OverSee , An AI Based Driver State Monitoring System

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In recent years[1], driver inattention or distraction is one of the major causes for road accidents. Every year many car accidents occur due to driver fatigue and distraction around the world and cause many casualties and injuries. In Bangladesh accidents occur primarily owing to the reckless driving of the drivers and due to emotional imbalance or drowsiness of drivers .To mitigate the numbers of road accidents , an inattention, fatigue and anger detection system should be designed in such a way that it triggers the alert system only when the driver is distracted beyond the acceptable limit. Thus, the objective of this research is to design a Driver State Monitoring System (DSMS) which combines the main approaches for driver fatigue, anger or distraction detection and accident prevention. Driver face monitoring systems capture the images from driver face and extract the symptoms of fatigue and distraction from eyes, mouth and head movemwnt. It it a dedicated device that estimates driver alertness based on extracted symptoms and alarms with voice command and colour popping alert on screen if needed.Raspberry Pi, CNN Algorithm, OpenCV, Tensorflow,Accelometer sensor

1 Introduction

Improvement of public safety and the reduction of accidents is one of the important goals of the intelligent transportation systems (ITS) [1]. One of the most important factors in accidents, especially on rural roads, is the driver fatigue and monotony. Fatigue reduces driver perception and decision-making capability to control the car. Research shows that usually after 2-3 hours of continuous driving, driver is fatigued and steering performance deteriorated. In the early afternoon hours, after eating lunch and at midnight, driver drowsiness is much more than other times. Monotony for certain task can reduce concentration for many rasons, the main reasons are 1)lack of personal interest, doing repetitive work for a long time,external factors(like talking over phone for a long time) [2] . Monotony in driving usually is caused by the second and third reasons. Prolonged driving on highways with flowing traffic has a negative effect on driver concentration. In this case, driver is not fatigued, but due to the monotony of

driving, his/her concentration will gradually be decreased and the driver will not have a careful control on the vehicle. Driver distraction can also be caused by talking to people or mobile phone [3]. Due to the importance of early detection of driver fatigue and drowsiness to avoid accidents, many researches and projects were done on this subject in the past decade The researches on the methods for driver distraction detection are also being done, but are less developed than the methods of driver fatigue detection Although, researches are being done, In Bangladesh this system is not developed at all. Some projects are being done, Some projects are being done but they don't include all the necessary features. Our purpose is to implement the ideas and researches being done over years on driver fatigue and distraction in Bangladesh and making a feasible and accurate detection system which will be easily usable and affordable.

2 Literature Review

many researches and projects were done on this subject in the past decade The researches on the methods for driver distraction detection are also being done, but are less developed than the methods of driver fatigue detection. The research paper published by Paweł Tarnowski, Marcin Kołodziej, Andrzej Majkowski, Remigiusz J. Ra presented the results of recognition of seven emotional states (neutral, joy, sadness, surprise, anger, fear, disgust) based on facial expressions. Coefficients describing elements of facial expressions, registered for six subjects, were used as features. The features have been calculated for three-dimensional face model. The classification of features were performed using k-NN classifier and MLP neural network [4]. The research paper published by Singh Himani Parmar, 2 Mehul Jajal, 3 Yadav Priyanka Brijbhan - describes how to find and track the eyes. describes a method that can determine if the eyes are open or closed. The main criterion of this system is that it must be highly non-intrusive and it should start when the ignition is turned on without having at the driver initiate the system. Nor should the driver be responsible for providing any feedback to the system. The system must also operate regardless of the texture and the color of the face.It must also be able to handle diverse condition such as changes in light, shadows, reflections etc. In given paper a drowsy driver warning system using image processing as well as accelerometer is proposed [5]. The paper proposed by Mohamad-Hoseyn Sigari,Mahmood Fathy In this paper, a new approach is introduced for driver hypovigilance (fatigue and distraction) detection based on the symptoms related to face and eye regions. In this method, face template matching and horizontal projection of top-half segment of face image are used to extract hypovigilance symptoms from face and eye, respectively. Head rotation is a symptom to detect distraction that is extracted from face region e extracted symptoms from eye region are (1) percentage of eye closure, (2) eyelid distance changes with respect to the normal eyelid distance, and (3) eye closure rate. and second symptoms related to eye region are used for fatigue detection; the last one is used for distraction detection. In the proposed system, a fuzzy expert system combines the symptoms

