Epilepsy Seizure Feature Extraction using Discrete Wavelet Transform for Healthcare Application

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Abstract

Epilepsy is a brain disorder which has been under scientific study for decades. The study and prediction of epileptic seizures requires the usage and analysis of EEG signal. The signal shows electrical activity in the human brain which helps doctors and medical staff to aid the patient. According to state of art methods, the analysis of EEG waveforms is very complex. In this project we aim to analyse the EEG waveforms in a simple and lucid way using Discrete Wavelet Transform (DWT) and extracting plots to differentiate between epileptic and non-epileptic cases.

Keywords: epilepsy, EEG, DWT, epileptic seizure.

INTRODUCTION

An electroencephalogram (EEG) was a trial that uses tiny alloy plates anodes add to our scalp to identify programmed activity in your brain. Synapses interact through circuit driving forces and are always dynamic, during the sleeping hours. Wavy lines on an EEG recording mark the presence of EEG. An EEG is only primary trial for spasm an EEG can likewise assume a part in distinguishing cerebrum problems. An EEG may be likewise be utilized to affirm mind demise in somebody in a resist unconsciousness a persistent EEG is utilized to archive track down the right degree of sedation for somebody in a medicinally incited unconsciousness. It doesn't involve introduction of any instruments. The cathodes are put aside the scalp albeit obtrusive terminals and later used in electrocorticography here and there called intracranial EEG the anodes don't send any simulation they simply file your cerebrum waves a mind pc interface BCI in some cases called a Neural control interface(NCI),mind machine interface(mmi),direct neural interface(DNI) or cerebrum machine interface(cmi) is an immediate response way between an upgraded or wired mind and an outer gadget BCI's are frequently aimed at exploring planning helping human psychological or tactile engine capacities as of late concentrates in human-pc association through the utilization of ai with factual worldly highlights removed from the front facing flap EEG brainwave information has shown significant degrees of achievement in grouping mental states and loose impartial concentrating mental passionate states negative unbiased positive and thalamocortical dysrhythmia. We utilize electrodes to connect the

brain and the computer, and we record the EEG data and save it as a dataset. We employ a variety of data sets in this effort to look at both epileptic and non- epileptic cases in patients. When the patient is normal and his or her EEG data obtained dynamically shows no health issues, the project displays a normal condition coupled with a voice command for the patient's understanding. When the patient is in a critical state and is having any prospective epileptic seizures, a voice command along with a text output is generated accordingly so that the medical staff can understand and alert the respective doctors for further treatment of the patient.

METHODOLOGY

A nervous system specialist typically makes the determination of epilepsy; however, it very well may be hard to make in the beginning phases. Electroencephalogram securing and translation, then again, require some investment and can be expensive. Mechanized discovery of related seizure action might be an answer. Various otherworldly edges are determined and the fitting recurrence sub-band mixes are developed to examine the impact of the elective meanings of the recurrence sub-groups that are being explored. The EEG signal is breaking down and a vector of otherworldly properties is characterized for every one of these recurrence sub-band mixes. In view of this component vector, an order pattern is utilized to quantify the suitability of the particular recurrence sub-band blend, as far as epileptic EEG characterization precision.

A classification strategy is developed based on this feature vector to assess the propriety of a given recurrence sub-band mix as far as epileptic EEG order precision. EEG signals in their crude structure should be pre- processed before they can be dissected or ordered. Pre-processing regularly incorporates separating and relic evacuation as accounts can contain undesirable commotion blended in with the genuine EEG energy/cerebrum wave/signal. Ancient rarities can begin from different sources like the subject, gear, or the climate and comprise of visual antiquities, for example, eye flickers; development of the EEG sensors; and electromyogenic curios, brought about by muscle development. Curios are regularly taken out by taking out specific frequencies from the EEG signal utilizing high-pass, low-pass, band-pass, and indent channels.

The information is pre-prepared by going it through a low pass channel to eliminate the superfluous recurrence groups since the required frequency region of epileptic seizures and normal brain waves are in the range of 30Hz to 50Hz only. The data that we process contains data that ranges for various frequency values which is not required in our study.

