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Multiagent Intelligent System For Driver Alertness In Indian Super Highway – A Road Map Survey

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Abstract

In the day today life, fast moving vehicles are inevitable. People tend to move from one to another swiftly irrespective of any changing environment. In these circumstances roads plays a key role and acts as major environmental factors to get rid of the obstacles faced on road for every vehicle. On the other hand driver plays an additional important role and acts as a mjor key player for implementing and testing any system that supports the environment factors. In this article we have measured the factors affecting driver performance like laziness, drowsiness, alertness and skillfulness that justifies the performance measures of the overall system. The functionality is measured with the individual parameter and compares the result with one or more system and gives out the optimized results. The proposed survey gives the better clarity in terms of the system analysis for efficient security intelligent.

Keywords*: Driver laziness, Alertness, skillfulness, Multi Agent System, Intelligent agent, objects classification methods*

1. INTRODUCTION

In depth, the traffic condition of the Indian road system is deeply routed and a driver has to be a professional in forecasting road condition and congestion. Generally the congestion parameter makes the driver alert as they have to be much more focus on the road system for safe driving [9]. Despite road condition, the driver efficacy is considered as one of the key parameter for intelligent system [1] for analysis that occupies the whole space in the aspects of security. There are certain parameters that adds value to the road safety

1.1 TRAFFIC CONDITIONS

An increasing number of countries monitor traffic flow and use this information to inform through matrix signs drivers about (the chance of) congestion. This application is generally restricted to motorways and some of the most important rural roads. The information may consist of a general message, that congestion is ahead or may arise, to advisory reduced speed limits and compulsory reduced speed limits.

1.1.1 A SAFE SPEED LIMIT: ROAD FUNCTION AND DESIGN SPEED

The speed limit needs to reflect the safe speed. Whether a speed is safe depends on the function of the road and, related to this the composition of the traffic flow (e.g. mixture of pedestrians and motorized traffic); the characteristics of the traffic situation (e.g. the density of at-grade intersections).

It also depends on the road design characteristics related to design speed, such as horizontal alignment (e.g. road width, obstacle free zones); vertical alignment (e.g. type of curves, gradients, 'design consistency').Matching speed limits to human injury tolerance in different potential impacts: In general, the concept of a safe speed, has been adopted as a basis for considering appropriate speed limits. The driver/vehicle/road system should operate such that, in the event of an impact, forces are not exerted on vehicle occupants or other road users which are likely to lead to a fatality. Thus, where pedestrians are

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present, vehicle speeds should be no higher than 30km/h. Where vehicle to vehicle impacts occur they should be at speeds below the impact speeds at which cars can be shown to safeguard occupant life. Ratings are being developed through the Road Assessment Program showing how well the road is designed to ensure forces involved in impact with road infrastructure also keep within the same thresholds, and these are being used in Sweden to indicate appropriate speed limits for roads with different ratings.

Road type/traffic situation	**Safe speed (km/h)**
Roads with potential conflicts between cars and unprotected road users	30
Intersections with potential side impacts between cars	50
Roads with potential head-on conflicts between cars	70
Roads where head-on and side impacts with other road users are impossible	≥100

Unfortunately there is not yet sufficient knowledge to define the safe speeds for motorized two-wheelers and heavy good vehicles. Also from a practical point of view this problem is as yet unsolved. The best solution is the separation from other traffic, but it is not clear how to realize that in practice.

2. SPEED LIMITS AND ROAD FUNCTION

Ideally, a road network consists of a limited number of mono functional roads. For example, in the Netherlands, Sustainable Safety distinguishes between three road functions.

2.1 FLOW FUNCTION:

Roads with a flow function allow efficient throughput of (long distance) motorized traffic. All motorways and express roads as well as some urban ring roads have a flow function. The number of access and exit points is limited.

2.2 AREA DISTRIBUTOR FUNCTION:

Roads with an area distributor function allow entering and leaving residential areas, recreational areas, industrial zones, and rural settlements with scattered destinations. Intersections are for traffic exchange (allowing changes in direction etc.); road links facilitate traffic in flowing.