to estimate level of driver hypo-vigilance. here are three main contributions in the introduced method: (1) simple and efficient head rotation detection based on face template matching, (2) adaptive symptom extraction from eye region [6], The next paper published by Anuj Kapurja, Deepak Chandra describes A Driver State Monitoring System that prevents any casualty on the road because of drowsiness while driving. It is an in-vehicle, vision-based electronic system for automobiles. It utilizes a camera installed on the vehicle facing towards the driver. It captures the edge-based face features of the driver. Thereafter, the real time image processor extracts the desired image from the image and estimates the correct position of the eye, the nose and the head orientation of the driver's face based on the predetermined values. The signal generator generates a warning signal when there is any abnormality detected based on the output of the status examination result generated by the real time image proces sor. These signals can be can be an acoustic signal, a videft signal, a photonic signal or a haptic signal [7]. In summary, previous studies showed many ways of driver state monitoring system. but none of them combined all the features like drowsiness, inattention at the same device. Also, there is another feature which is for anger detection. Some software has a feature of alarm or sound system but in ours we also used colours like green, yellow or red popping on the web app to concern the driver about his own state while he is driving in real time, which is not used in any other existing systems. We are also giving voice command over driver's current state to alert him/her more quickly. In order to make this device more user friendly, and safe use for everyone we are delivering a dedicated device for this whole process. The other systems offers mobile application or only camera detection, but this is a totally dedicated device which would turn on when the car,bus or truck is moving. So, it ensures the level of security at much higher point as the driver cannot turn on or off this device according to his will. This device has a feature of suggesting nearby parking slot or coffee shops when the driver is angry, drowsy or inattentive- which is not available in the existing systems. The paper is organized as follows. Section II discusses an idea about the related works. In Section III discusses the , conceptual design, and development of the present system. Section IV briefly discusses the methodology and implementation of the system. Section V presents discussion of the whole system. Finally, Section VI concludes the paper.

3 Conceptual Framework and Architecture

This proposed system of AI based driver monitoring is suggesting a dedicated device for the monitoring of drivers. As it is a dedicated separate device, it is portable and can be plugged in with any type of car just with a cable. This system will continuously monitor the driver until the car is running with a pi-camera by taking continuous video stream and analyzing it. As soon as the driver becomes drowsy or angry or inattentive – anything harmful for safe driving, this system will generate an alarm to let the driver as well as the passenger know about the condition and to take necessary step. It will generate

a continuous alarm if the driver is not aware and don't take any step to get better This system also has a suggestion system for the driver's current situation. It will suggest nearby coffee shop and parking slot to take rest and start again with a fresh mind. Other current systems don't give alarm to the inattentive driver, talking continuously in mobile phone or with the passenger. This system will take care of this issue too. The overview of the proposed system's architecture is presented in Figure 1 that shows the link between the physical level and logical level. The required equipment is also given in architecture. This system has a raspberry pi and pi camera for monitoring the driver and processing the system. It has two sensors which tracks the current location of the driver and checks if the car is running or not The flow diagram (see Figure 2) shows the process of alarming the driver. It takes the facial features from the video stream and processes the video to check if the driver is in any inconsistent state. If he is, the system will give alarm and suggestion in the display. If not, the driver is safe. Thus, the working principle of the system is summarized with help of the diagram. The proposed system includes both the hardware and software parts. We are using Raspberry Pi model 3B+ to implement this solution. Raspberry Pi Camera is used to capture the image of the driver from a live video stream. Using the image we find out the driver is drowsy or not, yawning or not, inattentive or not, currently, s/he is talking or not. According to these we parameters we give an alarm to the driver using a sound box which is connected to the raspberry pi's 3.5 mm sound port. A display is attached with the raspberry pi to see these in real time. The driver's real-time state is sending to the fire base and we are fetching the data in our web app to display from fire base The proposed system includes both the hardware and soft- ware parts.

4 System Development

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4.1 Hardware Development

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all our monitoring process will happen when the driving is on that means the car is moving so to get to know the car is moving or not an accelerometer sensor is used. If the car is moving then all of before-mentioned monitoring processes will occur otherwise when the car is in parking or in a traffic jam then no unnecessary alarm will be given. As a GPS sensor, Neo 6M GPS module is used which is attached with raspberry pi using serial communication, and an accelerometer sensor, MPU 9250 which is attached with raspberry pi using i2c communication.