Raw EEG signals are always collected in a chronological order. Nonetheless, interpretation explanation into dissimilar areas is conceivable and much of the time needed for investigation and highlight extraction. Recurrence portrayals, just as the Fourier change and the wavelet change, are models. Recurrence related metrics have the advantage of being less vulnerable to signal quality fluctuations caused by electrode location or the physical characteristics of subjects.

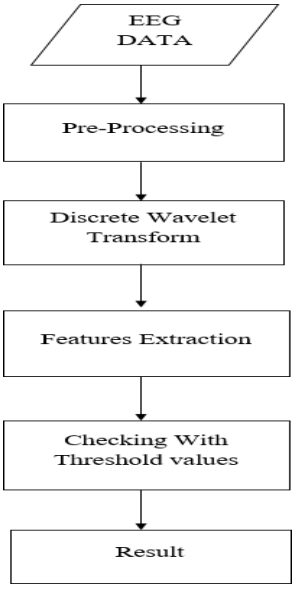

Fig. 1. Block diagram for [1] Wavelet Transform

Wavelets are a kind of numerical capacity that enjoys upper hands over average Fourier strategies for considering actual signs with discontinuities and solid spikes. The fields of applied number related like actual science, seismic topography and designing science have utilized and grown autonomously wavelets during most recent twenty years prior which winds up in new wavelet applications like pressure, radar, and tremor forecast. Haar wavelet was started and freely created by certain creators. Wavelets might be summed up as a group of capacities developed from change and enlargement of one capacity called mother wavelet. From different sorts of

persistent and discrete wavelets, Haar wavelet is that the discrete sort of wavelet which was first proposed and accordingly the first orthonormal wavelet premise is that the Haar premise. Differential conditions (DEs) are most imperative devices in numerical models for actual wonders. Numerous premises acclimated inexact the arrangements of DEs. Haar wavelet is simple premise acclimated inexact the appropriate response of DEs. set up a direct mathematical technique upheld Haar wavelet operational framework of joining for tackling two dimensional elliptic incomplete differential conditions (PDEs) of the shape, utilized Haar wavelet operational lattice for the mathematical arrangements of Fr Des

,utilized 'Haar' wavelet-semi linearization procedure for Fr DEs, utilized Haar wavelet strategy for addressing Fr DEs mathematically applied Haar wavelet change to unwind essential conditions (IEs) and DEs, settled 2D and 3D Poisson conditions and biharmonic conditions by the Haar wavelet technique while introduced a mathematical technique for reversal of Laplace change utilizing the methodology of Haar wavelet operational grid. The executions of Fr DEs which are utilized as numerical models in numerous genuinely huge fields and field. As of late, the approximated arrangements of the Fr DEs are considered utilizing Haar wavelet strategy which shows to be more reasonable to surmised the arrangements of them. These days, Haar wavelets are most by and large and easiest on account of their effortlessness, the Haar wavelets are compelling apparatuses for approximating arrangements of DEs. When this type of difficulty arises, largely estimated arrangements become available. The Haar wavelet approach is one of the estimated strategies for looking out.

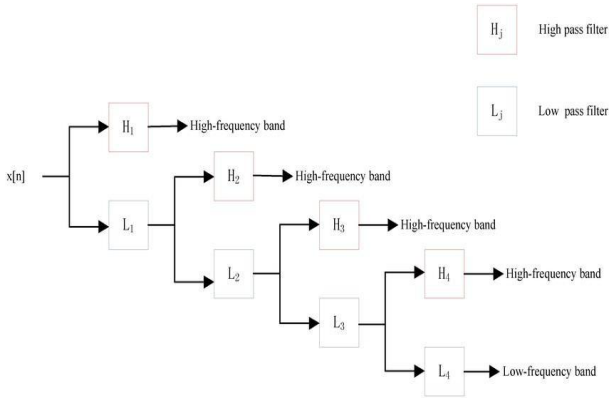

Fig. 2. 4-level Discrete Wavelet Transform [2]

The Haar transform, introduced by the Hungarian mathematician AlfrédHaar in 1910, is one of the oldest transform functions. The Haar wavelet is a set of recompute "square-shaped" role that jointly form wavelet family or reason in mathematics. Wavelet examine is similar to analysis in that it allows role to be described in terms of an 90 basis across an interval. Wavelets were not studied until much later, and the term "wavelet" was not coined until much later. Each wavelet is also known as Db since it is a particular case of the Daubechies wavelet.

