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Developing Classification Model for Depression Using Multi-modal Bio-signals

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Abstract— **Depression is one of the fatal mental diseases that not only affect daily activities but also can lead to suicide. Diagnostic methods of depression have not been developed quantitative methods so far. For the past decades, many researchers have tried to develop quantified diagnosis methods by using bio-signal. However, because of the complexity of depression, the bio-signal based diagnosis methods have yet to be used. In this study, we have researched if we can effectively diagnose depression using multi-modal bio-signals. We found that features extracted from multi-modal bio-signals could estimate depressive patients by 70 percent. These results indicate multi-modal bio-signals based features can be used for classifying depressive participants.**

I. INTRODUCTION

Major depressive disorder (MDD) plays a role in more than one half of all suicide attempts, whereas the lifetime risk of suicide among patients with untreated depressive disorder is nearly 20 percent [1]. Despite of its fatal effect on life, there is no quantitative method to diagnose depression. To quantify diagnostic method for depression, many researchers have tried to develop diagnostic method by using bio signal such as electroencephalogram (EEG), electrocardiogram (ECG), photoplethysmogram (PPG) and so on[2]. However, due to the complex characteristics of MDD, a robust diagnosis model that developed by using uni modal bio-signal has not been developed so far. In this study, we have tried to make multi-modal bio-signal based depression diagnosis model using EEG, ECG and PPG.

II. METHODS

Total 141 participants were recruited for this experiment. According to Beck's Depression Inventory (BDI), participants were classified into 'low depression' group (BDI score: 0-9, number of group : 90) and 'high depression' group (BDI score : 10-63, number of group : 51).

For the experiment, whole participants were instructed to gaze on the fixation cross that was given on the center of the monitor. We recorded the eyes-closed resting state of the participants' EEG, PPG, and ECG for 6 minutes.

EEG, PPG, and ECG were analyzed using MATLAB 2018b (Mathworks, MA, USA). We extracted total 112 features from EEG, PPG, and ECG. To avoid overfitting, only the features that has been significant different between the groups were selected. The statistical analysis were done using t-test.

To classify the severity of depression in to 'low' or 'high' we used a logistic regression model as a classifier using the features selected from above. Whole data were separated the 90 percent of train-data set and the 10 percent of test-data set. Train data set were used 5-fold cross-validation to avoid overfitting problem. Since the two groups were imbalanced in sample size, random sampling to equalize the sample size with two groups was done. Features were selected through sequential forward search algorithm that best represents acquired data.

III. RESULTS

Fig I. shows the performance of the developed logistic regression model. When using seven numbers of features selected by sequential forward search algorithm, the highest validation set's accuracy was reported 70.00 ± 2.67 percent and the highest test set's accuracy was reported 69.82 ± 1.74 percent.

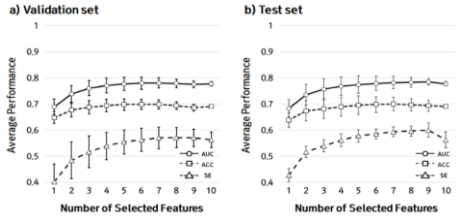

Figure 1. The classification results of developed model. Area under

IV. DISCUSSION & CONCLUSION

We found that features extracted from multi-modal bio-signals could estimate depressive patients by 70%. These results indicate multi-modal bio-signals based features can be used for classifying depressive participants.

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