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Review Paper on Electroencephalographic Evaluation of Sudarshan Kriya

Yugandhara Meshram[1], Prajakta Fulpatil[2]

[1]Department of Electrical Engineering, Veermata Jijabai Technological Institute (V.J.T.I), Mumbai, India

[2]Department of Electrical Engineering, Veermata Jijabai Technological Institute (V.J.T.I), Mumbai, India

Abstract: **Yoga b*reathing techniques are widely recommended for relaxation, stress management, control of psychophysiological states, and to improve organ function. Yoga techniques enhance well-being, mood, attention, mental focus, and stress tolerance .One of the advantages of Sudarshan-Kirya over other meditation practices is that it is a non-time consuming process which while relaxing your mind, also makes you more efficient, focused, aware and concentrated on your task. Various tools have been used to study the effect of relaxing techniques on the mind. The aim of this study is to assess and provide a comprehensive review of the benefits of Sudarshan Kriya Yoga (SKY) and its effects on Electroencephalographic (EEG) signals.***

Keywords: Electroencephalography, Sudarshan Kriya, Transcendental Meditation, Wavelet Transform, Coiflets

1. Introduction

In today's fast life, significant amount of mental stress due to hectic work schedules is leading to insomnia, negative emotions, depression and many other symptoms after an extended period. Past research has revealed that meditation can significantly affect physical and mental relaxation. Modern fast pace of life style requires some additional techniques, in addition to traditional systems such as yoga and meditation, which are considered not only time consuming but are believed to be just "relaxation" techniques. Thus, for the current state, a process is required which while relaxing your mind, also makes you more efficient, focused, aware and concentrated on your task.

Various techniques have been used to study the effect of relaxing techniques on the brain. These include EEG, evoked potentials (BAER, P300, Middle latency potentials), fMRI, SPECT.[1].

The remaining of this work is organized as follows: The second section gives a brief introduction about Sudarshan Kirya technique and its effects, Electroencephalography (EEG), time frequency analysis of EEG signals and the problem definition. The third section talks about literature review on Sudarshan Kriya and its effects on EEG, different time-frequency analysis methods used in EEG signal analysis. The fourth section discusses the Real-time recording of EEG signals for before performing Kriya. The fifth section gives the stepwise implementation of proposed algorithm and wavelet transform and the wavelet family used explained in detail. Finally, sixth section offers the advantages of proposed Algorithm and suggested some improvements for future.

2. General Overview

Sudarshan Kriya is a rhythmic breathing process. The word "Sudarshan", comes from Sanskrit language, it means 'Right or proper vision of who you are'. "Kriya" means purifying action. Thus, Sudarshan Kriya is a purifying action using the breath that re-establishes within us the experience of who we really are, which is pure energy, pure love, pure unlimited awareness. It is taught in workshops called 'Art of Living' propagated by Sri Sri Ravi Shankar.

Sudarshan Kriya is a process of rhythmic breathing, it involves various steps. The first step is called Ujjay Pranayama in which there is long deep inspiration while constricting the throat, followed by holding of breath and long deep expiration constricting throat and again holding breath. This is repeated for 7 – 9 cycles in 3 different stages are performed directing the flow of energy to abdominal area, middle part of the chest and upper chest, followed by 3 rounds of Bhastrika Pranayama(B.P). It involves 30 – 40 breaths per minute with relaxation for 30 seconds in between. BP is followed by rhythmic breathing (SK) in 3 phases (slow, medium and fast breathing at the rate of about 150-200 breaths per minute. Sudarshan Kriya is practiced as a brief & practical self-help stress management strategy. Feedbacks from the participants indicate that it reduces anxiety & depression and SK has been found to be useful in the treatment of depression.

These effects on the human brain can be analyzed using various techniques such as Electroencephalography (EEG), Functional magnetic resonance imaging(fMRI), Positron emission tomography (PET). Out of these techniques Electroencephalography is a non-invasive technique, which can be easily incorporated and analysis becomes easy. Other methods mentioned above have time resolution between seconds and minutes. EEG measures the brain's electrical activity directly, while other methods are indirect markers of brain electrical activity that record changes in blood flow. This study deals with time-frequency resolution of EEG signals recorded pre and post Sudarshan Kriya.

3. Literature Survey

Various neuro-electric and imaging studies of meditation are performed in the past. Neuroimaging studies indicate increased regional cerebral blood flow measures during

meditation. EEG has been used to study changes during meditation, and also long-term effect of regular practice of meditation for the past 2-3 decades. During Transcendental Meditation(TM) an increased regularity and amplitude of the alpha activity was noted. At present there are few reports on changes in EEG and SK. These studies revealed a dominant alpha band activity as compared to the remaining frequency bands. [bhatia].

