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An Implementation of Railway Derailment by Measuring Eye Blinking and Physiological Sensing for Safe Driving

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--ABSTRACT---
Despite the fact that number of Railway accidents have been occurred due to system failure and lack of attention. Therefore, Driver in-alertness is an important cause for most accidents related to vehicle crashes. This paper basically focused on Drowsy driver detection methods can form the basis of a system to potentially reduce accidents related to driver drowsiness that leads major accidents. An Automatic vision based system describes a real-time driver in alertness and shock related facial expression monitoring. This system obtains visual cues such as eyelid movement; gaze movement, head movement, and facial expression that typically characterize the level of alertness of a person are extracted in real time and systematically combined to infer the fatigue level of the driver. It distinguishes itself by the Two-Way Approach in eye gaze analysis. Shock analysis is done to identify the driver's expression and signals are sent for automatic braking system. An automatic vision based system is developed to model in Intel-Eye and it is used for predicting human alertness based on the visual cues obtained.

Keywords-*derailment, vibration sensing, eye blinking, accidents free, track.*

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I. INTRODUCTION

The primary contribution of this research is automatically initializing the eye blink detection in an image sequence for real time eye tracking applications. The never-ending saga of traffic accidents all over the world are due to deterioration of driver's vigilance level. Drivers with a depleting vigilance level suffer from a marked decline in their perception; recognition and vehicle control abilities & therefore pose a serious danger to their own lives and the lives of the other people. For this reason, developing systems that actively monitors the driver's level of vigilance and alerting the driver of any insecure driving condition is essential for accident prevention [17, 20]. Many efforts have been reported in the literature for developing an active safety system for reducing the number of automobiles accidents due to reduced vigilance. Though advance safety features are provided such as advances in vehicle design, including the provision of seat belts and airbags and improvements. One of the most damaging rail accidents is a derailment [1]. A derailment is an accident on a railway in which a train leaves the rails, which can result in damage injury, and death. Derailment of a train occurs when the wheels lift and slip out of the track. One of the major type of derailment has been studied is Excessive speed [1, 2]. However, future increases in Railway track will make it difficult to meet future casualty reduction targets unless more advanced accident avoidance technologies.

i. Sensing of physiological characteristics.
ii. Sensing of driver operation.
iii. Sensing of vehicle operation.
iv. To monitor the response of the driver.

II. LITERATURE SURVEY

Several studies have been done to prevent accidents in real life regarding Railway system failure and human failure. Some of the techniques are surveyed to cease the hazards.

i. Electronic Stability Control

Electronic Stability Control (ESC) systems act on the braking or power systems of a vehicle to assist the driver in maintaining control of the vehicle in a critical situation (caused, for example, by poor road conditions or excessive speed during cornering). ESC usually acts by sensing wheel slip in individual wheels and reducing power or braking to one or more wheels to regain stability. ESC can reduce accidents by more than 20 percent in normal conditions and more than 30 percent in wet or icy conditions. It has been available on some vehicles for around 10 years, and costs have been reducing due to improved technology and increased volumes. A driver's state of vigilance can also be characterized by indirect vehicle behaviors like lateral position, steering wheel movements, and time to line crossing. There is an important Spanish system called TCD [6, 17] based on steering wheel and lateral position sensors.

ii. Advanced Emergency Braking Systems (AEBS)

Some vehicles are already fitted with systems, which employ sensors to monitor the proximity of the vehicle in front and detect situations where the relative speed and distance between the two vehicles suggest that a collision is imminent. In such a situation, emergency braking can be automatically applied and the effects of the collision are either mitigated or avoided altogether [17]. The capability of such systems could be expanded in the future to cover other types of accident. There are significant casualty savings to be obtained by equipping vehicle with these systems. The level of casualties saved depends on the type of vehicle and the level of capability of the system. Current systems do not always avoid collisions, but they ensure that the collision takes place at a slower speed thus mitigating injuries. Future systems should be able to avoid collisions altogether, including may collisions with pedestrian and that is the highest benefit to cost ratios is likely to be achieved through fitting these systems to heavy vehicles due to the increased severity of front to rear collisions.

