Intelligent System to Recognize Human Brain Signals for finding Brain Diseases based on Neural Networks

Sasikumar Gurumurthy, B.K.Tripathy

Abstract— **Brain signals recognition has been a problem that computers are not efficient at. It is difficult to find the fine variations in the signal because the signals are too lengthy. Today, efficient brain signal recognition is limited to find different brain diseases such as epilepsy, tumor, encephalitis, and sleep disorders; using hardware like Electroencephalogram (EEG) wherein the strokes are directly detected and the brain signals is recognized. But if you want to convert a brain signal document to digital text, we have to extract the EEG signals and then recognize the brain diseases using brain signals. But the problem with this approach is that there are not many algorithms that could efficiently extract signals from a brain. Therefore brain signals recognition using software is still not as efficient as it could be. Fully automated systems to overcome the above problems are proposed. In this paper, we suggest the design of software which could do this job of translating brain signals to digital text data. We propose a new approach using which the problem of recognizing brain signals can be solved. We also provide the implementation details of this software. For the implementation of ours idea, we propose a new Neural Network Architecture, which is a modified version of the conventional Back Propagation Network. The technique adopted by the Back Propagation Network (BPN) used in neural network guided and stimulated me to design this paper. Details regarding the automatic preprocessing that would be essential and the shortcomings are also included in this paper. Our research work will be in classifying EEG with a neural network based intelligent systems.**

Index Terms— **Artificial neural network (ANN), Back Propagation Network (BPN), Electroencephalograph (EEG).**

I. Introduction

The scenario in any developing country is almost the same today. The western countries with their superior infrastructure, are making the most out of the technology while in countries like India, technology has been limited to the metropolitans where the infrastructure has been developed. But if we are to equal the developed countries in exploiting these technologies, we need to expand our infrastructure into the rest of our country including villages.

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But to this we should first implement a completely computerized way of doing everything. Everything from rations, electricity, grocery, to taxes should be kept track of by computers. This would drastically reduce the speed of processing to find brain diseases and manpower needed. This has to happen at some point of time, if not immediately, if we are to compete with the developed countries in any means. As it is obvious, establishing such an infrastructure in a country as huge as ours would require huge resources. The required number of computers, networks etc would be massive. This is one of the main areas of research in which the Indian department of information technology is involved. It is constantly working on producing cheaper [8] EEG devices, computers, components and software.

But even if we do produce such an infrastructure by the year 2020 as is expected, it would take a massive amount of manual work to do the switching or transition to such a system where everything is computerized. This is so because for over half a century, we have been recording every detail manually, and if we are to switch to a digital means, all these need to be converted into the digital media too. This means more work. Manually feeding all these details into a digital media would take mammoth manpower and time which cannot be practically accomplished. So a solution for this problem would be to computerize this transformation too, by developing software that would recognize brain signals and transform it into digital files or databases.

II. Our Model

The basic design of our software includes a buffer which is of equal size as the input EEG signal file [7]. The whole of the file is first scanned into this buffer. All the processing involved in the recognition process is performed on the data present in this buffer. The innovation or the difference in the recognition process is the way these signals are handled. As explained before in the already existing software, first a raster scan is performed on the signals and each signal is recognized making them not suitable for recognizing lengthy signals. To avoid this we prefer not to segment the lengthy signals before recognizing them. We accomplish the recognition process as and when the scanning is done. We use two simultaneous scans, a vertical and horizontal one; feed them to two different neural networks.

The key in this is that when a horizontal scan is performed, the signals are fed into a neural network which is trained to identify the bases of various brain signals. Once the base of a brain signals is identified, the lengthy signal, in the order in

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which they appear in the EEG, are transferred to a second buffer where the brain signals are placed. This is where the vertical scan comes into play.

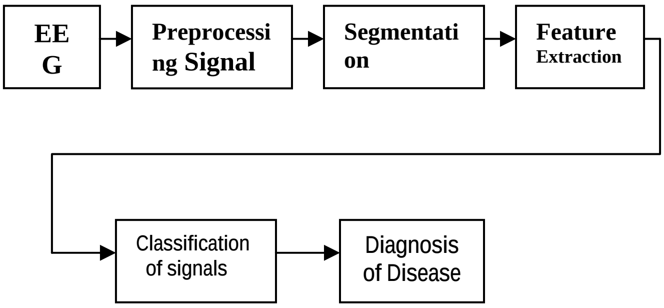

Figure 1: Block diagram of the proposed system

The brain signal buffer is scanned vertically and they are fed into the second neural network which identifies the brain signal based on the EEG pattern [10]. So when each of the signals is read, it is fed into the neural network which recognizes it at real time. But the output of this is not determined until the brain signals are decided for sure.