2.3 ACCESS FUNCTION:

Roads with an access function allow actual access to properties alongside a road or street. Both intersections and road links are for traffic exchange. At roads with a flow function and at the links of roads with a distributor function speeds of motorized traffic can be allowed to be high if

Motorized traffic is physically separated from pedestrians, cyclists, mopeds and slow moving agricultural vehicles [14]; and Road design standards are good

At roads with an access function and at intersections of roads with a distributor function speed must be low since here all road users make use of the same space. At these locations road engineering measures may be required to support the low speed requirement.

Speed limits and design speed

In general terms, the design speed of a road can be defined as the highest speed that can be maintained safely and comfortably when traffic is light. More specifically the design speed is used by road engineers to

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determine the various geometric design features of the roadway. The exact definition differs from country to country.

In principle, the required design speed depends on the function of the road and, hence, on the desired speed level. If, because of the road function, high speeds are desired, road quality and roadside protection need to be of an appropriate standard. The alternative to improving road standard is to reduce the speed limit consistent with the standard and risk of the road. The exact values for design standards of different road types differ as well from one country to another.

Clearly, the design speed must never be lower than the speed limit. It is not wise to have a speed limit which is much lower than the design speed of a road. This may damage the credibility of a speed limit.

Furthermore, it is important that the design speed is consistent over a longer stretch of road. A substantial reduction of design speed at a particular site must be supported by more than just a design with the reduced speed limit. Additional warning signs should preferably be accompanied by a change in road design characteristics and/or road markings.

3. CREDIBLE SPEED LIMITS: CHARACTERISTICS OF THE ROAD AND ROAD ENVIRONMENT

A credible speed limit is a limit that is considered to be logical by (the majority of) drivers for that particular road in that particular road environment. It is incredible when, for example,

The speed limit sign for built-up areas is located 'in the middle of nowhere' when actual buildings and town activities are not yet visible

The same speed limit is applied for a wide, straight rural road and a narrow, winding rural road

If different limits are applied for motorway sections with a similar cross section and a similar (rural) environment.(If other reasons than safety are the basis of these different limits, e.g. noise protection, environmental pollution, this must be clearly communicated to the road users.

In general, the principle of credibility implies that any transition from one speed limit to another must be accompanied by a change in the road or road environment characteristics.

Credibility of speed limits can be further enhanced by applying different speed limits for different weather and traffic conditions, i.e. by a system of dynamic speed limits.

4. INTELLIGENT MULTI-AGENT PROPERTIES

In this work, the multi agent [2] properties are defined based on the following parameters. The parameters are well defined and compared with the different system scenarios. In general the intelligent multi agent properties are defined with

(i) Traffic congestion and reliability
(ii) Driver alert system

These two properties defines an alert mechanism for driver and assist them while driving [13] at urban national highway.

TRAFFIC CONGESTION AND RELIABILITY

4.1 WHAT IS CONGESTION?

The roads filled with cars, trucks, buses and sidewalks filled with pedestrians are relatively known as Congestion. The term congestion is also known as "clog," "impede," and "excessive fullness”. The word congestion sounds familiar to the person who has ever sat in congested traffic. Congestion is usually related to an excess of vehicles moving on a portion of a roadway at a particular time resulting in slower speeds than normal or "free flow" speeds in the transportation realm. Usually stopped or stop-and-go traffic is meant as congestion. The following part of the chapter describes congestion, its measurement, causes and also its consequences.

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4.2 CAUSES OF CONGESTION AND UNRELIABLE TRAVEL

4.2.1 Background: The Seven Sources of Congestion

The seven sources of congestion can be classified into three broad categories, as shown below:

GROUP 1 —TRAFFIC INFLUENCING EVENTS

Traffic Incidents – The events that disturb the normal flow of traffic are usually by the physical restriction on the roads. The most common form of incidents on the roads is usually vehicular crashes, breakdowns and debris in the roads. The events that occur on the roadside can also influence the traffic flow by distracting drivers and ultimately degrading the quality of traffic flow. The incidents that occur off the roadway can lead to traffic incidents in the roadways.

Work Zones – The construction activities on the roadway can result in physical changes to the highway environment. The construction activities include a reduction in the number or width of travel lanes, lane "shifts," lane diversions, reduction, or elimination of shoulders, and even temporary roadway closures. Travelers have reported that the delays caused by work zones were the most frustrating conditions that they encountered on trips.