PIt's discovered successful in applications like sign and pressure in electrical and PC designing since it gives a direct and computationally productive methodology for examining the nearby parts of a sign.

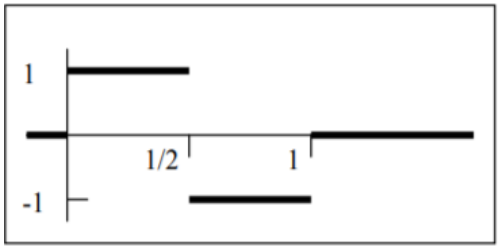

Fig. 3. The Standard Haar Wavelet

Properties of Haar Wavelet Transform: Each transform has the subsequent quality

1. Multiplications aren't required. The computation time is short since it simply requires additions and the Haar matrix contains many members with zero values. It's faster than the Walsh transform, which uses a +1 and 1 matrix.

2. insect and return long are the identical. However, the length should be an influence of two

3. It is accustomed examine the localized feature of wave. because of the 90 properties of each function, the amount components of signal are often examined.

FEATURE EXTRACTION

Because of the phenomenon of human stereotype, feature selection is one of the most difficult tasks in affective computing. This is on the grounds that various people express same feeling with various trademark reaction designs for an equivalent circumstance. Each subject associated with the test was having different physiological records

that showed high connection with each emotional state. From the acquired EEG information, it was seen that physiological highlights were exceptionally associated with the condition of excitement among two subjects. The crude EEG information is then prepared to remove the chose highlights and genuine incentive for them. Diverse sign handling strategies are accessible for the root mean square rms to has for some time below believed to be a significant boundary for isolating cramp from non-cramp events to the rms is a viable sign strength assessor in EEG recurrence ranges since it estimates the greatness of the fluctuating amount in an examination on neonatal seizure recognizable proof rms was found to have a general exactness of 77.71 percent when 21 highlights for seizure grouping were analysed in any case the picturing was apparently lower to than that in another investigation where rm was utilized related to different highlights instead of as a solitary component

Here, we classify the patients into two major groups and the neurologist is under the responsibility of further diagnosis and patient assistance. The two major groups are namely: critical and non-critical condition according to epileptic seizures data, data classification and feature selection. The principal seizure recognition and classification results were distributed in 1979. Utilizing a spike and sharp wave discovery strategy, Gorman contemplated the programmed acknowledgment of epileptic movement in broadened EEG chronicles. This exploration prompted the investigation of useful attractive reverberation imaging (FMRI) and the connection between changes in cerebral hemo-dynamics and epileptic seizures occasions noticeable in EEG. In 2013, sound system electroencephalography (EEG) utilizing high recurrence exercises in the wavelet area was proposed. While the recognition affectability was high (86%) and the particularity was satisfactory (0.47/h), the discovery delay is long (mean postponement 16.2 s).

The data is then analysed to gain some statistical insights in order to identify and differentiate the normal person from a patient who has epileptic seizures. The mathematical parameters that are used are namely:

Minimum Value – Minimum value of the EEG data set is taken and a graph is plotted with all the minimum values in the given range of frequency. This minimum value is obtained by wavelet decomposition function – wavedec and plotted as a graph using the plot function that MATLAB provides.

Maximum Value- Maximum value of the EEG data set is taken and a graph is plotted with all the minimum values in the given range of frequency. This maximum value is obtained by wavelet decomposition function – wavedec and plotted as a graph using the plot function that MATLAB provides.

Mean Value -For an informational index, the math mean, otherwise called consolution or number-crunching normal, is a focal worth of a limited arrangement of numbers: explicitly, the amount of the qualities partitioned by the quantity of qualities. The mathematical mean of a bunch of numbers l1, l2, ..., ln is regularly determined by taking the frequency, all things considered, and separating the entirety by number of samples.