III. The Inspiration

The solutions that we have proposed is inspired by the Electroencephalograms (EEGs) are becoming increasingly important measurements of brain activity and they have great potential for the diagnosis and treatment of mental and brain diseases and abnormalities [4]. With appropriate interpretation methods they are emerging as a key methodology to satisfy the increasing global demand for more affordable and effective clinical and healthcare services. Developing and understanding advanced signal processing techniques for the analysis of [7] [8] EEG signals is crucial in the area of biomedical research. Our proposed work focuses on these techniques, providing expansive coverage of algorithms and tools from the field of digital signal processing. It discusses their applications to medical data, using graphs and topographic images to show simulation results that assess the efficacy of the methods.

The EEG typically scans each signal of the brain [9] and based on current input brain signal, the digital signal processing is made. The transition continues till a predefined EEG brain signal is reached. The final EEG signal that is reached decides what the brain disease is. This is exactly what we do with the digital signal data file containing the EEG brain signals. We scan each signal column and based on the pattern so far scanned and the current brain signal column the match percentage is calculated for the various pre processed lengthy brain signals. If a match is found to be good enough, then the recognition is made.

IV. The Problem

The problem here is that during such a real time operation, signals like brain and eye, muscles could be recognized as same before the complete EEG signal could be scanned [6]. So there is a need for an extra constraint which would make sure that this kind of real time processing does not end up in wrong results. The constraint is brought in to the network such that the recognition of the EEG brain signals [5] is based on the signals recognized till the previous EEG signal of brain and the current signal [7]. That is if a brain signal has been recognized till the previous signal of EEG and if the next few brain signals of EEG do not take it closer to any other signals in terms of the lengthy signals, then the corresponding EEG brain signals is recognized. If the next few EEG signals do take it closer to some other signals then, the EEG till which the signal (s1) was recognized is kept track of, and then if it starts to deviate from that EEG signal then it is still recognized as s1, and the next signals starts from the electrode next to s1.

On the contrary, if it takes the recognition extremely close to some other signals (s2), then the brain signal is recognized as s2 and not s1. For example, ‘Electrode 1’ could be s1 and ‘Electrode 2’ could be s2. In that case, s2 is recognized. If some other brain signals like were in the following signals, it might take the signal closer to ‘Electrodes’ but starts to deviate there after then it is recognized as Electrode 1 and some other signals. Thus the recognition could be performed at real time. Therefore the recognition could be extended to digital signal processing form.

V. Implementation

A. *Using Back Propagation Network*

The idea that we proposed can be easily implemented using a conventional back propagation network. The network as usual can have one or two hidden layers [1]. The number of output units is equal to the number of digital signals present in the brain that is being recognized.

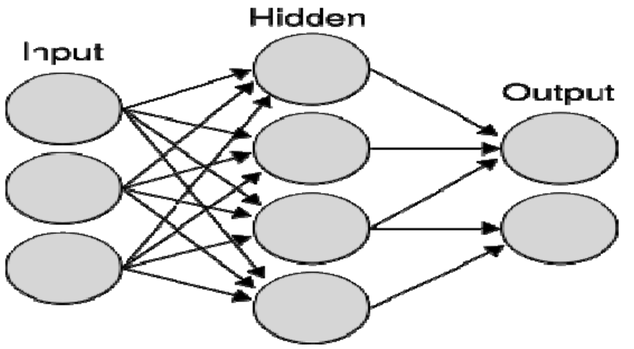

Figure 2: Architecture of back propagation network

The number of signals in the input layer is equal to the sum of the number of signals in the output layer and the maximum EEG signal of the brain. The input to the brain consists of different sets of electrodes. One set represents the pattern of the signal of brain that is currently being analyzed. The other set is basically the output that is being fed back into the input layer. The output of the EEG brain signals would represent the percentage match of the pattern so far scanned with the various brain signals. So when this information is fed back as a part of the input, and the other part being the information on the pattern, then the output depends on both the previously recognized patterns and the current pattern.

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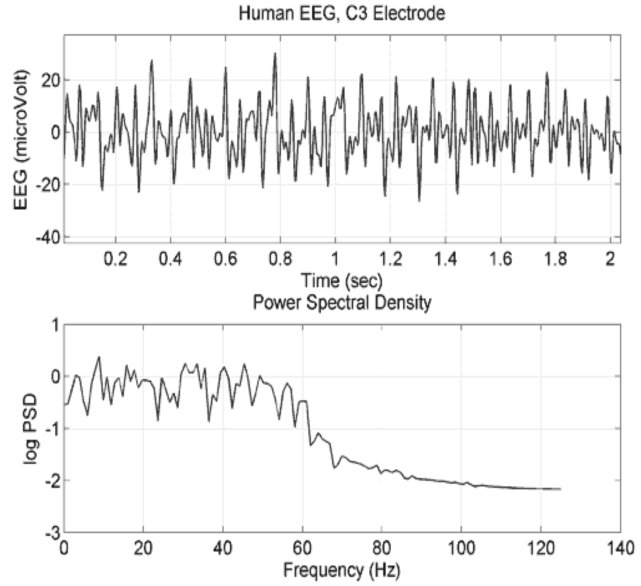

