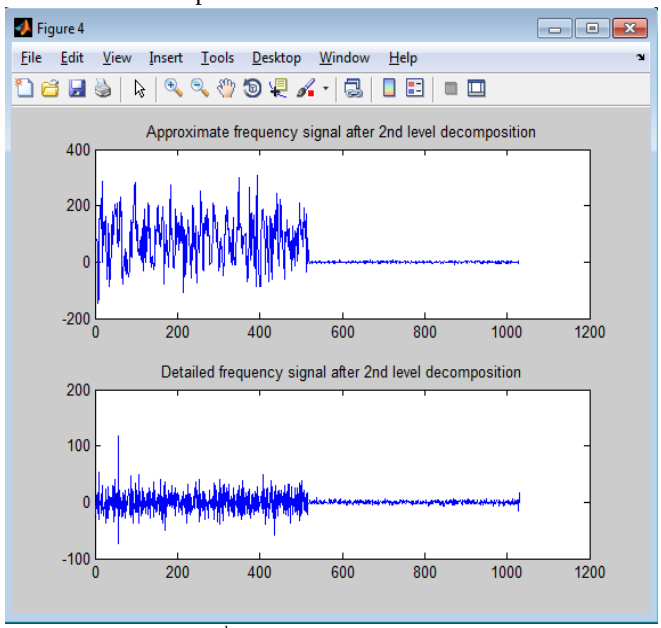


Fig : 2nd Level of Signal Frequency decomposition

In the above figure, 2nd level of signal decomposition is made and explained. The processed signal of 1st level of decomposition is provided as input to 2nd level. The obtained signals are now free from inter-oppressed noises and thus the feature patters are extracted. But there exist, a small value of threshold noises and thus 3rd level of decomposition

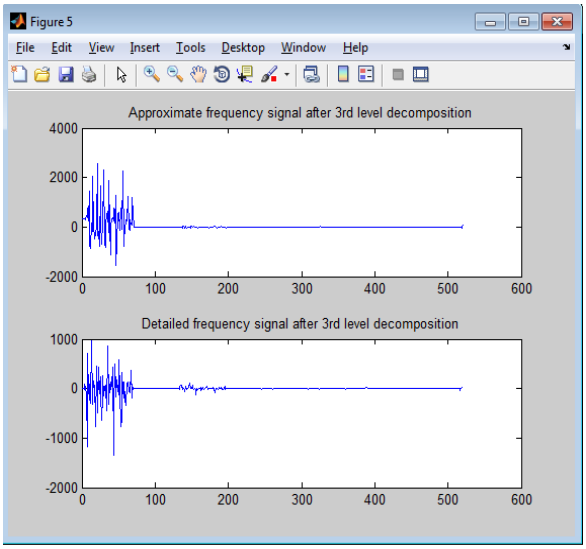


Fig: 3rd level of Signal Decomposition

The above graph demonstrates 3rd level of decomposition and refinement of signal attributes in more detailed and presided manner. Here the signal quality for authentication is improved and thus resulting signal attributes help in building a neural networking iteration.

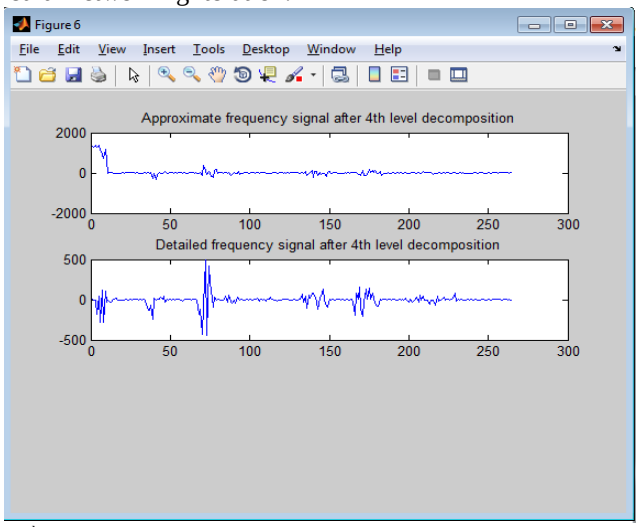


Fig: 4th Level of Signal decomposition

In this graph, the decomposition is finally conducted on incoming EEG signal and the same is processed for neural networking in generating an overall segment for processing, training and classification.

