**Eye detection using EEG signal: ensemble forest structure classifier**

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# 1 Introduction

Eye state detection is the task of predicting the state of eye whether it is open or closed, or simply called eye blink detection. This detection has widely been used, for instance, in autonomous driving eye blink is a direct signal to monitor driver fatigue and drowsiness[1], also in medical assistance to help person impaired in movement capability to make some decision and communicate with the world[2].

Usually there are two main methods for eye blink detection. The first is vision-based method, which integrate computer vision and machine learning techniques. Significantly amount of research have been conducted on this area。[Talal Bin Noman](http://www.frontiersin.org/people/u/529183) et al (2018) [3]devised a Mobile-based blink detection system on Android Platform by using both haar classifier and Normalized Summation of Square of Difference template-matching method, [Nassr Alsaeedi](https://www.ncbi.nlm.nih.gov/pubmed/?term=Alsaeedi%20N%5BAuthor%5D&cauthor=true&cauthor_uid=30841622)\* et al(2019)[1] achieve real-time eye blink detection by analyzing eyeblink phases, Aleksandra Królak et al (2012) [2]estimate eyeblink using IR spectrum of eye image. But vision-based method still encounters many problems, such as easy-effected by illumination, image scale, glasses etc.

Another way to estimate eye blink is using brain activity signals by the mean of electroencephalography (EEG) measures, even this method has been implemented for decades, there still has much studies needed to be explored. S. Rihana et al(2013)[4] implement a probabilistic neural network to accomplish binary classification for eye blink. Rajesh Kanna. K et al(2015) [5]design a decision tree with C4.5 algorithm to estimate eye states. Ali Al-Taei(2017) [6]devise an ensemble classifier to predict the state of eyes.

In this paper, we will introduce a forest structure to tackle this classification problem, not much like a normal ensemble decision tree structure, we will devise a new feature extractor to form the training dataset. The training and testing data is supported by Rösler and Suendermann[7], which has been published on Kaggle.

# 2 Research design and method

**2.1 Feature extractor**

Usually EEG signal comes from several sensor on the brain, directly using all the data maybe not the best way for training process. Because the eye blink behavior is not much related to all EEG signals, to diminish effect on training process of useless data, we will separate the EEG signal into different part as the training feature, using a slide window to form a spatial relationship between the sensor, as the figure1 illustrates, sliding window will scan all the original measurement and then to generate several sequences of new feature for the training process.

A screenshot of a cell phone

Description automatically generated

Figure 1 illustrates the feature exaction process

**2.2 ensemble forest**

After the feature exaction, every new sequence feature will be trained using a single decision tree, and finally all the single tree will form a forest structure. Here because we can define different size of the sliding window, then we can generate different type of forest, this diversity is very important to ensemble algorithm. Figure 2 illustrates the algorithm structure.

A close up of text on a black background

Description automatically generated

Figure 2 illustrates ensemble forest structure

# 3 expected results

By using this methods we hope the new ensemble forest structure can perform best among all the tested method, which means a lowest error rate of the testing data.

# 4 reference

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Objectives

1. algorithm svm + tree + adaboost + tensorflow + ensamble（log odds ratio）methods feature combine
2. experiment
3. plan with list
4. conclusion