Better Modelling of Operator Functional State (OFS) by Eye Movement Analysis of EOG for Stress Recognition

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Abstract- Different techniques have been elaborated for examining and detecting the stress of a person. The Operator Functional State (OFS) is modeled using ANN, Random Forest and Decision Tree classifier models that expand research in brain imaging as an approach for performing stress recognition using Electro occulography by categorizing Ground truth annotation.
The investigation of stress detection performed using eye movement analysis and results are approved utilizing study on person engaged with an office surrounding utilizing a model arrangement of intellectual action like reading a printed paper. This procedure achieves great exactness and sets up a Random Forest model which gives great precision with least error.

Index Terms- **Operator Functional State, Random Forest Modelling, Electro Occulography**.

I. INRODUCTION

There is need for stress identification in people like administrators and academicians who are busy with their continuous reading and learning tasks. Electro Occulography(EOG) data will be useful in such scenarios to develop and alter the strategy of stress. By monitoring the eyes and EOG investigation it is trusted that the indications of administrator's stress can be identified sufficiently early enough to prevent from failures. There are a few human exercises like vehicle driving, heavy instrumentality operation, unsafe materials manipulation, wherever the attention and acutely aware control may be an important factor [1].

"Operator Functional State" describes the association of task execution and the person's background condition. OFS, has specific relevance to the behavior of operators who are busy in continuous work, industrial control processes aviation, air navigation management and transport organizations. There is need for managing complex control systems, particularly for those that have safe acute features, means individuals cannot take rest they feel stressed or take interventions when they feel exhausted. [2].

The OFS approach identifies the energetic quality of transformation onto work outcomes. Personal state is identified by OFS. OFS also maintain an approach relies on the need to correlate these processes under task conditions, There is great potential for increasing security and precision of critical systems by evaluating an Operator's Functional State [2][3] . Live observing of functional state utilizing physiological and behavioral information still tackle few difficulties before accomplishing the precision required in numerous operational settings.
One open query for dimension of granularity of the models: Is that the general model is adequate or should subject explicit models be prepared to guarantee high precision? Another test for the assignment of a notable ground truth to train classifiers. This is critical in order to train models that are operationally relevant [2][3].

Random Forest Modelling is reported that expands the research in brain imaging as an approach to handle Electro occulogram data analysis using Ground truth annotation.

Different computational methodologies dependent on EOG signals have been well developed for investigating and identifying stress of a person. The predominant purpose behind estimating stress is to measure the psychological expense of performing tasks so as to predict individual's efficiency as well as frame work's performance execution. It is important to portray mental conditions of operator performance, by discovering designs in timely changing physiological estimates like EOG (Electro Occulography), with eye blinks.

There have been a few works on gathering and handling electrooculography (EOG) signals in recent years. We report modelling characteristics of eye movement for stress recognition that opens the research in brain imaging as an approach to handle EOG data analysis. EOG signals can easily construct the classifier models and carry out performance analysis in terms of processing time, error rate and correlation coefficient. For the present exploration, Random Forest classifier is employed.

II. RELATED WORKS

Authors in [9], depicted ANN architecture as new approach for analyzing Electro occulography data using the classification of Ground truth annotation. This exploration shows optimum ANN paradigm for the Electro Occulography data by changing the network properties such as the type of the network, training function, transfer function and hidden layer neurons. ANN architecture hence inferred consists of nonlinear sigmoid activation function for hidden layer and Levenberg-Marquardt back propagation method for training the model.

In research paper [10], the work has been done on decision tree (DT) modelling of EOG data characteristics. The authors have done the analysis of eye movements for stress recognition. They have performed the comparative analysis of eye movements for detection of stress and validated the method study in an office surroundings using an example set of two activities, Physical activity related to operating heavy machines, Cognitive activities like working with computers.

III. RANDOM FOREST MODELLING

A RF is a collection of unpruned decision trees. Ensemble models are often robust to variance and bias. RF modeling is used when huge amount of training datasets especially a maximum count of input parameters are considered. The algorithm is efficient with respect to a huge number of variables since it repeatedly subcategorizes available variables.

