STRESS DETECTION IN AUTOMOBILE DRIVERS USING PHYSIOLOGICAL FEATURES

BITS ZG628T: Dissertation

by

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ABSTRACT

This project puts forward methods analyzing physiological data during real-world automobile driving tasks to determine the cognitive stress drivers. In the dataset used, galvanic skin response signals of 15 drivers were recorded continuously who followed a set route that experienced open routes as well as heavy traffic conditions. The duration of the drive was of at least 50 minutes; but this, however, varied depending upon the traffic situation. The analysis was done over a span of 5 minutes for all three levels of stress: high, medium and low, in different areas of the route which included the city, highway and the driver being completely at rest. These sets of data were then used to extract various features, like mean, variance, frequency of spikes exceeding a particular threshold, area under spikes, sum of durations of rise to local maxima and sum of rise in magnitudes during spikes. These were evaluated using neural networks and Support Vector Machine (SVM) and the results were compared. We found out that SVM gives better results in this application than neural network.

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1. Background

Stress recognition in automobile drivers is a growing concern because of increase in number of onboard electronic appliances, like cell-phones, audio and video players, navigation systems, which can lead to distraction of the driver's attention from driving. In driving circumstances, when there is high traffic and the driver experiences a higher degree of stress, automated management of the appliances may be desired. Understanding frustration of drivers has been listed as one of the vital areas for the improvement of intelligent transportation systems.
Various protocols can be used to measure driver workload. These include eye glands and on road matrix, but these parameters are very costly and difficult to maintain. Therefore, as an alternative, we can use physiological sensors to obtain electrodermal activity that can be processed by an automated on board system. This system can give us an indication of the driver's internal state under natural driving conditions without causing any obstruction while driving.

2. Objectives

The objectives of my project are as follows:

To classify automobile drivers stress into low, medium and high using only one physiological signal, that is EDA. It will be collected from hand and foot of the driver in the Physionet drivers' stress detection dataset. As our approach used only one signal, hence, the interference with driving is minimum as we do not need to collect more signals.

3.Scope of Work

Scope of this dissertation is to create a model to identify the physiological signals which can be used as a powerful metric for stress detection. These signals can be obtained continuously without interference in driving this information can be supplied to the automated systems that can help the driver to cope up with stress.

4.Mid–Sem Update Details

In this project we are making an attempt to identify the physiological signals which can be used as a powerful metric for stress detection. These signals can be obtained continuously without interference in driving this information can be supplied to the automated systems that can help the driver to cope up with stress. This may include management of non critical on board electronic systems. Calls and messages can be set to silent mode, navigation system can be set to provide only vitalin formation during high stress situations. The volume of music player can be lowered or relaxing tunes can be played to ease the driver. On the contrary the driver can be presented with more entertainment options during low stress.
In the Physionet dataset used [2], the signals are gathered for a drive, which includes regions are low, medium and high stress. The driver rests in the garage for the initial 15 minutes and then drives through the city traffic. He, then, reaches the highway, crossessome tolls, makes a U-turn and traces his way back to the garage. For the purpose of feature extraction, 5 minutes of data is extracted from each of the three driving situations, that is, city, highway and rest. These are a set of non overlapping 5 minutes this is done to decrease the amount of computation needed to detect stress.

METHODOLOGY - The algorithm uses 5 minutes interval of non overlapping sets from rest, city and highway representing low, high and medium stress levels respectively. To ensure the correctness of algorithm it is necessary to choose these sets carefully. The last 5minutes from the 15 minutes of rest conditions were used. The span on the highway consists of the time between two toll booths when the driver were safely in their lane. The segment of high stress situations were taken from the city drive where there was a busy traffic stretch. The most efficient paper were ferred sites that electrodermalactivity(EDA) and heart rate gives the best combination for stress detection. Here, we are making an attempt to constrict the signals to EDA by adding on some features so that an efficient algorithm can be proposed using one signal only. This would decrease the hardware requirements for the system, hence, the easiness of data collection increases and the system can be simplified. The overview of proposed methodology has been shown in figure 1. We propose to use around 16 features derived from hand and foot galvanic skin response(GSR) as described in algorithm A. These include four statistical features, that are, mean and variance of normalized signals. The normalization of the signals is done using standard deviation. For normalization, the mean of the array of data values is first found out. Then, we find standard deviation. After that, all the values are normalised by subtracting mean from them and then dividing them by the deviation.

