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A Survey on Driver Drowsiness Detection Techniques

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Abstract:
The number of accidents during driving is increasing day by day and drowsy driving has been implicated as a causal factor in many accidents. In this paper, we review various ways through which drowsiness has been detected. The goal of driver drowsiness detection systems is to reduce these accidents. It has been seen that most of the accidents occur due to driver's drowsiness and a small due to lack of attention. Therefore this paper survey the driver's fatigue monitoring techniques with other detail.

Keywords: Driver drowsiness; Drowsiness detection techniques.

I. INTRODUCTION

According to available statistical data, over 1.25million people die each year on the road and 20 to 50 million people suffer non-fatal injuries due to road accidents [1]. Driver's drowsiness has been noticed as a major factor in many of the accidents because of the noticeable decrease in driver's perception of risk and recognition of danger, and diminished vehicle-handling abilities due to fatigue [2]-[4]. Drowsiness involves physical as well as physiological changes. Physical changes involve sleeplessness while physiological changes involves rate of actions and reactions taken by driver. A number of methods have been proposed to detect drowsiness state, and are mainly classified into three approaches. The first approach is to monitor driver's behaviors related to drowsiness, such as the inclination of the driver's head, sagging posture, decline in gripping force on steering wheel, and lane departure using a camera to track road marking. The second approach is eye movement detection and third one is to analyzing facial image changes such as yawning. Drowsiness detection techniques have been reviewed in the next section.

II. DRIVER DROWSINESS DETECTION TECHNIQUES

Three driver detection techniques are described in detail in this section. These are:

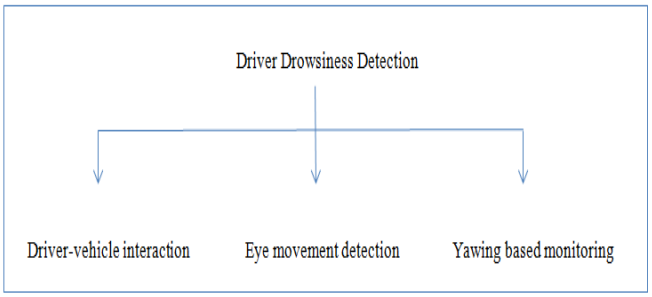

Figure.1. Type of drowsiness detection techniques.

A. Driver-vehicle interaction

Driver drowsiness can be noticed on the basis of driver-vehicle interaction. There are moments when a driver still looks awake but does not process any information therefore performance degrades due to drowsiness may be induced by brain functions associated with sleep deprivation. To address this issue, approach has been addressed which measures the performance of drivers from the driver vehicle interaction. Driver-vehicle interaction is measured in three phases. These are:

1) Sleep deprivation measurement.
2) Task observation.
3) Performance measures.

1) Sleep deprivation measurement

Sleep deprivation level is used to measure the level of homeostatic need for sleep. There are two sleep-deprivation levels are considered, one is "partial sleep-deprivation" and another "no sleep-deprivation". The level of sleep deprivation is proportional to the amount of sleep that each subject had before the day of driving.

2) Tasks observation

A series of simulated driving and non-driving tasks were given to the subjects and their respective actions were observed. Lane tracking performance can lead to overall driving malfunction; therefore lane-tracking is generally considered a main indicator for detecting driver's drowsiness [11]. Five different tracking tasks for non-sleep deprived and partial deprived subjects in a random order while driving.

The five tracking tasks involved the followings:

a) A curved road;
b) A straight road with changes in steering dynamics;
c) A straight road with a lead vehicle;
d) A straight road without any disturbance;
e) A straight road with disturbances (e.g., wind gusts).

Some simulated response tasks were given to each subject in random order during simulated driving and their instantly response was observed. The four simulated response tasks involved the followings:

a) Single Lane Change Task (SLCT).
b) Double Lane Change Task (DLCT).
c) Auditory Psychomotor Vigilance Task (APVT).
d) Visual Psychomotor Vigilance Task (VPVT).