Fourier transform is the most popular transformation to find the frequency content. Fourier analysis of a signal gives all the frequency components present in the signal but fails to comment on the instance or the time at which those frequencies exits. Short time Fourier Transform gives both time and frequency analysis but the drawback is once a window has been chosen for STFT then time-frequency resolution is fixed. However, wavelet transform provides a better time-and frequency resolution. The aim of the present study is to study the sequential changes in EEG, during the SK using wavelet transform technique.

4. Real Time Data Acquisition

In this research, we select 20 normal subjects from different age groups, in which, 11 were male and remaining 9 were female participants. EEG data was recorded for each subject before performing the Kriya practice. Then EEG electrodes were placed on their head properly to measure the electrical activity in various parts of their brain through EEG signals.EEG Signals are low frequency low amplitude signals. For analysis purpose the recorded signals are passed through a band-pass filter and amplified. The band pass filter passes filter frequencies from 0.5Hz to 40 Hz. The pre-processed data is then loaded into MATLAB and time-frequency analysis is done on it.

5. Methodology

The proposed algorithm for analyzing EEG signals is as shown in Fig 1. The pre-processed EEG data is loaded in MATLAB for further processing. Fig 3 shows pre-processed EEG signal, for one subject before performing Kriya, which is decomposed as shown in Fig 4. For decomposing the signal, best method is using Wavelet transform [6] as it gives both time and frequency resolution.

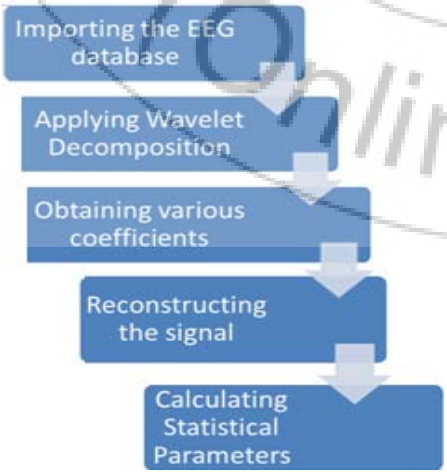

Figure 1: Flow of work

The wavelet that is used here is Coiflet which are designed for the purpose of maintaining a close match between the trend values and the original signal values. Following a suggestion of Coifman, these wavelets were first constructed by Daubechies[7], who called them "coiflets." General characteristics of Coiflets are compactly supported, wavelets with highest number of vanishing moments for both phi and psi for a given support width. The order of the wavelet ranges from 1 to 5.It is orthogonal and nearly symmetrical. Figure 2 shows the scaling and the wavelet function for coiflet. The function ψ has 2N moments equal to 0 and, what is more unusual, the function φ has 2N–1 moments equal to 0. The two functions have a support of length 6N–1. The coifN ψ and φ are much more symmetrical than the dbNs. With respect to the support length, coifN has to be compared to db3N or sym3N. With respect to the number of vanishing moments of ψ, coifN has to be compared to db2N or sym2N.

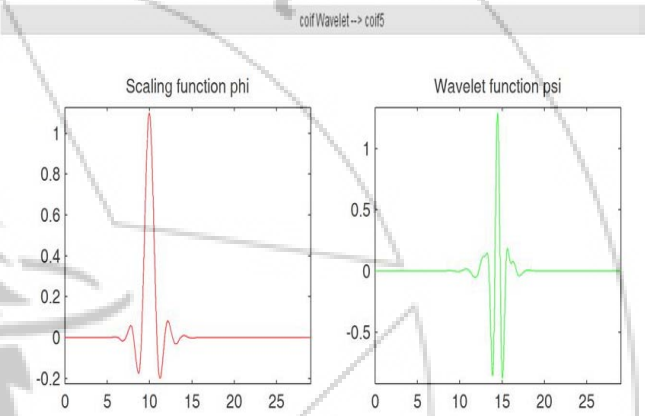

Figure 2: Scaling and Wavelet function for Coiflet

To extract different frequency bands from the EEG signal, it is decomposed using coiflet and the results are interpolated to the length of the given time series taking care of the frequency and time components simultaneously. These interpolated sequences correspond to the different bands of frequencies. The detailed coefficients at 5th level correspond to Gamma band (40Hz above), 6th level corresponds to Beta band (13-40Hz). The detailed coefficients at 7th level correspond to alpha band (8-14Hz) and those of 8th level correspond to theta band (4-8Hz). The approximate coefficients at level 8 correspond to delta band (0-4Hz). These frequency bands are reconstructed at each level and the further the statistical parameters are evaluated.