Standard Deviation - In statistics, the standard deviation is a measure the amount of variation or dispersion of a set of values. A low standard deviation indicates that the values tend to be close to the mean (also called the expected value) of the set, while a high standard deviation indicates that the values are spread out over a wider range. It is simpler but less effective than absolute deviation. A useful property of the standard deviation is that unlike the variance, it is expressed in the same unit as the data. The standard deviation of a population or sample and the standard error of a statistic (e.g., of the sample mean) are quite different, but related. The sample mean's standard error is the standard deviation of the set of means that would be found by drawing an infinite number of repeated samples from the population and computing a mean for each sample.

$$\sigma = \frac{\sqrt{\sum x^2 - x^2}}{\mathrm{n}}$$

Variance - In probability theory and statistics, variance is defined as the squared deviation from the mean of a random variable. As In technical studies, where measurable information examination is far and wide, change is a helpful instrument. The change is the square of the standard deviation, the second focal snapshot of a dissemination, and the irregular variable's

covariance with itself, and it is ordinarily signified by the letters Var (X).

Power – Power spectral examination is a well-known technique for analysing EEG signals. The pharmacological effects of anaesthetics on the brain and the level of sleepiness can be measured using spectral characteristics. This approach has been used to measure depth of anaesthesia in a variety of ways, and it has been included into a number of commercially available EEG monitors.

Root mean square (RMS) value - The square root of the mean square (RMS or rms) is defined as the root mean square (RMS or rms) (the arithmetic mean of the squares of a set of numbers). The quadratic mean, commonly known as the RMS, is a special instance of the generalized mean with exponent 2.RMS can alternatively be expressed as an integral of the squares of the instantaneous values during a cycle for a continuously evolving function. The data that has now been processed is utilized to create graphs that allow doctors and medical personnel to distinguish between different types of patient problems. The data that is now processed is used in plotting graphs that enable the doctors and medical staff to differentiate between various kinds of patient conditions.

TABLE I.NORMAL EEG VALUES

Parameters	Max Value	Mean Value	Min Value
Power	37.938	33.085	27.713
RMS	21.154	19.168	16.746
Variance	34.868	31.83	26.835
Standard Deviation	20.132	18.728	16.351

The maximum, minimum and mean values of attributes like power, RMS, variance and standard deviation have been extracted in parameter extraction from EEG data of a normal person and used as threshold values to determine the condition of patient according to dynamic or real time input.

TABLE II. EEG VALUES OF EPILEPTIC PERSON

Parameters	Max Value	Mean Value	Min Value
Power	55.657	48.59	40.449
RMS	30.664	27.099	22.29
Variance	55.657	48.5	39.421
Standard Deviation	30.6	27.273	22.273

The maximum, minimum and mean values of attributes like power, RMS, variance and standard deviation have been extracted in parameter extraction from EEG data of a person with epilepsy and used as threshold values to determine the condition of patient according to dynamic or real time input.

SIMULATION RESULTS

A healthy person's electroencephalogram (EEG) changes with age. Spindles – short runs of rhythmic activity in the 12 to 14 Hz range (sometimes referred to as the "sigma" band) with a frontal to central maximum – are a hallmark of stage II sleep, according to the normal EEG alterations based on the person's state, sleep. In Stage II, the majority of activity occurs at 3 to 6 Hz. Stages III and IV sleep, which are collectively referred to as "slow-wave sleep," are distinguished by the presence of to delta frequencies. Non-REM (or "NREM") sleep is characterised in Stages I–IV. The electroencephalogram (EEG). The EEG during "REM" sleep looks a lot like the EEG when you're awake. In the EEG of an awake adult, most waves up to eight Hz and higher frequencies are normal. Waves with a clone to a frequency of seven Hz or less often are divided as eosinophilia in awake adults, although they normally can be seen in kids or in adults who are too asleep. β action: electromagnetic waves running somewhere in the range of fourteen and 30 Hz in recurrence, and somewhere to in the range of five and 20 μV in abundancy. This kind of movement happens in the front facing locale when individuals are cognizant and alert. These waves are especially obvious when an individual is thinking to or getting tactile incitement. An EEG records the electrical activity of the brain at the time the test is being performed. The activity of the brain alters during an epileptic episode. On an EEG recording, this alteration, known as epileptiform brain activity, can sometimes be noticed. Anomalies in the electroencephalogram (EEG) can take two forms. For starters, normal brain function may be disturbed and altered without warning. In epileptic seizures, this is a very regular event