3) Performance measures

a) Measure the driver performance during driving depends upon the root mean square (RMS) error with root mean

threshold (RMT), which is usually used to measure the general tracking performance observed through various ways.
b) The reaction time is a measure of how fast a driver reacts to stimuli presented abruptly, i.e.,

RT= taction - tstimulus

Where, tstimulus is the time during which a stimulus is present to the driver Taction is the time the man vehicle system takes to react upon the given stimulus.

B. Eye movement detection

Various measuring systems like electrooculography (EOG), infra-red cameras or other image-based detectors can be used for detecting eye movements. Based on eye movements various features like blink duration, amplitude etc. are defined and extracted, then classified in various drowsy state.
Various methods employed to detect driver's drowsiness by eye's movement are:
1) Blink detection by median filter- When awaken, time at which a person does not suffer from sleep deprivation, blink often follow similar characteristics, i.e. their amplitude and duration do not change remarkably. This implies that blink duration detected by applying a fixed-window size median filter [6]. As blink duration not only varies from person to person, but also for an individual according to the level of drowsiness, therefore, applying a fixed-window size median filter is not a good solution for blink detection.
2) Fast eye movement detection based on blink's pattern- The eye blink detection method is based on the derivation of the EOG signal [7, 8]. But EOG signals are very sensitive to any muscle artifact around the electrodes; it might be possible that some artifacts are confused with eye movements.

C. Yawning based monitoring

Driver's drowsiness can be measured on yawn of the subject and there are various ways of doing it. Gravity-Center template, Viola face detection method etc. has been used for detecting face, and then grey projection and Gabor wavelet to detect mouth corners or mouth window is extracted and spatial Fuzzy c mean clustering to know the lips position[9]. LDA has been applied to classify feature vectors to detect yawning. Geometric and haar-like features also have been used for detecting mouth and ration of mouth height and width which ultimately detect the yawn of the subject [10].

Steps to detect yawn of the subject is as follow:

Step1: Detect face of the subject – Face of the driver using degree of variability in size, shape, color and texture using RGB and lighting conditions.

Step2: Tracking the face – Detected face used as a template in tracking upcoming frames and matched based on its location and various other correlation factors.

Step3: Eye detection – After locating face, eyes are detected to make sure that mouth is tracked correctly.

Step4: Mouth detection – This is an important step as it detects position of lips and mouth, therefore ultimately helps in yawn monitoring of the subject.

Step5: Yawn detection – Yawning is first detected by measuring the hole in the mouth as a yawning component, and then location of mouth is verified to see the validity of detected component. The verification criteria is number of pixels located in yawning mouth with respect to number of mouth pixels as well as relative location of the open mouth with respect to the lips.

III. EXISTING RULES, POLICIES AND MEASURES

There are few existing measures given and suggested by government keeping in mind road safety and how to reduce accidental risks. These are:

A. Transportation Policies

The National Center on Sleep Disorders Research and NHTSA expert panels on driver fatigue recommend three priorities for an educational campaign:
• Educate young people (ages 16–24) about drowsy and rough driving and how to reduce accidental risks;
• Raise public awareness about drowsy driving risks and harms and learn how to reduce them
• Educate shift workers about the risks of drowsy-driving and how to reduce them.

B. Fatigue Detection Techniques

Along with transportation policies, reliable and applicable drowsy-driving detection techniques may help to detect fatigue. Researchers have developed a number of different drowsiness-detection methods, which can be classified in terms of their specific procedure and measure used to detect fatigue.
Summarized the detection techniques based on:
• Physiological signals, including pulse rate and EEG.
• Physical changes, including changes of head position, eye-closure rate, and eyelid movement.
• Driver–vehicle data, including steering angle, throttle/brake input, and speed.
• Secondary tasks that periodically request responses from drivers.

IV. CONCLUSIONS

Driver drowsiness detection systems have been very advantageous in reducing day by day road accidents and thus encouraged to use. This paper gives a review of few driver drowsiness detection techniques and existing measures supported by government. Paper has revealed characteristics of drowsy driving and its adverse effects can be seen clearly. Three drowsiness detection methods; driver-vehicle interaction, eye movement detection and yawning based monitoring systems are explained in detail with simple and understandable procedure used.

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