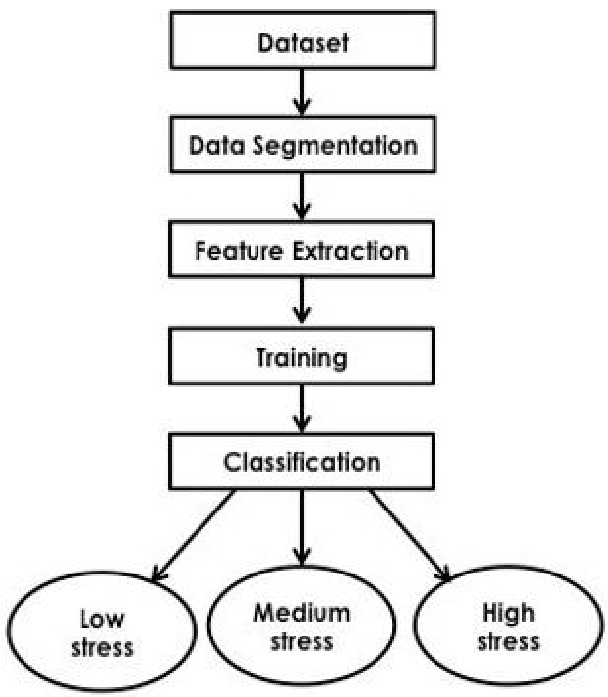

Fig. 1: Overview of proposed methodology

Eight features were calculated from skin conductivity signals to identify orienting responses. An orienting response is a hike in GSR signal due to activation of skin sweat glands as a consequence of sympathetic nervous activation. The proposed algorithm detects beginning and peak softhese responses by first extracting the slopes beyond a threshold value and then finding out the local minima just preceding it. Let the time duration between the onset and the peak be represented by Od and the total increase in amplitude be represented by Om . Using both of these values, four features are extracted: frequency of such responses, sum of magnitudes $\sum$Om, sum of duration of response $\sum$Od, and sum of approximate area under responses ($\sum (1/2) \times Om \times Od$). All these are calculated for hand and foot GSR.Other than the aforementioned features, we also included two more features. One is the standard deviation of Power Spectral Density (PSD). Power spectral density gives us the power of a given signal in different frequency domains [9]. If we want to calculate the total power of signal in a frequency range, then, we need to take summation of PSD in that range. In this project, we calculated the standard deviation of PSD. Other feature is the total energy of the signal. When the driver is in high stress, then, the energy of the signal will be more in comparison to when it is under low stress. These are calculated for both hand and foot GSR. After obtaining feature matrix of all the sample points, we used them to train two different classification algorithms and their testing results are compared. The algorithms are trained on all data points, except one, and then they are tested on that point. This is repeated for all data points in the sample space.

Artificial Neural Network (ANN) was developed to imitate human brain. They are composed of multiple nodes, called neurons, which imitate the working of human neurons. Different neurons are connected by links. They take inputs, then perform some computation on those inputs and pass the results to other neurons. There are three layers of neurons in an ANN- input layer, hidden layer and output layer. The input layer is of the size of feature matrix, i.e. 16; the output layer classifies each data point into low, medium and high stress level, so it has 3 neurons; and the hidden layer consists of 10 neurons. SVM is classifies different classes via a hyperplane . All the data points are plotted on n-dimensional coordinate system and then a hyperplane separating them is identified. These planes will classify the data points in different classes.

Both ANN and SVM are used to obtain results by classifying test data and then their results are compared.

5. Plan of Work

Phases	Start Date-End Date	Work to be done	Status
Dissertation Outline	17 Jan 2020 – 21 Jan 2020	Literature Review and prepare Dissertation Outline	Completed
Design & Development	22 Jan 2020 – 15 Feb 2020	Design & Development Activity	Completed
Testing	16 Feb 2020 – 13 Mar 2020	Software Testing, User Evaluation & Conclusion	Pending
Dissertation Review	14 Mar 2020-25 Mar 2020	Submit dissertation to Supervisor & Additional Examiner for review and feedback	Pending
Submission	26 Mar 2020-30 Mar 2020	Final Review and submission of dissertation	Pending

6. Literature References:

The state art is the base for any successful research project. In current project, the literature inclined towards the new domain of conversational information retrieval is considered. The following are referred journals from the preliminary literature review.

- J. Healey and R. Picard, “Detecting Stress During Real-World Driving Tasks Using Physiological Sensors,” *IEEE Transactions on Intelligent Transportation Systems*, vol. 6, no. 2, pp. 156–166, 2005.

- R. R. Singh, S. Conjeti, and R. Banerjee, “Biosignal based on-road stress monitoring for automotive drivers,” *2012 National Conference on Communications (NCC)*, pp. 1-5, 2012.

- D. S. Lee, T. W. Chong, and B. G. Lee, “Stress Events Detection of Driver by Wearable Glove System,” *IEEE Sensors Journal*, pp. 194–204, 2016.