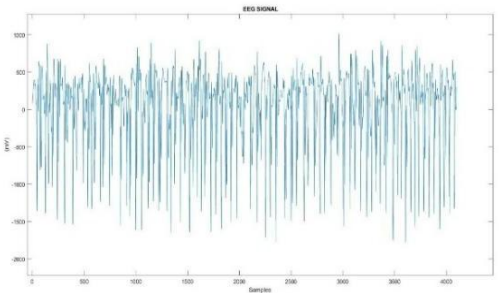

Fig. 4. EEG data of normal person

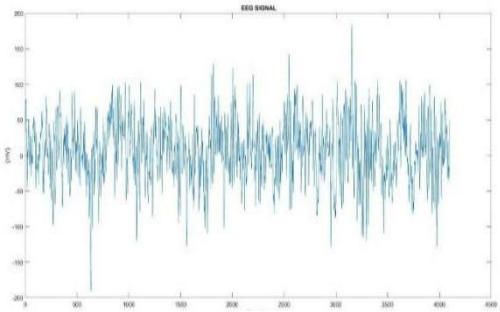

Fig. 5. EEG data of epileptic person

The EEG waveform of an epileptic person is highly distributed in Mv as shown in the figure. This indicates that the person has an abnormality in the brain neuron activity which leads to physical complications. Doctors and clinical staff are trained to read the EEG waveform data and thus can determine what diagnosis, medical tests and medication needs to be prescribed to the patient with the reference of the EEG waveform.

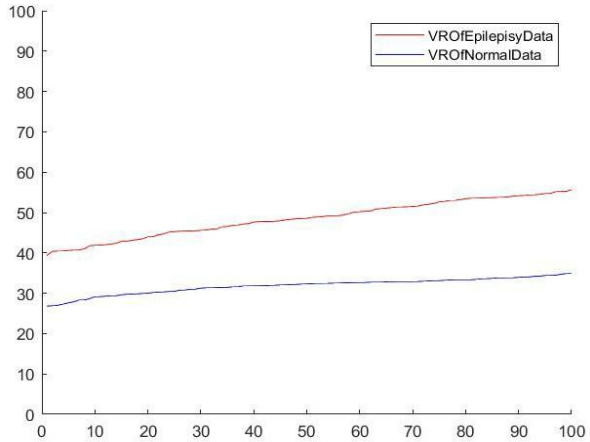

Fig. 6. Statistical Measure: Variance of Epileptic and Non-epileptic person

The variance attribute of the EEG data is obtained via wavelet decomposition and according to the threshold values mentioned in Figure 3 and Figure 4, the plots are generated. The red line in the plot shows the variance in EEG data of a person with epilepsy and the blue line in the plot shows the variance in EEG data of a normal person.

This clear difference in data extracted and plotted as graphs gives us a clear idea of the magnitude of abnormality.

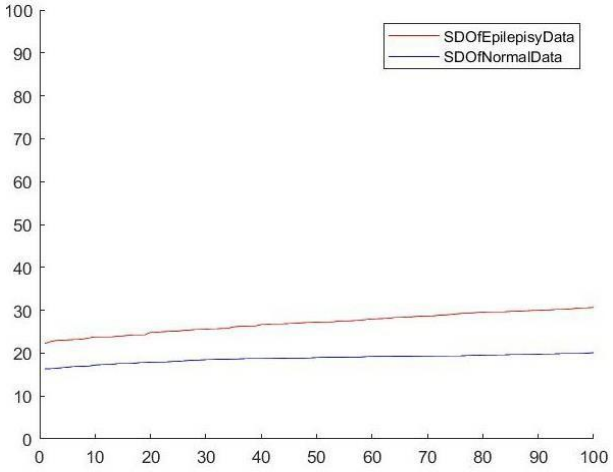

Fig. 7. Statistical measure: Standard Deviation of EEG for Epileptic and Non-epileptic person

The Standard Deviation measure is a statistical parameter like variance and is obtained by the square root of variance. The plot follows the same colour code as that of variance and shows a clear difference between person with and without epileptic disorders.

