EEG Based Detection of Alcoholics: A Selective Review

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ABSTRACT

The short term and long term effects of alcohol on various organs of the body, especially on the human brain is well established by numerous studies. Invasive methods such as Transcranial Magnetic Stimulation (TMS) and non invasive imaging techniques such as Computed Tomography (CT), Magnetic Resonance Imaging (MRI), Positron Emission Tomography (PET), and functional MRI activated electro-encephalogram (EEG) have been used to study the changes in EEG activity due to alcoholism. Even with the advent of neuro imaging techniques, EEG happens to be an important tool for brain study providing a non-invasive and cost effective method to detect the effects of alcohol on the human brain. This paper discusses the harmful effects of alcohol on different organs of the body. The advances in the development of EEG signal processing algorithms over the past decade for alcoholic detection are reviewed and their limitations are reported. Further the use of EEG for mass screening of alcoholics and biometric application is discussed in detail.

Keywords: Alcoholics Screening, Electroencephalogram (EEG), Neural Network Classifiers, Signal Processing, Visual Evoked Potentials

INTRODUCTION

Alcoholism is a social bane that affects human life in all aspects. Addiction to alcohol affects a person’s social life as well as the physical body causing damage to the organs and the brain. Many research studies have been done to find the ill effects of alcohol (Varner et al., 1990; Di et al., 2010; Karaken et al., 2010) and the extent to which it damages the human body. Some of the harmful effects include lack of coordination between body and mind, loss of vision, imbalance in walking, incoherent speech, memory slips and depression to name a few. These effects can be observed when a person is in an inebriated state and may vanish once the person has given up drinking. The short and long term effects of alcohol on the human brain and the probable reversal of the ill effects caused by heavy drinking on the brain still remains an open research problem for the biomedical research community.

Researchers have shown the ill effects of alcohol on the human brain by observing and analyzing the electroencephalogram (EEG)
(Balli, 2007; Maurage et al., 2007a, 2007b; Chen et al., 2007; Pallares et al., 2007; Martin et al., 2003; Porjesz & Begleiter, 2003) of the alcoholic subject comparing with that of a control subject. EEG records the brain’s electrical signal by placing electrodes on the scalp of the head. These signals show real–time activity of the brain. A typical single channel EEG recording of a control and an alcoholic subject is as shown in Figure 1. It can be observed that the time series EEG data cannot be analyzed qualitatively by visual inspection due to complex non-linear nature and hence qualitative signal processing application is inevitable. This qualitative procedure involves extraction of features from EEG series by time-domain, frequency-domain and time-frequency domain approach followed by pattern recognition for discriminating alcoholics from normal. As an illustration, the power spectral densities (PSD’s) of the EEG of both control and alcoholic subject are as shown in the Figure 2. It can be seen that the power contained for both control and alcoholic subjects are different.

This review paper has been organized as follows: first, we describe the effects of alcohol on human physiological system. Some of the effects of alcohol on different components of EEG signal are reviewed in the section afterwards. Some of the existing state of the art signals processing techniques for alcoholic detection in EEG recordings are discussed and reviewed in the following section. A discussion on the potential use of EEG as a biomarker for alcoholism and as a mass screening tool is done next. The potential and limitation of the existing computational approaches are then discussed. Finally, as concluding remarks, the future challenges and open problems are briefly addressed.

**ALCOHOL AND ITS EFFECTS ON HUMAN PHYSIOLOGICAL SYSTEM**

Alcoholism is one of the psychiatric phenotype, which is influenced by genetic as well as environmental factors. The effect of alcoholism leads to cognitive, emotional, and behavioral impairments. Heavy drinking not only affects the human brain but also damages other vital organs of the body. Studies show that females are more affected than males in the way the alcohol consumption damages the various organs.

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**Figure 1. Sample plot of EEG signal of control and alcoholic subjects**

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