RF classification algorithm is given below

Algorithm: Random Forest classification algorithm

1: Produce samples of ntree bootstrap from the original information.
2: Produce reduced classification tree for each sample, with the following modifications.
Instead of selecting the superior partition among all predicting arguments at every node, select the predicting variables randomly sample mtry and select the best partition among those variables.
3: Produce ntree initial samples from the primary information.
4: Forecast new data by combining predictions

IV. RESULTS AND DISCUSSIONS

This section investigates details of experiments conducted to classify blink patterns with classifier model Random Forest. For simplicity purposes, the system considered a participant learning in office surroundings using set of cognitive activities namely, working with computers: reading printed paper. The classification algorithm, Random Forest is applied. The classification procedure is executed by RF modelling. The current learning reports RF modelling of stress detection by analyzing EOG data. Current learning shows the performance estimation of different RF Model configurations

EOG Dataset

Column1: timestamp [sec] represented by Column 1 ; Column 2: timestamp [usec]; Column 3: horizontal EOG [Mobi amplitude units]; Column 4: vertical EOG [Mobi amplitude units]; Column 5: ground truth annotation.

Annotation format for ground truth: 1: null, 2: Read, 3: browse, 4: Write, 5: video, 6: copy 7: disspeak; 8: disphone:

Candidates(Gender)

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(1) male

(2) male

(3) male

(4) male

(5) male

(6) female

(7) female

(8) male

Experimental Runs (number type comment)

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(0) Run 1, carrying out a random sequence of office activities (1) Run 2, carrying out a random sequence of office activities The number in brackets corresponds to the number attached to each filename.

```
> p <- read.csv("E:/Kalas/p1.csv");
> summary(p)
      ts1                   ts2             horizontal
 Min.   :1237450899   Min.   :     0   Min.   :449873
 1st Qu.:1237451352   1st Qu.:251078   1st Qu.:525677
 Median :1237451586   Median :499207   Median :561205
 Mean   :1237451686   Mean   :500524   Mean   :568081
 3rd Qu.:1237452136   3rd Qu.:751199   3rd Qu.:599950
 Max.   :1237452687   Max.   :999976   Max.   :722174
    vertical          annotation
 Min.   :225597   Min.   :1.000
 1st Qu.:444059   1st Qu.:3.000
 Median :575604   Median :4.000
 Mean   :581477   Mean   :3.899
 3rd Qu.:700607   3rd Qu.:6.000
 Max.   :946489   Max.   :8.000
> |
```

Fig 1. Descriptive Statistics – EOG Data Participant

RF Modeling
No. of trees - 300
No. of variables – 2

```
Summary of the Random Forest Model
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Number of observations used to build the model: 68419
Missing value imputation is active.

Call:
 randomForest(formula = as.factor(annotation) ~ .,
              data = crs$dataset[crs$sample, c(crs$input, crs$target)],
              ntree = 300, mtry = 2, importance = TRUE, replace
                               = FALSE, na.action = na.roughfix)

               Type of random forest: classification
                     Number of trees: 300
No. of variables tried at each split: 2

        OOB estimate of  error rate: 0.01%
Confusion matrix:
      1    2     3     4    5     6   7    8   class.error
1 11393    0     0     0    0     0   2    0 0.00017551558
2     0 4725     0     0    0     1   0    0 0.00021159543
3     0    0 10579     0    0     0   0    0 0.00000000000
4     0    0     0 16272    0     1   0    0 0.00006145148
5     0    0     0     0 6285     0   0    0 0.00000000000
6     0    0     0     0    0 17617   0    0 0.00000000000
7     2    0     0     0    0     0 275    0 0.00722021661
8     0    0     0     1    0     0   0 1266 0.00078926598
```

