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FPGA Based Sleep Disorder Detection Using Brain Waves

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Abstract **–** In this paper, a FPGA Based Sleep Disorder Detection using Brain Waves has been proposed. Personality has been conceptualized from a variety of theoretical perspectives. Design of EEG based emotion analysis is developed in existing system. The Alpha, Beta, Theta and Delta waves are used in the detection of sleep disorder. This project involves the fusion of MATLAB-FPGA development. The waves are trained using a convolutional neural network and tested using a FPGA kit.Keywords - Very high-level design language (VHDL), Electro-encephalogram (EEG), Field programmable gate array (FPGA).

I.INTRODUCTION

The changes in the sleeping activity are due to sleep disorders which are also brain disorder. This disorder does not allow the patient from gaining ample amount of sleep. A normal person requires 7-10 hours of sleep each day for his regular actions to be normal. In living organisms, the brain is the controller which control all actions. Likewise, the sleep actions are also controlled by the brain. The sleep disorders which are not diagnosed properly can bring some serious medical issue. Sleep disorder is common in children mainly school going children suffer from this disorder. There is treatment available for some sleep disorder by which they can be cured while some are manageable but can't be cured. [1] Sleep Disorder is characterised by 1. Frequently waking up during night 2. Waking up early 3. General feeling of exhaustion 4. Feeling slow and not refreshed during day. The complexity of the human brain is one of the most well documented fields of academic study. Nowadays multiple technologies exist to record brain wave patterns, Electroencephalography being one of them. Through, Electroencephalogram based signal, the brain's inner mechanisms and their association with psychological and psychiatric disorders can be established. Brain cells communicate by producing tiny electrical impulses. In an EEG, electrodes are placed on the scalp over multiple areas of the brain to detect and record patterns of electrical activity and check for abnormalities. EEG cannot be used to "read the mind," measure intelligence, or diagnose mental illness.

Data:

Signal recorded from surface of the scalp

Strength: 1-20 microvolts
Bandwidth: 0-35Hz

[2] EEG activity can be broken down into 4 distinct frequency bands:

Beta activity > 13 Hz
Alpha activity 8 Hz-13 Hz
Theta activity 4 Hz-7 Hz
Delta activity < 4 Hz

Alpha activity is also a normal activity when present in waking adults. It is mainly seen in the channels recorded from the back of the head. It is fairly symmetrical and has amplitude of 40 µV to 100 µV. It is only seen when the eyes are closed and should disappear or reduce in amplitude when the eyes are open. Beta activity is a normal activity present when the eyes are open or closed. It tends to be seen in the channels recorded from the center or front of the head. Some drugs will increase the amount of beta activity in the EEG. Theta activity can be classed as both a normal and abnormal activity depending on the age and state of the patient. In adults it is normal if the patient is drowsy. However, it can also indicate brain dysfunction if it is seen in a patient who is alert and awake. In younger patients, theta activity may be the main activity seen in channels recorded from the back and central areas of the head. Delta activity is only normal in an adult patient if they are in a moderate to deep sleep. If it is seen at any other time it would indicate brain dysfunction. Abnormal activity may be seen in all or some channels depending on the underlying brain problem. [3] There are a number of other waveforms which tend to be a little more specific to certain conditions. For example, spike and wave activity indicates a seizure disorder and may be seen in the EEG even if the patient is not having an epileptic seizure. Other epileptic conditions may be diagnosed if spikes or sharp waves are seen. [4] Triphasic waves are sometimes seen if the patient has severe liver or kidney disease that is affecting brain function. These are just brief descriptions of some of the simpler waveforms that may be seen in any one EEG recording. Combinations of any of the above patterns are possible which can make interpretation of the record difficult. Abnormal activity is not always specific to any condition and may suggest a few different diagnoses.