Various Methodology or Techniques have been adopted to provide safety regarding Accidents. Based on 'Radio Communication', 'Microprocessors' and, Global Positioning System (GPS)' technology, the **Anti-Collision devices at Level Crossing (LC) Gates** [6, 18] and on board

III. OBJECTIVE

With reference to this paper, the main objective is to avoid sudden damages or accidents causes by wheel climb and rail roll that leads to derailment. Since, not all the faults described in this paper, the priority given to the error that comes due to either System fault or Human fault. The study of the derailment has been focused about the defects in the train itself, but in this paper, the main purpose is to prevent derailment to monitor the causes related to it and identify the actions related to it. The type of derailment described above have a common cause of high lateral force at the wheel-rail interface. Therefore, any condition that leads to high lateral forces or lead to lower the ability of the system to sustain the force should be corrected. This is possible only when the vibration related to the forces should not cross the limit; otherwise the vibration that comes out due to broken rail is very high and can be computed using Simulation method to detect the level of derailment [7]. The effect of vibration depends on the magnitude of acceleration suffered by a passenger, its direction and frequency. To meet this condition, velocity, acceleration or jerk of vibration of train must be limited to certain extent [10]. Among these methods, the techniques based on human physiological phenomena are the most accurate. This technique is implemented in two ways:

i. Measuring changes in physiological signals, such as brain waves, heart rate, and eye blinking.

This technique while most accurate, is not realistic, since sensing electrodes would have to be the driver's body, and hence be annoying and distracting to the driver. In addition, long time driving would result in perspiration on the sensors, diminishing their ability to monitor accurately.

ii. Measuring physical changes such as sagging posture, leaning of the driver's head, the open/closed states of the eyes, trauma state expression in eyes seen through widening of gaze.

Locomotives can apply brakes in time, in case the Gate is open to road traffic on the track area is obstructed by any vehicle.

Anti – Collision Device (ACD) has been validated by Electronics Test & Development Centre, Chennai, India.

Gate protection system CAN NOT Prevent a train collision when,

i. The train is a 'NON' ACD Train.
ii. 'Adequate' braking distance at that speed is not available when a 'dangerous' collision like situation arises.

This technique is well suited for real world driving conditions since it can be non-intrusive [16] by using image processing to detect changes. Driver operation and vehicle behavior can be implemented by monitoring the steering wheel movement, accelerator or brake patterns, vehicle speed, lateral acceleration, and lateral displacement. The final technique for detecting drowsiness [17, 21] is by monitoring the response to the system to indicate alertness. The purpose of the system is based on eyes closer and yawning count of the driver. By monitoring the eyes and mouth, it is believed that the symptoms of driver fatigue can be detected early enough to avoid an accident. The eye blink frequency increases beyond the normal rate in the fatigued state. In order to detect fatigue and shock expressions probability an eye image parameters must be extracted first.

IV. METHODOLOGY

Driver operation and vehicle behaviour can be implemented by monitoring the steering wheel movement, accelerator or brake patterns, vehicle speed, lateral acceleration, and lateral displacement. These too are non-intrusive ways of detecting drowsiness, but are limited to vehicle type and driver conditions.

Eye Detection System

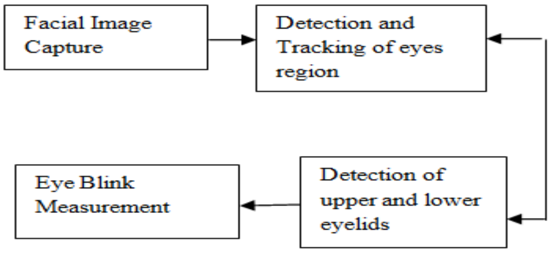

Fig 1: Process of Eye Blink Measurement

The final technique for detecting drowsiness is by monitoring the response of the driver. This involves periodically requesting the driver to send a response to the system to indicate alertness. The problem with this technique is that it will eventually become tiresome and annoying to the driver. Available blink detectors in market or we can incorporate it with a special instruction written in image processing that, if there is no pupil found for the certain period of pre-determined i.e. time greater than the human eye blinking time then consider an event called "blink", for which the set of operations will be followed. Here, in this case we need to set time as 1 second or above it, as "blink event" is different from "normal eye blinking". We need to perform testing for only blink event estimation, and not to find normal eye blinking.

Developing Systems that actively monitors the driver's level of vigilance and alerting the driver of any insecure driving condition is essential for accident prevention.

The implementation of a system solves the several areas of difficulty:

1. Identifying and tracking the head location.

2. Identifying and tracking the location of the eyes.

3. Detecting blinks of the eyes.

4. Being able to process the information in real-time using a moderately priced processor that will be running other applications in the foreground.