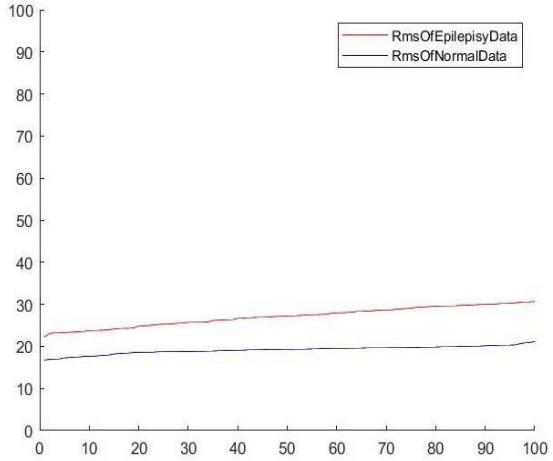

Fig. 8. Statistical Measure: RMS values of Epileptic and Non-epileptic EEG data

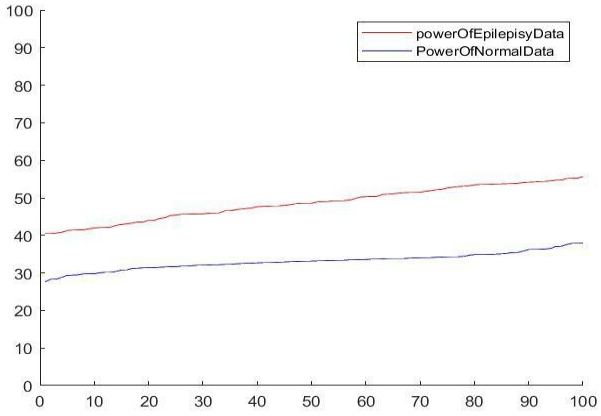

Fig. 9. Statistical Measure: Power

Root Mean Square value is the value of the EEG data samples squared and divided by the total number of samples and taken the square root of the value. This data helps the doctor in knowing how much the mean value is differing with respect to the ideal average.

The power is a feature extracted to know how much more power is obtained in the electrical activity of the brain of a person with epileptic disorders with respect to the normal value.

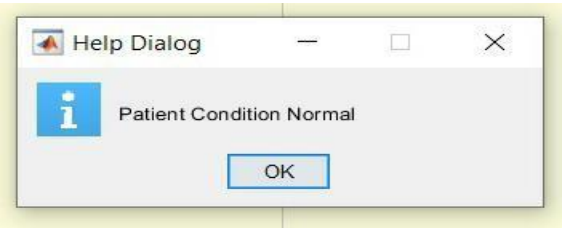

Fig. 10. Output Dialog box Normal Condition

The output dialog box is implemented in the project in order to give more clarity regarding the condition of the patient who has taken the EEG test. This particular dialog box shows that the condition of patient is normal as the algorithm code compares it with the threshold values of a normal person.

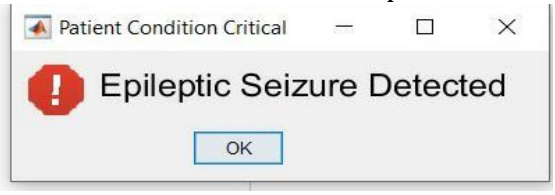

Fig. 11. Output Dialog box Epilepsy detected

The output dialog box is implemented in the project in order to give more clarity regarding the condition of the patient who has taken the EEG test. The dialog box depicts that the patient is not in the normal condition and is suffering or likely to suffer from epilepsy.

CONCLUSION AND FUTURE SCOPE

With at coming of innovation, the cerebrum and PC can be associated and mind waves study proficiency expanded by a remarkable level from considering EEG waveforms through intrusive copper cathodes to non- obtrusive and safe terminals that give exact EEG waveforms. Through this specific task, we can obviously see that the EEG waveforms when appropriately investigated can help us in drawing valuable deductions and supporting the patient deprived in a proficient manner as it helps the specialists and clinical staff to comprehend the seriousness of the state of the patient on account of the wide assortment of information inductions that are drawn.

The discourse box alongside the voice order helps the clinical staff even with fundamental clinical preparing to alarm the patient and specialist immediately and make a prudent move which forestalls any death toll or harm to life.

Electroencephalography (EEG) is a complicated signal that could involve decades of learning as well as intensive data processing and feature extraction methodologies to effectively interpret. Deep learning (DL) is lately demonstrated promising future in improving gain understanding of EEG signals due to its capacity to construct excellent contextual information from raw data. The question of whether DL truly provides advantages over more traditional EEG processing approaches remains unsolved.

During January 2010 and July 2018, 54 papers on Deep Learning application to EEG were published, spanning a variety of application sectors such as sleep, brain-computer interfacing, epilepsy and cognitive and affective monitoring.

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