Modeling of Driver Behaviour Recognition and Prediction using Dynamic Bayesian Network

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Abstract— With the numbers of vehicles increasing, the numbers of road accidents which are causing fatalities are also increasing. So human lives are lost and thus cause instability in their family and the organization in which they work. This paper focuses on recognizing the behaviour by observing the driver's facial gestures and predicts a context aware system architecture which is proposed to collects the information related to the driver's behaviour to detect the abnormal behaviour among the drivers. Dynamic Bayesian network is used to capture static and dynamic aspects related to the behaviour of driver which leads to accurate detection of behaviour.

Keywords— Dynamic Bayesian Network, Driver-behaviour, safety, Reckless behaviour, Fatigue, Normal Behaviour

INTRODUCTION

At the present time, large number of people are using cars and private vehicles. The biggest concern regarding the increased use of private transport is the rising number of deaths that is occurring as a result of accidents on the roads; the associated expense and related dangers have been recognized as a serious problem that is being confronted by modern society. According to the U.K. Department of Transport's report for road casualties in Great Britain for the first quarter of 2011, there were 24 770 people killed or seriously injured due to road accidents. This number represents a small decrease of 5%, as compared with the previous 12 mo period [1]. Driver errors due to being affected by fatigue, being drunk, or being reckless are the main factors responsible for most road accidents. Many researchers have been working in the area of driver monitoring and detection over recent decades; therefore, multiple systems have been proposed to monitor and detect the status of drivers. Some researchers have tried to monitor the behavior of the vehicle or the driver in isolation, whereas others have focused on monitoring a combination of the driver, the vehicle, and the environment, to detect the status of the driver in an attempt to prevent road accidents. However, there is still no comprehensive system that can effectively monitor the behavior of a driver, the vehicle's state, and environmental changes to perform effective reasoning regarding uncertain contextual information (driver's behavior). In this paper, we propose a context-aware architecture for a driver behavior detection system that can detect four types of driving behavior in real-time driving: normal, fatigued, drunk, and reckless driving. It will then alert the driver by operating in vehicle alarms and sending corrective action, respectively. The functionality of the architecture is divided into three phases, which are the sensing, reasoning, and acting phases. In the sensing phase, the system collects information about the driver, the vehicle's state, and environmental changes. The reasoning phase is responsible for performing reasoning about uncertain contextual information to deduce the behavior of the driver. The behavior of the driver is considered as an uncertain context (high-level contextual information); therefore, effective reasoning techniques about uncertain contextual information must be performed. Driver behavior is developed over the course of driving; therefore, we have designed a dynamic Bayesian network (DBN) model to perform a probabilistic reasoning to infer the behavior of the driver. You can put the page in this format as it is and do not change any of this properties. You can copy and past here and format accordingly to the default front. It will be easy and time consuming for you.

A. Related Work

Several researchers have examined the development of driver monitoring and detection systems using range of methods. Some have attempted to measure the driver's state or the vehicle's behavior to detect fatigued and drunk drivers. Meanwhile, other researchers have tried to monitor the driver, the vehicle, and the environment to detect the state of the driver. The main studies are summarized in the following. In [5], the focus of the paper was on building a context-aware smart car by developing a hierarchical model that is able to collect, to reason about, and to react to contextual information about the driver, the vehicle, and the environment, providing a safe and comfortable driving environment. However, this system is restricted to warning the driver and controlling the vehicle and does not warn other vehicles on road by sending warning messages. In [6], a context-aware system is proposed that is used to collect and analyze contextual information about the driver, the vehicle, and the environment in real-time driving. It also collects information from questionnaires completed by the drivers to create driving situations. The Bayesian network is used to reason about this contextual information, which is relatively uncertain information, by using a learning process to observe and predict the future behavior of the driver. The system was able to predict the future behavior of the driver and cannot detect the current state of the driver and warn other vehicles on the road. In [7]–[9], the detection of the fatigue level of the driver using a video camera to extract different cues such as eye state, eyelid movement, gaze movement, head movement, and facial expression is attempted to measure the fatigue level and warn the driver via in-vehicle alarms. In [10], a program that works on a mobile phone and that contains an accelerometer and orientation sensors placed in the vehicle to detect a drunk driver in real time is developed. The program compares current accelerations with typical drunk driving patterns. When the program indicates that the driver is influenced by alcohol, warning messages are generated to alert the driver, and a message is sent to inform police. In [11], a drunk and drowsy driver detection system combining breath and alcohol sensors in a single device is developed. This device is able to measure the degree of alertness of the driver to detect charged water clusters in the driver's breath to detect the presence of alcohol using breath and alcohol sensors. In [12], a system for drowsy driver detection in real-time driving by collecting information about the driver's behavior, such as the speed of the vehicle, the vehicle's lateral position, the yawing angle, the steering wheel angle, and the vehicle's lane position is proposed. Their system uses artificial neural networks to combine different indications of drowsiness and to predict whether a driver is drowsy and to issue a warning if required. In [13], a noncontact system to prevent driver drowsiness by detecting the eyes of the driver and checking whether they are opened or closed using a charged-coupled device (CCD) camera has been developed. The system is based on capturing the face of the driver and on using image processing techniques to check if the eyes are closed for long intervals.