Weather – The traffic flow is affected due to changes in environmental conditions. Due to precipitation, bright sunlight on the horizon, fog, or smoke, the driver's visibility is reduced. After precipitation has ended, Wet, snowy or icy roadway surface conditions will also lead to the same effect.

GROUP 2 — TRAFFIC DEMAND

Fluctuations in Normal Traffic – The rate of vehicles traveling on the roadways will differ day-to-day. Thus the traffic rate is unreliable and at no time any intruder vehicles can pass by without any notifications [15].

Special Events – Due to the demand fluctuations the traffic rate will be radically different from typical patterns. On special occasions, the traffic demand causes “surges”.

GROUP 3 — PHYSICAL HIGHWAY FEATURES

Traffic Control Devices –The control devices such as railroad grade crossings and poorly timed signals also contribute to congestion and travel time variability.

Physical Bottlenecks ("Capacity") – Transportation engineers have long studied and addressed the physical capacity of roadways. The highway section is capable of handling the maximum amount of traffic. The factors that determine the capacity are: the number and width of lanes and shoulders; merge areas at interchanges; and roadway alignment (grades and curves). Toll booths are also be considered as a special case of bottlenecks as they restrict the physical flow of traffic. Driver behavior also plays a vital role in determining capacity. Research has shown that drivers familiar with routinely congested roadways space themselves closer together than drivers on less congested roadways. So there is an increase in the amount of traffic that can be handled.

The seven sources of congestion that are related to the underlying traffic flow characteristics that disrupt the traffic will be discussed in Highlight Box 1. We typically think of a bottleneck as a physical restriction on capacity (Category 3 above). However, disorderly moving vehicles can cause similar effects on traffic flow as restricted physical capacity.

As all the traffic flow effects are similar, traffic disruptions produce losses in highway capacity, at least temporarily. Conventionally, the main focus of congestion responses was aligned to adding more physical capacity: changing highway alignment, adding more lanes (including turning lanes at signals), and improving merging and weaving areas at interchanges. But addressing the "temporary losses in capacity" from other sources is equally important.

Highlight Box 1 –What is the reason for traffic flow breakdown?

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What are the reasons for break down to stop-and-go conditions? As per the definition made by layman, highways are used by too many cars at the same time is essentially correct. This idea is formalized as capacity by transportation engineers—over a given period, the ability of vehicles to move past a point. Traffic flow breaks down, speeds drop and vehicle crowd occurs if the capacity of a highway section is exceeded. These are the reasons for traffic to back up behind the disruption. So, what are the situations that lead to traffic backups?

The three types of traffic flow behavior that causes traffic flow to break down are:

As a result of reduced speed, clumping of vehicles will occur. A sudden change in speed when the vehicles are forced to get closer and closer together causes shock waves to form in the traffic stream, rippling backward and causing even more vehicles to slow down. The factors that cause the vehicles to reduce the speed while traveling in their intended lanes are:

Visual Effects on Drivers- Driver behavior plays a vital role in traffic flow. When the vehicles are moving at high speeds and the volume of the traffic is very high, sudden slowing down of vehicle should be done to disrupt traffic flow. In this case, driver speed is influenced by some kind of a visual sign that includes:

Distractions on roadsides – Drivers are distracted by abnormal or natural events.

Limited lateral clearance –When barriers get too close to travel lanes or if a vehicle has broken down on the shoulder the drivers will slow down the vehicle.

Traffic incident "rubbernecking" – It is called a morbid curiosity. When the accident occurred in the opposite direction of the travel lane or there are many clearances with the travel lane, most of the drivers will decelerate to glace the crash scene.

Inclement weather – Drivers usually slow down the vehicle due to poor visibility and slippery road surfaces.

Abrupt Changes in Highway Alignment- Drivers slow down the vehicles in the sharp curves and hills either because of safety concerns or because their vehicles cannot maintain speed on high ranges. During construction, the lanes may be redirected or shifted which is an example of this type of bottleneck.

Intended Interruption to Traffic Flow- To manage flow bottlenecks is necessary. Few examples of this type of bottleneck are traffic signals, freeway ramp meters, and tollbooths.

