Detection of Eye-blink artifact in the EEG

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Abstract. An electroencephalogram (EEG) is often corrupted by different types of artifacts. Many efforts have been made to enhance its quality by reducing the artifact. The EEG contains the technical artifacts (noise from the electric power source, amplitude artifact, etc.) and biological artifacts (eye artifacts, ECG and EMG artifacts). This paper is focused on eye-blinking artifact detection from the video which is recorded with EEG data simultaneously. Detection of eye artifacts is not a simple process and therefore there are many efforts to develop an optimal method for eye artifact detection or in better case its elimination. In this paper there is described an unusual detection method based on image processing and analysis.

Keywords. EEG, artifact, image processing, object recognition

I. INTRODUCTION

Electroencephalography is the neurophysiologic measurement of the electrical activity of the brain by recording from electrodes placed on the scalp or, in special cases, subdurally or in the cerebral cortex. The resulting traces are known as electroencephalogram (EEG) and represent an electrical signal (postsynaptic potentials) from a large number of neurons. These are sometimes called brainwaves. EEGs are frequently used in experimentation because the process is non-invasive to the research subject.

![Segment of EEG record with marked eye artifacts in channels Fp1 and Fp2. EEG record with 19 channels is used.](image)

The EEG record is often digitalized and stored on appropriate type of storage medium (CD, DVD, hard disk …) for additional processing and analysis. The EEG record contains many types of artifacts. An artifact is event or process which has not its source in an examined organ. One type of artifact is eye artifact – blinking and eye movement. However the amplitude of the electrooculographic (EOG) signals is only six-times greater than EEG signals, there is a large interference because of short distance between sources of these signals. The eye artifact is best seen in first two channels Fp1 and Fp2 (Fig. 1). The international 10-20 system of electrode placement is used.

II. EYE-BLINK DETECTION METHOD

The video record is obtained from two cameras. The first one is scanning the whole person in the bed and the second one is focused on the face. Detail of the face is used for the detection method.

To detect eye blinking (opening and closing eyes), there is used measurement of mean value of intensity in the selected region of interest. The measurement is carried out for each frame and at the end the curve of mean intensity is made. The moments for opening or closing eyes are set according to increasing or decreasing values of the curve.

In the pre-processing phase it is appropriate to reduce image data in order to accelerate detection of blinking. That means, only area focused on the face is cut from all frames and color depth from true color (24-bit) to grayscale (8-bit) is changed [1].

Let us set region of interest (ROI) in the reference frame. The way of setting ROI is interactive. The ROI has dimensions (k x l) and coordinates of upper left corner (L, T) for left and right eye (Fig. 2). In the application a user can set optimal ROI interactively in order to reach adequate signal to noise ratio. The ROI has to be selected in appropriate way, whole eye (in opened and closed state) must be in the selected area.

Then computation of mean intensity for N-th frame is given by

\[ I_{avg}(N) = \frac{1}{k \cdot l} \sum_{i=1}^{k} \sum_{j=1}^{l} f(i+T, j+L) \]  

(1)

where \( f(i,j) \) is luminance (intensity) level of pixel at coordinates i, j in the frame N.