If the eyes are closed, the driver is drowsy, and the system will issue a warning to the driver. The driver behavior detection systems described earlier focus on the detection of driver's status (drunk, affected by fatigue, drowsy) by monitoring the driver or the vehicle and by issuing warning messages to the driver to prevent road accidents. While these systems have achieved good results in terms of improving road safety, they are limited to alerting the driver or controlling the vehicle itself. Moreover, they have not considered the behavior of the driver as a high-level context (uncertain context). This paper attempts to construct a comprehensive system that is able to detect normal and abnormal driving behavior using a context-aware system to collect and analyze contextual information about the driver, the vehicle's state, and environmental changes and to perform reasoning about certain and uncertain contexts. The driver and other vehicles are then alerted by operating an in-vehicle alarm and by sending warning messages containing corrective actions via wireless technology provided by VANETs, thus providing a flexible yet more accurate proactive driver behavior detection system..

B. Overview of Driver Behaviour

The behavior of the driver can be represented as follows:

$$B = \{St{=}1,\ St{=}2, \ldots, St{=}n\}$$

where B is the behavior of the driver, S is the state, and t is the time. The states of the driver were classified into four classes: normal driving Sn, drunk driving Sd, fatigued driving Sf , and reckless driving Sr. As defined, each state may be characterized by capturing observable context C. The state may be referred to as:

$$(St{=}i) = \{C1, C2, C3, \ldots, Ck\}.$$

In conclusion, the behavior of the driver is considered as the current unobservable state $St{=}i$ that can be characterized by capturing a set of observable context Cj , where $St{=}i$ is the state at time = i, and Cj is the context that need to be captured to characterize the state. Based on the previous definitions [15]–[23] of the driving behavior, we have defined four categories of driving behavior. 1) Normal behavior: Behavior is considered to be normal when driver concentrates on the driving task. This can be characterized by controlling the speed of the vehicle, avoiding sudden acceleration, driving without alcohol intoxication, maintaining a proper position between lane markers, and the driver having his or her eyes open while driving. When the driver matches the aforementioned criteria, behavior is considered normal.

2) Drunk behavior: This refers to driving while intoxicated by alcohol and is characterized by a set of observable actions such as sudden acceleration, driving without maintaining the proper lane position, driving with out controlling the speed, and usually having closed eyes for more than 80% for a period of time.

3) Fatigue Behavior: In [24], fatigue is defined as an evolving process that increase during driving and is associated with a loss of effectiveness in driving. In [24]–[26], it is stated that a driver driving after a period of 17 h with no sleep behaves exactly as a driver who has 0.05% intoxication of alcohol. A driver driving after a period of 24 h with no sleep behaves exactly as one who has 0.1% intoxication of alcohol. Based on this argument, fatigue driving was defined as driving that exhibits the same characteristics as drunk driving but without alcohol intoxication in the driver's blood. 4) Reckless behavior: The reckless driver is defined as a driver who drives at high speed and a high degree of acceleration and puts other traffic participants at risk. The driver is classified as driving in this category when there is no alcohol intoxication and the driver's eyes are opened, but the following behaviors are exhibited: driving with sudden acceleration, not maintaining the proper lane position, and not controlling the vehicle's speed.