Fig 2. Summary of Random Forest Model

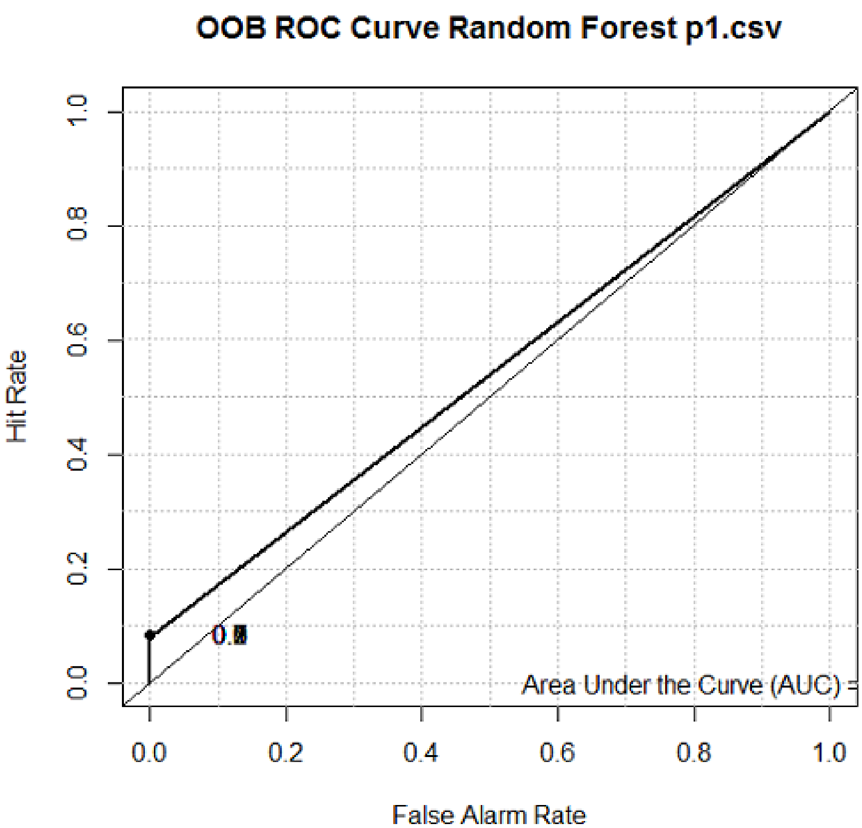

Fig 3. ROC curve based on out-of-bag Predictions

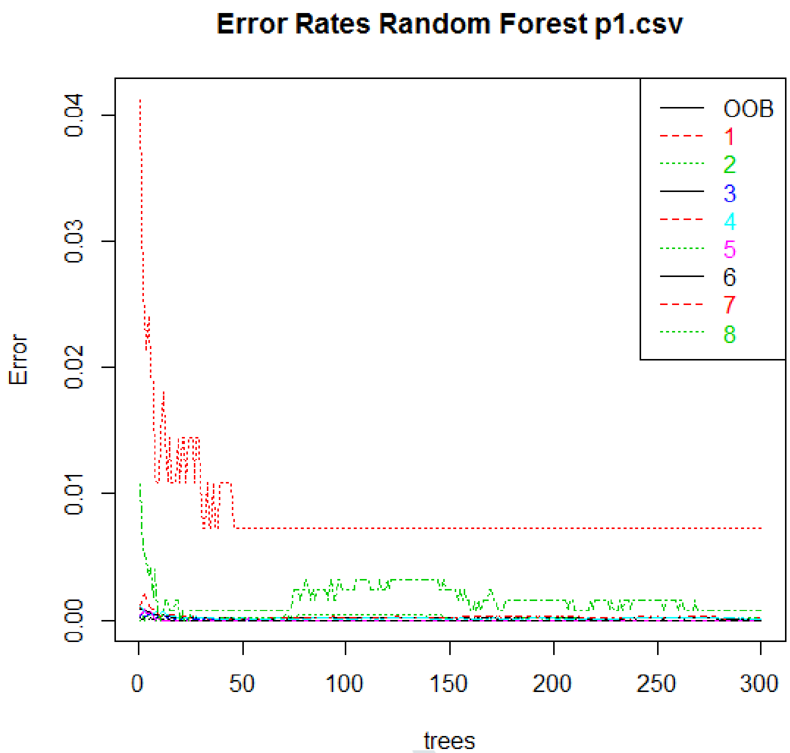

Fig 4. Mean Square Error Plot

Error matrix for the Random Forest model on p1.csv [validate] (counts):

Actual \ Predicted	1	2	3	4	5	6	7	8
1	2446	0	0	0	0	0	0	0
2	0	1012	0	0	0	0	0	0
3	0	0	2231	0	0	0	0	0
4	0	0	0	3561	0	0	0	0
5	0	0	0	0	1375	0	0	0
6	0	0	0	0	0	3718	0	0
7	1	0	0	0	0	0	70	0
8	0	0	0	0	0	0	0	247

Error matrix for the Random Forest model on p1.csv [validate] (proportions):

Actual \ Predicted	1	2	3	4	5	6	7	8	Error
1	0.17	0.00	0.00	0.00	0.00	0.00	0	0.00	0
2	0.00	0.07	0.00	0.00	0.00	0.00	0	0.00	0
3	0.00	0.00	0.15	0.00	0.00	0.00	0	0.00	0
4	0.00	0.00	0.00	0.24	0.00	0.00	0	0.00	0
5	0.00	0.00	0.00	0.00	0.09	0.00	0	0.00	0
6	0.00	0.00	0.00	0.00	0.00	0.25	0	0.00	0
7	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00	0
8	0.00	0.00	0.00	0.00	0.00	0.00	0	0.02	0