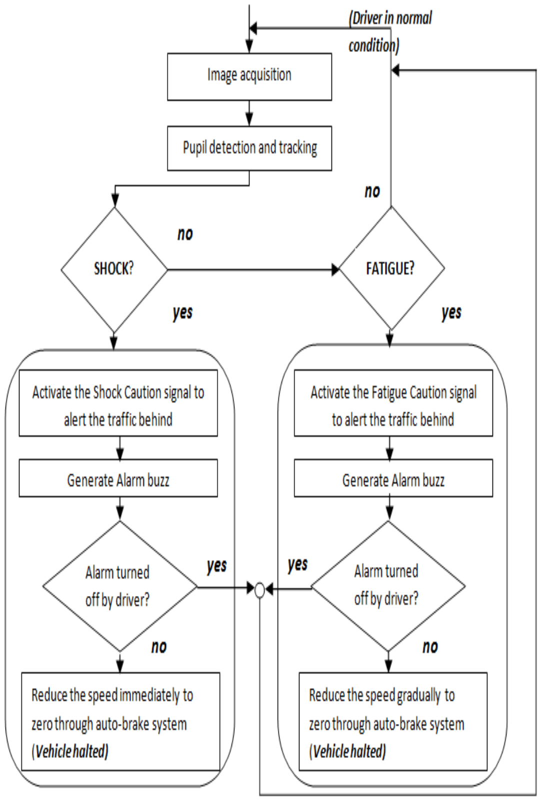

Fig 2: Generated an alarm to wake up the driver and it also slows down the vehicle as done in automatic braking systems.

The general architecture of our system consists of these major modules:

i. Image acquisition,
ii. Pupil detection
iii. Tracking
iv. Analysing visual behaviour.

The image acquisition is based on a low cost charge coupled device micro-camera to near IR. The pupil detection and tracking stage is responsible for segmentation and image processing. The pupil detection stage is simplified by the "bright pupil" effect, similar to the red –eye effect in photography. We then use two Kalman filters in order to track the pupils robustly in real time. In the visual behaviour stage, we calculate some parameters from the images in order to detect some visual behaviour easily observable in people experiencing fatigue: slow eyelid movement, smaller degree of eye opening, frequent nodding, blink frequency, and face pose. When the driver experiences a shock during a head on collision the widening of his eye gaze is measured i.e. a greater degree of eye widening is seen. The parameters obtained are sorted and correspondingly caution signals for fatigue and shock situations are seen. The shock caution signals are not only used to alert the driver, it is also used to signal the vehicles behind. The fatigue caution signal generated an alarm to wake up the driver and it slows down the vehicle as done in automatic braking systems. Despite all the warning signals if the driver continues to doze off, then the speed of the vehicle is graduated to zero. This is new breakthrough in accident avoidant systems proposed by Intel-Eye. Finally, in the driver vigilance evaluation stage, we fuse all individual parameters obtained in the previous stage using a two-way approach fuzzy system, yielding the driver inattentiveness level. An alarm is activated to signal other vehicles on road if the level of in-alertness exceeds a certain threshold.

The above diagram is a detail explanation of the work, so let us see that how all components work:-

1. First of all facial image captured by the camera that is called image acquisition.
2. After that taking only the image of eye or eyelids that is called pupil detection and tracking.
3. Now it will take decision that driver is in safe condition or unsafe condition and the unsafe condition is identify with the two main reasons.

Shock- If eyelids are in upper position continuously in more than two second that means Driver is shocked and in unsafe condition. Here again we are facing two types of situation-

Yes- If driver is really shocked that means they are in unsafe condition and then the all component perform following job-

i. Alerting alarm will activate.
ii. In addition, alarm start to buzz.
iii. Suppose alarm turn off by the driver that means driver is again alert for driving. In addition, the all component will again perform own job as usually.

But if alarm is not turning off by the Driver that means driver is not alert for driving yet. In that condition the vehicle speed, reduce immediately through auto-break system that is called **“vehicle halted”.**

No- If driver is not shocked that means they are again in two positions-

i. May be he/she in safe condition that’s why, the all component will again perform own job as usually.
ii. May be he/she in unsafe condition reason for Fatigue.

Fatigue- partially or fully closed eye lids for more than 2 second that means driver is Fatigue and vehicle is operated by the drowsiness driver which is very dangerous. Here again we are facing two type of situation-

Yes- If driver is really fatigue that means they are unsafe condition and then the all component perform following job-

i. Alerting alarm will activate.
ii. In addition, alarm start to buzz.
iii. Suppose alarm turn off by the driver that means driver is again alert for driving. In addition, the all components will again perform own job as usually.

But if alarm is not turning off by the Driver that means driver is not alert for driving yet. In that condition vehicle speed, reduce immediately through auto-break system that is called **“vehicle halted”**

V. EXPERIMENTAL RESULTS AND DISCUSSION

With the help of these data sheet which is mentioned in the below table, we can understand that:-

1. After capturing the facial image by camera, the camera will divide the facial image into different frame. It can create 30 frames per sec. same as in normal condition people blink their eyes 0.333333333 times per sec.

2. So naturally the normal people’s blink their eyes 20 times per minute approximate.
   In addition, 1800 frames will create per minute by camera.

3. So according to per minute or per second of blinking we can count the total image frames and then we can take decision that driver is in safe condition or not? And in that conditions, counting occurs in three stages:

   i. Lower.

   ii. Medium.

   iii. Higher.