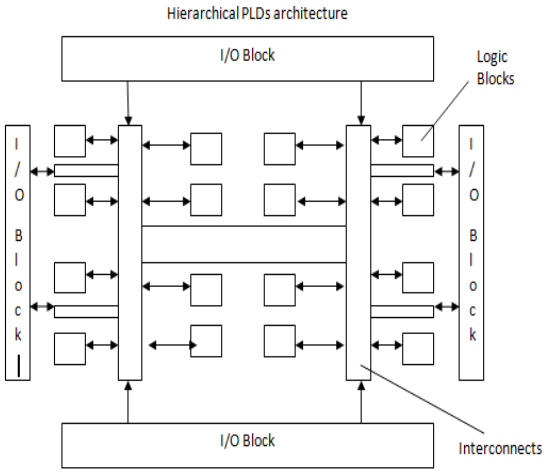

Fig 1. FPGA ARCHITECTURE

A precise architecture of an FPGA varies from manufacturer to manufacturer. Here, we present a generic FPGA structure that contains the following elements. [5] **Programmable logic blocks:** Logic blocks can be formed from thousands of transistors to millions of transistors. They implement the logic functions required by the design and consist of logic components such as transistor pairs, look-up tables (LUTs), and Carry and Control Logic (flip flops and multiplexers). [6] **Programmable I/O blocks:** They connect logic blocks with external components via interfacing pins. **Programmable interconnect resources:** They are electrically programmable interconnections (pre-laid vertically and horizontally) that provide the routing path for the programmable logic blocks. Routing paths contain wire segments of varying lengths which can be interconnected via electrically programmable switches. The FPGA density depends of the number of segments in used for routing paths.

II.LITERATURE SURVEY

In the present Generation the Sleep Disorder has become common among most of us. There can be many reasons while few among them are tension, depression, working under pressure, fear etc. This type of Disorder is very common among school children, Working adults, and aged people. The brain plays a vital role in the sleeping actions of humans. There are many technologies and researches going on regarding the brain wave activity.

In the present, [7] a dry electrode in placed on the forehead, from which useful information regarding the various cognitive dysfunctions and disorders can be detected and treated. The use of dry electrode on the forehead allows for easy and rapid monitoring on an everyday basis. [8] The other method for determining the sleep disorder using the Welch Algorithm based on the PSD Analysis on EEG Signals. The rapid eye behaviour of several patients and normal people is analysed and an accurate PSD (Power Spectral Density) estimate is calculated using the MATLAB software by Trapezoidal Integration method. The disadvantage of this method is that it involves a lot of mathematical calculations and is a very tedious process. [9] The sleep apnea, which is a serious sleep disorder that pauses breathing while sleeping. The sleep apneic events are detected using classifiers, MEMS sensors and Blood Oxygen sensors, while the SVM and Neural Network Classifiers are used to classify these events from the normal events. The Disadvantage of this method is its affordability, timing and calculation of the sleep apnea during the night-sleep.

III.METHODOLOGY

EEG brain wave dataset is extracted from various patients. EEG signals and Features are extracted and filtered to detect the Peaks. Using Alpha, beta, theta, delta waves and their frequencies a slow Disease called SLEEP DISORDER is detected. A database which consists of raw data undergoes Principal Component analysis.

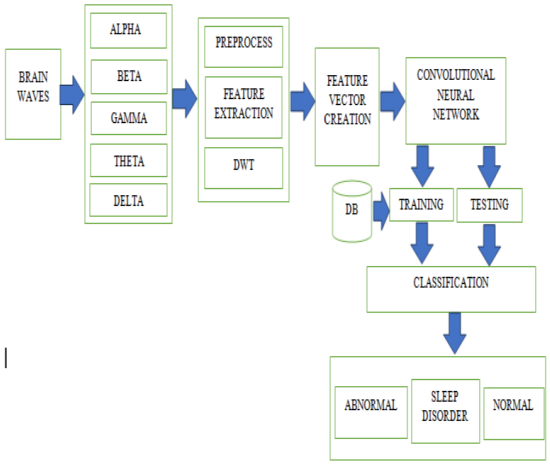

Fig 2. BLOCK DIAGRAM

First, the brain wave dataset is extracted from the source and then the alpha, beta, theta and delta waves are fetched from these brain waves. These waves are pre-processed using discrete wavelet transform to obtain the feature vectors. A trained Database for the disorder detection is fed into the convolutional neural network. The extracted brain vectors are compared with the trained dataset using a threshold comparator, from which the threshold peaks is obtained. Using these peak values, the sleep disorder can be detected as follows:

Sleep Disorder : 18<value<70
Normal : 71<value<90

Abnormal : 0<value<1

IV.HARDWARE IMPLEMENTATION

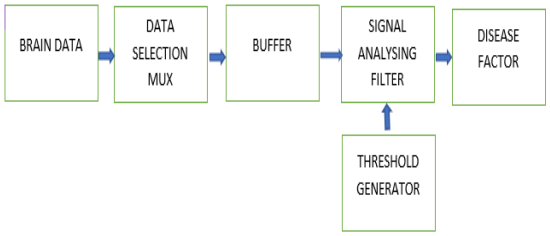

Fig 3. HARDWARE FLOWDIAGRAM

The brain data in a array is got which is stored in a memory designed inside the FPGA. The data selection multiplexer is designed in which selection is done using reconfigurable bits. Buffer is used to hold the data for one clock period to control the flow of data. Signal analyser is nothing but the digital filter with threshold comparator. Here the threshold generator generates different threshold for normal person and Sleep disorder affected person. The disease factor is generated to find out the disease level.