A. *Classification and Decision making*

Since the signal is decomposed and attributes are defined and extracted. The process of classification and signal processing under neural networking is to be initialized. In this regards, some basic information on SVM and other processing parameters are defined and processed. In this section, the system is reported with a signal spectrum analyzer for demonstrating a signal in various ratios of spectrum such as alpha, beta, gamma and theta is plotted. This improves the analyzing spectrum of given system. The alpha, beta, gamma and theta power spectrum values are truly different and most differently plotted with respect to frequency and amplitude comparison. The gamma retrieves maximum amplitude of 10, whereas beta has maximum amplitude of 2000 and then it is increased with 10^4 for theta and alpha and the same is reflected in larger value spectrum of 10^5 for Delta, this demonstrates the signal power ration with respect to amplitude and frequency. The detailed description is shown in th above figures in which, the users input of EEG signal is processed, trained and later added with performance, training state and regression computation. Signal under this is trained with respect to the power and attributes extracted.

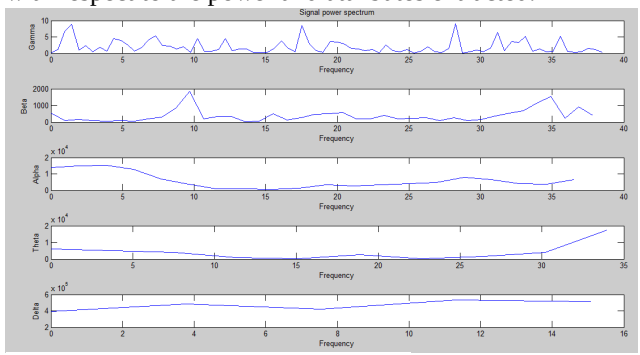


Fig : Power spectrum of incoming EEG signals

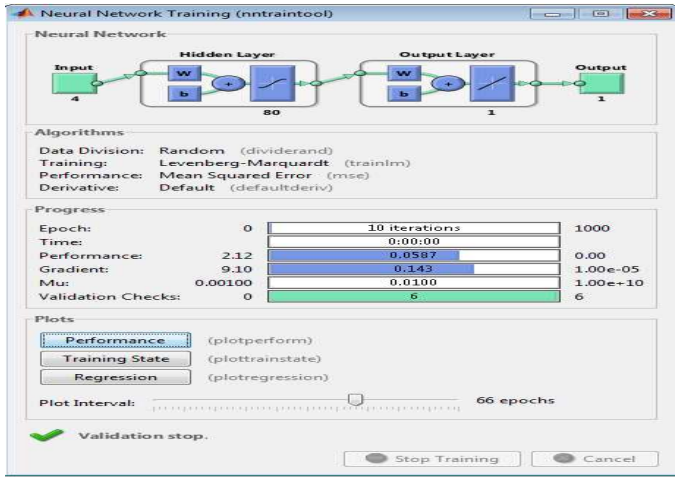


Fig : Neural Networking Console for EEG authentication

B. *Performance Estimation*

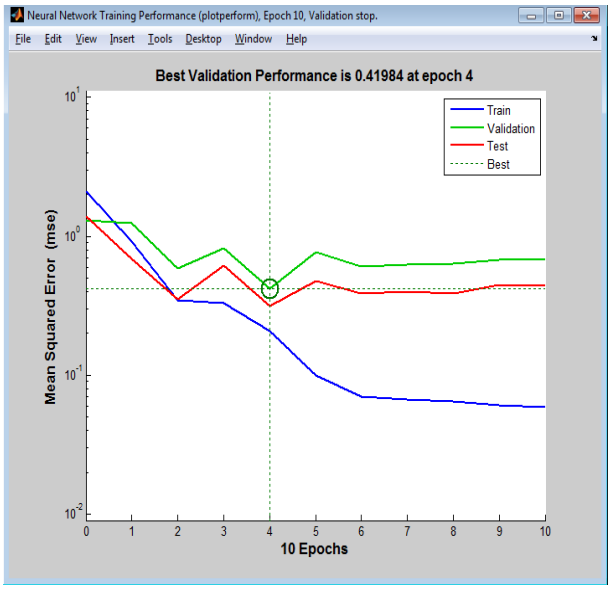