4. And again this three stages are divided into two main dangerous category:-

Lower, Medium and High condition has two type of main dangerous category:-

i. Below.
ii. Above.

5. Now let us see all condition and their dangerous category one by one:-

First of all we will take the natural condition for example – actually the normal people blink their eyes 20 times per minute, suppose in that situation, blinking of eyes of any people is less than natural condition, then both condition are very dangerous.

First is lower condition where we will find that in this condition the driver is in less danger, it has again two conditions-

Below:- When the people or diver blink their eyes, only 10 times per minute i.e. less than the natural condition and it is considered 50% dangerous to the driver and it is considered the below category of lower level.

Above:- When the people or driver blink their eyes 30 times per minute i.e. greater than the natural condition, and that is why it is considered dangerous to the driver, and it is considered above category of lower level.

Second is Medium condition where we will find that in this condition the driver is in medium danger, it is better than higher level but dangerous than lower level. It has again two conditions.-

Below: - When the people or driver blinks their eyes only 5 times per minute i.e. very less than the natural condition and that is why it is considered 75% dangerous to the driver and it is considered as below category of medium level.

Above:- When the people or driver blinks their eyes 40 times per minute i.e. very greater than the natural condition and that is why it is 75% dangerous to the driver and it is considered above category of medium level.

Last is higher condition in which the driver is in higher danger and it means the life of the driver is not safe and again it has two conditions-

Below: - When the people or diver blinks their eyes zero times ,it indicates serious danger to the driver and 100% confirms that life of the driver is not safe., and that is why it is considered below category of higher level.

Above: - When the people or driver blinks their eyes 60 timer per minute i.e. more than the natural condition then it is considered 300% dangerous to the driver and the chances of accident gets confirmed and that is why it is considered above category of higher level.

Time	Template	Measurement	50%	50%	75%	100%	100%	300%
Sec	Frame	Blinks	Lower		Medium		Higher	
			Below	Above	Below	Above	Below	Above
1	30	0.333333						
60	1800	20	10	30	5	40	0	60
3	90	1	0.5	1.5	0.375	2	0	3
6	180	2	1	3	0.75	4	0	6
9	270	3	1.5	4.5	1.125	6	0	9
12	360	4	2	6	1.5	8		12
15	450	5	2.5	7.5	1.875	10	0	15
18	540	6	3	9	2.25	12	0	18
21	630	7	3.5	10.5	2.625	14	0	21
24	720	8	4	12	3	16	0	24
27	810	9	4.5	13.5	3.375	18	0	27
30	900	10	5	15	3.75	20	0	30
33	990	11	5.5	16.5	4.125	22	0	33
36	1080	12	6	18	4.5	24	0	36
39	1170	13	6.5	19.5	4.875	26	0	39
42	1260	14	7	21	5.25	28	0	42
45	1350	15	7.5	22.5	5.625	30	0	45
48	1440	16	8	24	6	32	0	48
51	1530	17	8.5	25.5	6.375	34	0	51
54	1620	18	9	27	6.75	36	0	54
57	1710	19	9.5	28.5	7.125	38	0	57
60	1800	20	10	30	7.5	40	0	60
63	1890	21	10.5	31.5	7.875	42	0	63
66	1980	22	11	33	8.25	44	0	66
69	2070	23	11.5	34.5	8.625	46	0	69
72	2160	24	12	36	9	48	0	72
75	2250	25	12.5	37.5	9.375	50	0	75
78	2340	26	13	39	9.75	52	0	78
81	2430	27	13.5	40.5	10.13	54	0	81
84	2520	28	14	42	10.5	56	0	84
87	2610	29	14.5	43.5	10.88	58	0	87
90	2700	30	15	45	11.25	60	0	90
93	2790	31	15.5	46.5	11.63	62	0	93
96	2880	32	16	48	12	64	0	96
99	2970	33	16.5	49.5	12.38	66	0	99
102	3060	34	17	51	12.75	68	0	102
105	3150	35	17.5	52.5	13.13	70	0	105
108	3240	36	18	54	13.5	72	0	108
111	3330	37	18.5	55.5	13.88	74	0	111
114	3420	38	19	57	14.25	76	0	114
117	3510	39	19.5	58.5	14.63	78	0	117

Table 1: Implementation on data sheets showing variations on Eye Blinking Measurement using Template Generation technique in MATLAB.

VI. CONCLUSION

This method establishes interface very easily with drivers. Life of the driver can be saved by locking the ignition system of the vehicle. Driver enter the state of stress can be identified by automatic vision based analyzers used in eye motion interfaces. This approach is used to slow down the vehicle when the system senses the driver’s danger zone.

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