V.OUTPUT

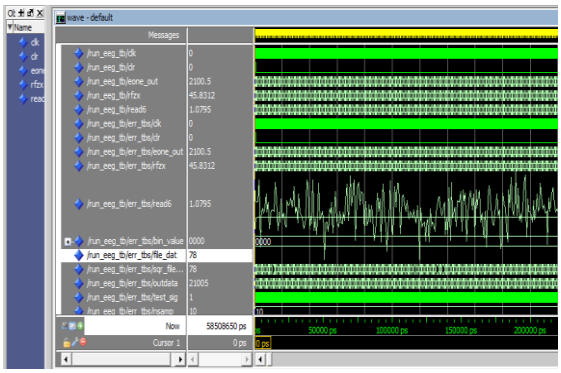

Fig 4. EEG DATA READ

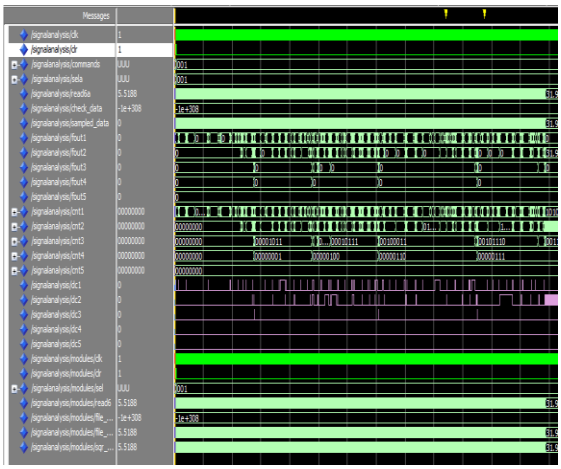

Fig 5. SIMULATION OUTPUT

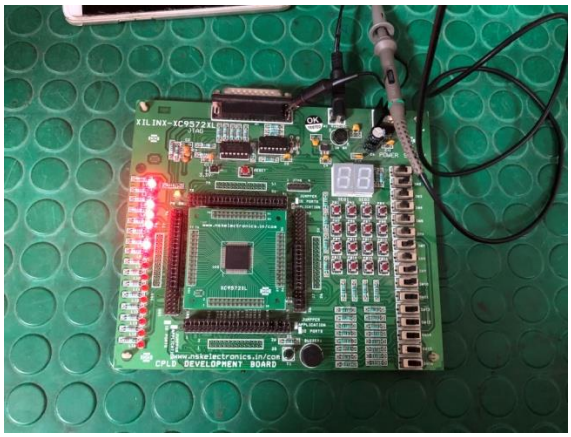

Fig 6. FPGA KIT WITH DATA READ

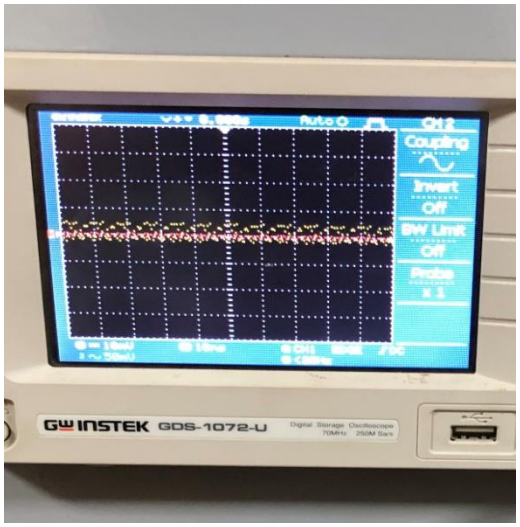

Fig 7. CRO OUTPUT OF EEG BRAIN WAVES

VI.CONCLUSION

In this paper, a FPGA based Sleep Disorder Detection using Brain waves is implemented that detects whether the patient is normal or abnormal or has sleep disorder. The brain wave dataset is extracted, and then DWT, filtration is performed for vector creation. The threshold comparator compares each data and determines the peak value, from which the sleep disorder disease can be detected. The hardware implementation is also introduced in this paper. This method can be implemented in Smart Hospitals, Employee stress detection in organisations. In the future, brain related diseases like alzheimer, epilepsy, apnea etc., can be detected and treated.

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