4.2 Software Development

The main purpose of front-end development is to make the whole system easily accessible and usable for the driver. Our alarm part will alert the driver vocally but to make the system more feasible and workable to the driver we made a web app to show all the present state in front of the driver. We are suggesting the nearest coffee shop or parking spot automatically to the drowsy or inattentive driver based on his/her state. This suggestion will come to the driver using this front end. We kept our front end so much simple so that it doesn't attract the driver too much because the more attractive front end will create driving risk for the driver. We are using HTML, CSS, Bootstrap, Python, and JavaScript for front-end development and Firebase is used for back-end development of the web app. HTML and CSS are used for developing the skeleton of the web app and for designing Bootstrap is used Python is used for writing the main computer vision code which fetches the driver's image in real- time and using dlib library we fetched the landmark of the current of the driver and calculated that he is drowsy or not, inattentive or not, talking or not. We are sending these state parameters to firebase to store and retrieved them in our web app and make an alarm to the driver. For the alarm system, we used pygame library of python .JavaScript is used to go ahead with more complex designs and make the website more responsive and look attractive. It is also used for implementing the functionalities of the web app like blinking the current state with different colors, building a connection with the Firebase, and store and retrieve data from Firebase. Firebase is a technology that allows the system to create web applications without server-side programming, making development faster and easier. Real-time synchronization of data across all clients is very useful in Firebase.

5 Evaluating the Prototype

An evaluation study was conducted in an academic environment by using the agile process to measure the functional accuracy and usability of the proposed system. For each primary functionalities of the system, a test case scenario was prepared and then conducted five times. The percent of the success rate and the average delay in seconds are shown in Table I. The evaluation tasks were designed for experienced drivers. 4 experienced and professional drivers were

invited as test subjects. The invited drivers had an average age of 45 years. age ranging from 30 - 60 years and had a driving experience of ten years. During the evaluation study, firstly a brief presentation about the objective of this study was given to the participants. Second, the proposed system was demonstrated to them and the opportunity to use the system was given to them from their respective point of view for roughly 10-15 minutes. Finally, participants were invited to perform a set of tasks with the system. Finally, they were asked to provide their opinion about the usability and effectiveness of the proposed system, and give any recommendations they might have come up with. A summery of the recorded data is presented in table 1. The results showed that each participant was able to perform the designated tasks with a comparatively minimum number of attempts (see Table 2). For example, for 60% tasks participants did not ask any questions from the observing researchers. A similar result was found for the number of attempts. Except for task number four, all other tasks took less than or around one minute to complete. The participants view the graphical results generated by the tool during their testing and generally it is said that it would be an efficient way to monitor a driver's state. Participants were satisfied with the system's performance, and functionality, and expressed the overall usability of the system is good. According to them, the system is very easy to learn for anyone.

6 Discussion and Conclusion

This Driver state monitoring system detects drowsiness, inattention and talking detection in real time. Image is captured by Pi Camera and data comes from GPS and Accelerometer sensor and through the algorithm it calculates the percentage of driver's state. Multiple research work has been made on this but none of them combined all the features like drowsiness, inattention at the same device. Also, there is another feature which is for anger detection. Some software has a feature of alarm or sound system but in ours we also used colours like green, yellow or red popping on the web app to concern the driver about his own state while he is driving in real time, which is not used in any other existing systems. We are also giving voice command over driver's current state to alert him/her more quickly. In order to make this device more user friendly, and safe use for everyone we are delivering a dedicated device for this whole process. The other systems offers mobile application or only camera detection, but this is a totally dedicated device which would turn on when the car,bus or truck is moving. So, it ensures the level of security at much higher point as the driver cannot turn on or off this device according to his will. This device has a feature of suggesting nearby parking slot or coffee shops when the driver is angry, drowsy or inattentive- which is not available in the existing systems. There are many possible changes for the evolution of our project. Initially we are working on the speed limit of Dhaka city's road. In future it can be extended to all over Bangladesh. Then each and every road's speed limit can be showed using our device. Here, we have to use external internet connectivity to run

the device. But in future we can add an internal internet connectivity using a portable WiFi attached to it. A new feature to measure the safe distance from another vehicle can be introduced. Alcohol detector can be added as an extra feature in future. An alcohol sensor can be used to detect if the driver alcoholic or not. Become alcoholic is also cause a great risk at the time of driving and it is very common in Bangladesh.

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