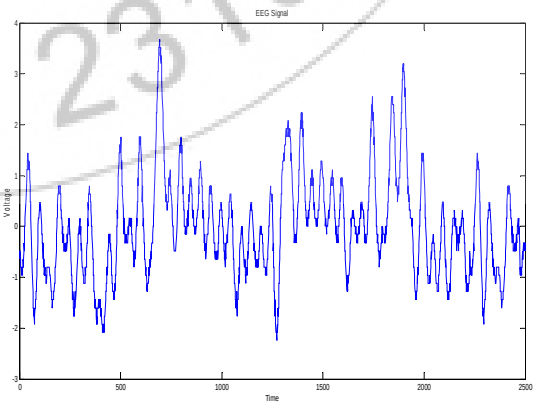

Figure 3: EEG signal

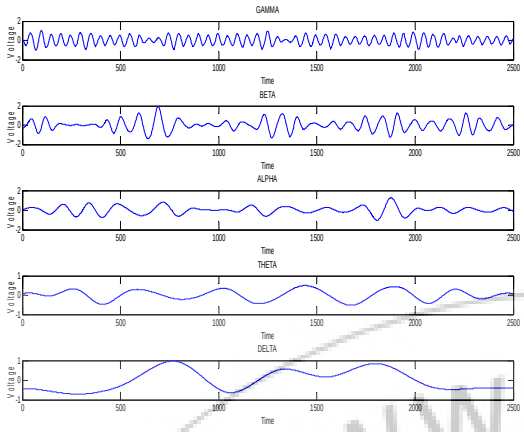

Figure 4: Extracted frequency bands

6. Conclusion and Future Work

Wavelet Transform proves out to be the best method for the time-frequency analysis of EEG signals as it gives the required frequency information along with the time instance at which it occurs. Also the Coiflet family of wavelets gives better details at each level of decomposition as compared to other wavelet families. The further research continues by analysis the EEG signals that will be recorded for the same subjects after performing Sudarshan Kriya. The statistical features of both the datasets will be compared to derive results.

References

[1] M. Bhatia, A. Kumar, N.K. Bharadwaj, R.M. Pandey, V. Kochupillai, "Electrophysiologic evaluation of Sudarshan kriya: An eeg baer p300 study", Departments of Neurology, Medical Oncology, Biostatistics, All India Institute of Medical Sciences, New Delhi – 29, India

[2] M.Teplan, "Fundamentals of EEG Measurement", MEASUREMENT SCIENCE REVIEW, Volume 2, Section 2, 2002

[3] On, F.R.; Jailani, R.; Norhazman, H.; Zaini, N.M., "Binaural beat effect on brainwaves based on EEG," Signal Processing and its Applications (CSPA), 2013 IEEE 9th International Colloquium on , vol., no., pp.339,343, 8-10 March 2013

[4] M.Bhatia, "EEG During Sudarshan Kriya: A Quantitative Analysis", *All India Institute of Medical Sciences, N. Delhi, India, April 2013*

[5] Shih-Feng Wang; Yu-Hao Lee; Yung-Jong Shiah; Ming-Shing Young, "Time-Frequency Analysis of EEGs Recorded during Meditation," Robot, Vision and Signal Processing (RVSP), 2011 First International Conference on , vol., no., pp.73,76, 21-23 Nov. 2011

[6] Ahmed, T.; Islam, M.; Yusuf, M.S.U.; Ahmad, M., "Wavelet based analysis of EEG signal for evaluating mental behavior," Informatics, Electronics & Vision (ICIEV), 2013 International Conference on , vol., no., pp.1,6, 17-18 May 2013

[7] Daubechies I, *Ten lectures on wavelets*. Philadelphia, PA: SIAM, 1992.

[8] Chaudhuri, A.; Nayak, S.; Routray, A., "Use of data driven optimal filter to obtain significant trend present in frequency domain parameters for scalp EEG captured during meditation," *Students' Technology Symposium (TechSym), 2014 IEEE* , vol., no., pp.7,12, Feb. 28 2014-March 2 2014

[9] Ahani, A.; Wahbeh, H.; Miller, M.; Nezamfar, H.; Erdogmus, D.; Oken, B., "Change in physiological signals during mindfulness meditation," *Neural Engineering (NER), 2013 6th International IEEE/EMBS Conference on*, vol., no., pp.1378,1381, 6-8 Nov. 2013

[10] D. P. Subha,; P. K. Joseph; R. Acharya; C.M.Lim, "EEG Signal Analysis: A Survey," Springer Science+Business Media, 2008

[11] Chuan-Yi Liu; Pei-Chen Lo, "Investigation of Spatial Characteristics of Meditation EEG; Using Wavelet and Fuzzy Classifier", Proceedings of the fifth IASTED International Conference: biomedical engineering, pages 91-96, ACTA Press Anaheim, CA, USA, 2007

Author Profile

Yugandhara Meshram received B.E. degree in Electronics and Communication from Dr. Babasaheb Ambedkar College of Engineering and Research, Nagpur in 2012. She is pursuing Master of Technology in Electronics and Telecommunication from Veermata Jijabai Technological Inistitute, Mumbai.

Prajakta Fupatil received B.E. degree in Electronics and Telecommunication from Yashwantrao Chavhan College of Engineering, Nagpur in 2011. She is pursuing Master of Technology in Electronics and Telecommunication from Veermata Jijabai Technological Inistitute. Mumbai, India