Fig 3: EEG Signal Recognition using electrodes

Based on this it is decided whether the pattern matches more with the brain signals or not. Thus when the percentage match exceeds an EEG signal data, then the brain signal is recognized. But the problem with this implementation is that we would have to create a way to link the values representing the percentage match with the EEG signals [9] and the brain signals that they stand for. Instead of this, we refined the neural network so as to give a new architecture that would perfectly suit the problem in hand.

B. The Preprocessing

The preprocessing required for the recognition is pretty simple; the whole of the EEG signals is reproduced by stretching the brain signal as is necessary [10]. This is done so that the EEG signals to be recognized are in standard size. If only this is the case would the number of states per EEG signals would be the same as the ones given during implementation phase.

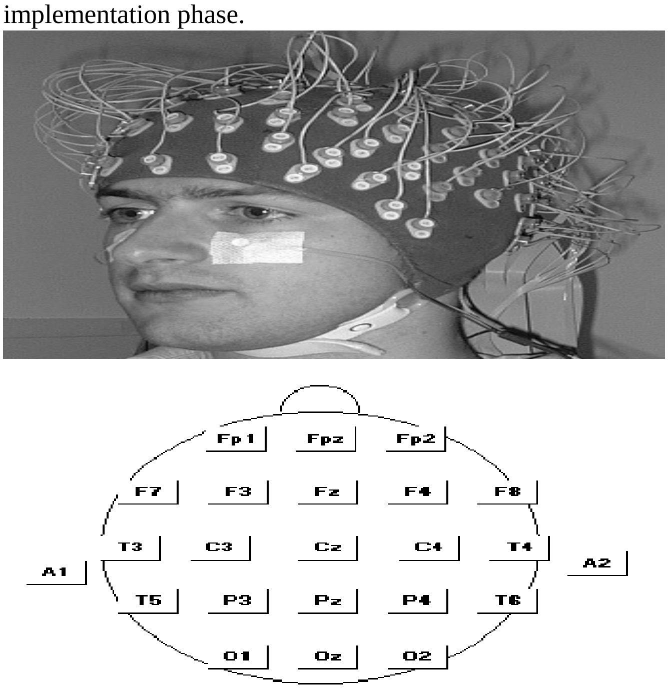

Fig 4: Electrodes connected with Head to Read EEG Signals

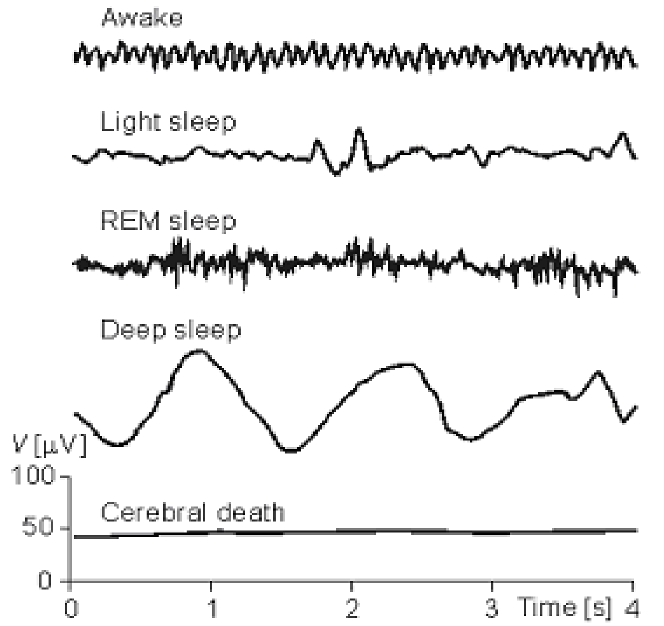

Fig 5: Signal Analysis

VI. Conclusion

There are a few challenges in this method that we have yet to overcome which we hope to do in the next couple of years. The major one is setting the thresholds for optimized brain signals recognition [7]. These signal processing include the number of brain signals that needs to be looked ahead before the electrode could deliver the output. Another factor of concern with algorithm, when the proposed neural network is used, is the time constraint. But with faster pre-processors coming up, this should not be much of a concern, at least not the major concern. Provided these challenges are taken care of, we believe that the algorithm could prove to be a highly effective means of recognizing brain signals with a high degree of precision.

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