C. Flowchart

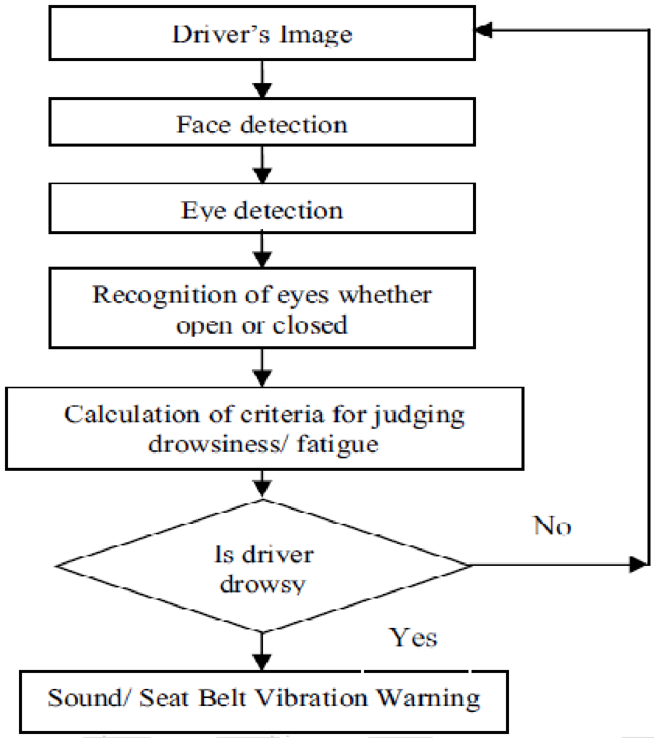

Fig 1. Eye Tracking System

This system will detect a driver fatigue by processing of eye region as shown in flow chart in Fig.1. After image acquisition, face detection is the first stage of processing. Then symptoms of hypo-vigilance are extracted from the eyes. If eyes are blinking normally no warning is issued but when the eyes are closed for more than half second this system issues warning to the driver in form of alarm and vibration.

PROPOSED SYSTEM

Firstly the face will be detected with the help of camera This is the process of gathering the contextual information which is done by sensors. Then reasoning is done by a subsystem. This level employs the extraction of the situation of the driver and calculates the parameters. And finally the detection part is performed which is done by Bayesian network. As stated previously in the definition driver behavior, this refers to a transition between a set of states during the course of driving. For example, the alcohol level in the driver's blood may be low at the beginning of the driving but will become higher if the driver is drinking while driving; the level of fatigue may also increase during driving. This fact indicates that, in addition to the observable context at the current time slice, the driver's state at the previous time slice is also considered an indicator for the state at the current time slice.

CONCLUSION

Comparison between all possible evidences of drunk behavior. Monitoring and detecting the behavior of drivers is vital to ensuring road safety by alerting the driver and other vehicles on the road in cases of abnormal driving behavior. Driver behavior is affected by many factors that are related to the driver, the vehicle, and the environment, and over the course of driving, a driver will be found to be in a particular state; the driver can then stay in this state for a period of time or shift to another state. Hence, it is important to capture the static and dynamic aspects of behavior and take into account the contextual information that relates to driver behavior. In this paper, we have proposed a driver behavior detection system from viewpoint of context awareness. Our contributions are threefold: 1) A context-aware architecture, which can detect the behavior of the driver, is presented by capturing information about the driver, the vehicle, and the environment; 2) a DBN algorithm for inferring driver behavior from different kind of sensors under uncertainty has been formulated to capture the static and dynamic aspects of the behavior; and 3) definitions for normal and abnormal driving behaviors are given. The evaluation result has demonstrated the detection accuracy of the proposed model under uncertainty and the importance of including a great amount of contextual information within the inference process. Our future work comprises designing a corrective action algorithm to calculate the appropriate corrective actions for other vehicles on the road.

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