Fig : Performance estimation of 10 Epochs

C. *Training Set Validation*

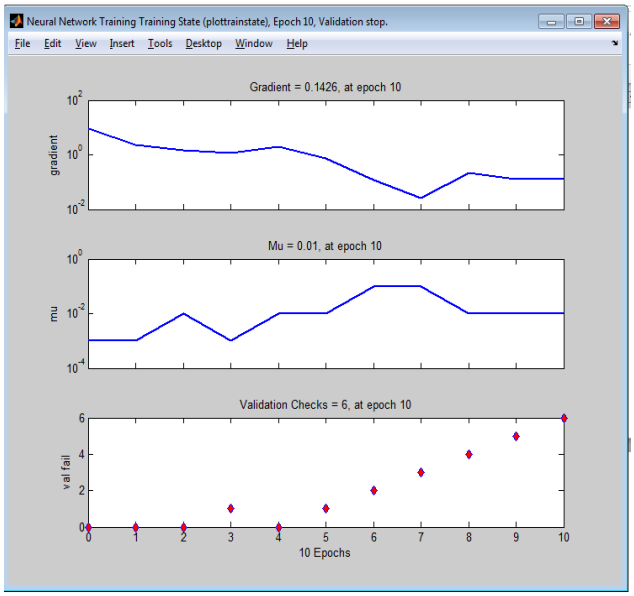


Fig : Training Set Validation

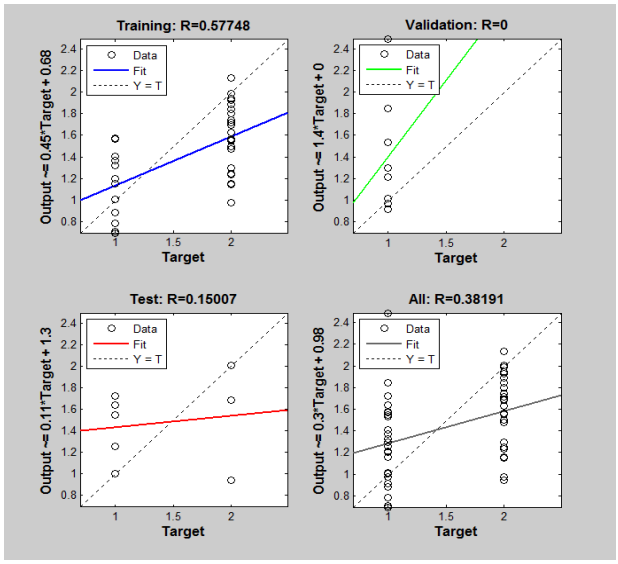


Fig : Regression Validation

V. CONCLUSION AND FUTURE WORKS

The designed application is processed and aimed to find a permanent solution in the era of security and threads. The processed system aims to provide, a secure personal computer access using, user's EEG signals as passwords. Currently used systems are highly calibrated and processed with modern security applications such as finger prints, passwords (strings) and Iris in most sophisticated systems. But preying from these applications is easy and hence, the proposed system is designed with users EEG signal acquisition and then processing for validations.

The proposed system has successfully retrieved signals and processed with higher degree of accuracy in MATLAB using neural networking concept. The processed system is secure and has higher degree of reliability for deployment, the performance is shown and discussed with detailed in previous chapters.

A. *Future Enhancement:*

In future this system can be deployed in higher alerting areas for providing security. In proposed system, an independent hardware is used for signal acquisition and there is chance for tamper such external devices, hence in near future, this can be improved by packing entire application into a commercial product.

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