Chapter 14
Remote Monitoring via EEG of Persons in Severe Depression

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ABSTRACT
Mental illness in the form of depression or suicidal tendencies is found in one out of every four Indians. Severe depression usually leads to suicides. The numbers of well trained professionals, brilliant students at premier institutes who have committed suicide due to depression are on the rise. Recently the pilot of a major German airline, suffering from severe depression, deliberately plunged the aircraft into the Swiss Alps killing both himself and all the passengers in the plane. It is therefore important to develop a technique via which one can identify unambiguously who is suffering from depression. There are no general behavioral characteristics via which one can identify such people. However, analysis of the EEG spectra can accurately estimate the mental health of the patient. By making it mandatory for students/employees of an organization to have their EEG done periodically, one can isolate the people who are suffering from this disease.

INTRODUCTION
Depression

Depression is thus a mental state characterized by specific (strange) brain attractors and unusual neuronal activity. This state of the brain can easily be identified using lyapunov exponents, correlation dimension analysis and PSD (Power Spectral Density) analysis of EEG spectra. Our chapter is to first classify these attractors by taking the EEG spectra from patients known to be in a depression and severe depression. The ideal next step would be to couple this with non invasive EEG monitoring.

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Depression, especially manic depression is a disease much worse than cancer. Their entire internal biochemistry has changed. They look normal, act normal yet they are not normal. At any moment they can act in such a way that will bring great harm to themselves and to people around them. The Armed Forces of our country will be very much interested in the outcome of this research. A pilot who is severely depressed should not be flying a multi-billion dollar jet similarly depressed soldiers should not be going to mission critical engagements. In all these cases non invasive EEG diagnostic process is required. Electroencephalographic measurements are commonly used in medical and research areas.

**EEG and Its Significance**

The electroencephalography (EEG) is defined as electrical activity of an alternating type recorded from the scalp surface after being picked up by metal electrodes and conductive media. Thus electroencephalographic reading is a completely non-invasive procedure. When brain cells (neurons) are activated, local current flows are produced. EEG measures mostly the currents that flow during synaptic excitations of the dendrites of many pyramidal neurons in the cerebral cortex. Differences of electrical potentials are caused by summed postsynaptic graded potentials from pyramidal cells that create electrical dipoles between soma and apical dendrites (neural branches). Brain electrical current consists mostly of Na+, K+, Ca++, and Cl- ions that are pumped through channels in neuron membranes in the direction governed by membrane potential. Only large populations of active neurons can generate electrical activity recordable on the head surface.

**Attractors**

The mammalian brain exists in a number of attractors, which is a set that evolves to itself under the dynamics. Attractors may contain invariant sets. A limit set is a set of points such that there exists some initial state that ends up arbitrarily close to the limit set (i.e. to each point of the set) as time goes to infinity. Attractors are limit sets, but not all limit sets are attractors: It is possible to have some points of a system converge to a limit set, but different points when perturbed slightly off the limit set may get knocked off and never return to the vicinity of the limit set. In order to characterize these attractors generally the time series can be obtained by recording of signals from the frontoparietal, occipital and temporal regions of the brain.

Mathematical modeling like- Discrete Wavelet Transformation, Fast Fourier Transformation, Neural networks, Lyapunov exponents, Correlation dimensions, was formulated to correlate the prevalent condition with the normal condition and mathematical models which were help for determining the degree of depression cases via remote EEG.

**MAIN FOCUS OF THE CHAPTER**

The central aim of this chapter is to study the tools based on remote EEG parameters which characterize EEG spectra for accurate and rapid classification. These tools may lead to a comprehensive basis for analysis and characterization of human brain based on EEG signals for depression patient.

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