Fig 5: Error Matrix for Random Forest Model

'Random Forest' modeling for stress detection is reported in the current learning by examining EOG data. Performance estimates of different Random Forest configurations and comparison of the classification accuracy has been performed efficiently by current work. The investigation reported, represents optimal RF architecture achieved by calibrating total trees and selecting variables to partition the data set. A classification model thus required 300 trees in the forest with 2 partitioning variables. Furthermore the execution of the model is assessed with reference to "out-of-bag" error values. The output showcases prediction of the patterns based on the characterization of psychological states of operator performance by EOG with eye blinks data by using the Random Forest modelling [3].

In this work, the implementation of the resultant model is evaluated by OOB. The "out-of bag" keeps track of OOB error estimate which is calculated where observation data are not incorporated in the "bag" which is subgroup of train data sequence used in constructing the DT. Performance of the model can be pictorially represented using "Receiver Operating Characteristic (ROC) curve".

It draws the True Positive rate versus FP rate. Error plot is useful for deciding optimal count of trees to be built. Plot error rate progressively for the total trees to be built [4]. An error matrix shows the true outcomes against the predicted outcomes. Simulation of Random Forest Model is carried out in R and Rattle environment.

Random Forest package in R surroundings is used to investigate model structure, variety of trees within the forest and selection of variables for partitioning the dataset. The system used the input data set for the framework adjustment of model and validation set to regulate learning method. The system has performed the performance analysis for numerous RF configurations and compared the classification accuracy. RF builds several Decision Trees using random set of data and variables. Random Forest package is used to analyze model structure, total trees in RF and selection of variables for dividing the dataset. In the ongoing research work, RF model is adjusted with two variables “ntree and mtry” to achieve optimum design. The parameter ntree identifies the count of trees to be produced to obtain optimal Random Forest, whereas mtry identifies how many variables are to be considered when making a decision about splitting the dataset. The work results in the maximal depth of the tree attained to be 2 and total trees in the forest be 300 [6][7][8].

V. CONCLUSION

Optimum RF architecture is also evolved by varying its different parameters such as total no. of trees and selection of variables to partition the dataset. The resulting RF architecture requires 300 RF trees with 2 partitioning variables. Thus derived RF model efficiently classifies EOG samples into the given stress pattern classes with very less error. The output suggests that the RF has the potential to display EOG samples as the best modelling tool for modelling of EOG samples.

The EOG information will assist when designing the algorithm to manage the operator’s attentive conditions by means of interpreting eye-movement information. In future development, work is sustained with these following fields: it’s vital to search the acute point in situations, where person’s attentive state is simply changing into poorer compared to safe threshold. The demand can introduce two problems for carrying out the investigation: First problem deals with determining the secure attentive condition of an individual when engaged in continuous learning and reading activity. Second, finding the critical point with an eye tracking system. A model is designed which uses this information and determine a assessment criterion once the person is getting adequately overloaded and therefore the psychical index like blink interval of time and duration shift from absolutely attentive condition by an excessive amount, then deliver a warning to the person[1].

This work dealt with learning about blink’s physiological principle and the correlation between blinks and the Electro occulogram signal ,also the correlation between stress and blink movements and explain EOG data in detail to the operator state operating machines and locate the source of certain specific activities related to Electro occulogam data.

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Authors Profile

Mrs. Mamata S. Kalas , Having been graduate from University Of Mysore, in 1993, From B.I.E.T,Davangere, started her professional carrier there itself. In 1995, came to kolhapur, after her marriage and since then she has worked as lecturer at D.Y.Patil's college of Engg.,Bharati Vidyapeeth's College Of Engg.,Kolhapur.She is M.Tech(CST) Graduate and her dissertation work is based on image segmentation using parametric distributional clustering. She has been awarded with M.TECH (CST) from Shivaji University, Kolhapur of Maharashtra in June 2009. She is persuing Ph. D in computer science and Engineering at Walchand College of Engineering, Reseach center, Shivaji University, under the guidance of Dr.B.F.Momin. She is currently working as an Assistant Professor at KIT'S College of Engg, Kolhapur.She is in her credit, 16 Years of teaching experience, Two Papers
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