Vehicle Merging Maneuvers- This the most damage causing form of traffic disruption that has the most severe effect on traffic flow; expect the bad weather (snow, ice, dense fog). Physical restriction or blockage of the road is likely to create some sort of disruption which causes vehicles to merge into other lanes of traffic. Traffic flow is influenced by this kind of disruption related to the number of vehicles to be merged in a given space over a given time. These disruptions are:

One or more traffic lanes lost areas – this is the event that occurs at bridge crossings and in work zones which are called lane drop.

Lane-blocking traffic incidents-This event occurs where traffic merges across several lanes to access entry and exit points. It is called weaving points.

Freeway on-ramps – It is an area where traffic from local streets merges with a freeway.

Freeway-to-freeway interchanges – it is a special case where one freeway flow is conducted to another. Due to the involvement of high traffic volumes, this type of event is considered as the most severe form of bottlenecks.

The level of traffic that attempts to use the roadway is based on all of these disruptions in traffic flow.

Due to special events, the usage of highways is in high level which creates the problem in traffic flow

4.2.2 CAUSES FOR CONGESTION BY THE SEVEN SOURCES

In the highways system, congestion is caused by one or more interactions of the seven sources. These interactions vary extremely from day-to-day and highway-to-highway which is very complex. The sources of congestion occur with infuriating irregularity nothing will be the same from one day to the next! This is the problem except the physical bottlenecks. The level of traffic may vary from day-to-day. One day the level of

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traffic might be lower and the weather might be good; the next day traffic might be heavier than normal, a severe crash may occur that blocks traffic lanes and it might be raining. The combination of these events which leads to congestion is analyzed in Washington, D.C. The occurrence and combination of different events explains the worst traffic days experienced in Washington.

Frequency and duration of traffic incidents explains the irregularity in event occurrence which is another example of traffic flow fluctuation. The traffic incidents that occurred on a 14-mile stretch of Interstate 405 in Seattle, India during peak hours for the first four months of 2003 are shown in figure 2.1. Some days have countless traffic incidents and others have extremely incident-free. During peak hours, at least one traffic incident will occur every day on the highways. On crowded urban freeways, traffic incidents are an unpreventable fact.

Traffic demand is another source of variability, which is hardly the same from day-to-day. During the weekdays, the traffic is more when compared to weekends. Especially on routes used for commuting on routes in recreational, tourist, or shopping-dominated areas, weekend traffic higher.

Based on the observation of Group1 to Group3 the following criteria's are evaluated and described as follows

(i) Traffic Intensity Monitoring
(ii) Multiple Object Detection

The evaluation of the above measures declares drivers alertness and the remaining part of this works details the process based on overall observation.

The driver alertness is mostly concerns on Traffic intensity monitoring. It's implemented with micro and macro traffic space and intensity. Driver alertness is mostly focused when the vehicle is navigated in macro urban traffic where vehicle operation is limited apart from vehicle steering control.

While addressing the road surveillance for providing driver alertness in macro urban surveillance that does various classification techniques to provide various road conditions. Such classification provide best accuracy rate for predicting road condition for provide driver alert system. The accuracy is compared with various other system for providing traffic condition and intensity.

(a) Traffic Intensity Monitoring

Fig 1: Indian traffic road condition

The above figure represents Indian road traffic condition where driver will be 100% percent aware and cautious as per the traffic demands. The role of multi agent [7] in this scenario acts a medium for providing traffic role condition as it continues to give alert message often irrespective of the condition. Traffic condition

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never reduces its efficiency of multi agent [10] as its role is to enhance safe and smooth driving by its alert message.

(b) Multiple Object Detection

The multiple objects here define the vehicles and the objects found on the highway. In order to identify the vehicles blob analysis is implemented. This analysis identifies moving objects along with the background subtraction for a fast moving vehicles and obstacles. The concept of blob analysis is implemented in the driver vehicle using the front camera that are defined for identifying moving objects including vehicles and obstacles. Each and every frame taken from the camera are subjected to blob analysis for background subtraction and uses HaaR Cascade method to classify the frames for identifying objects and vehicles in national highways.

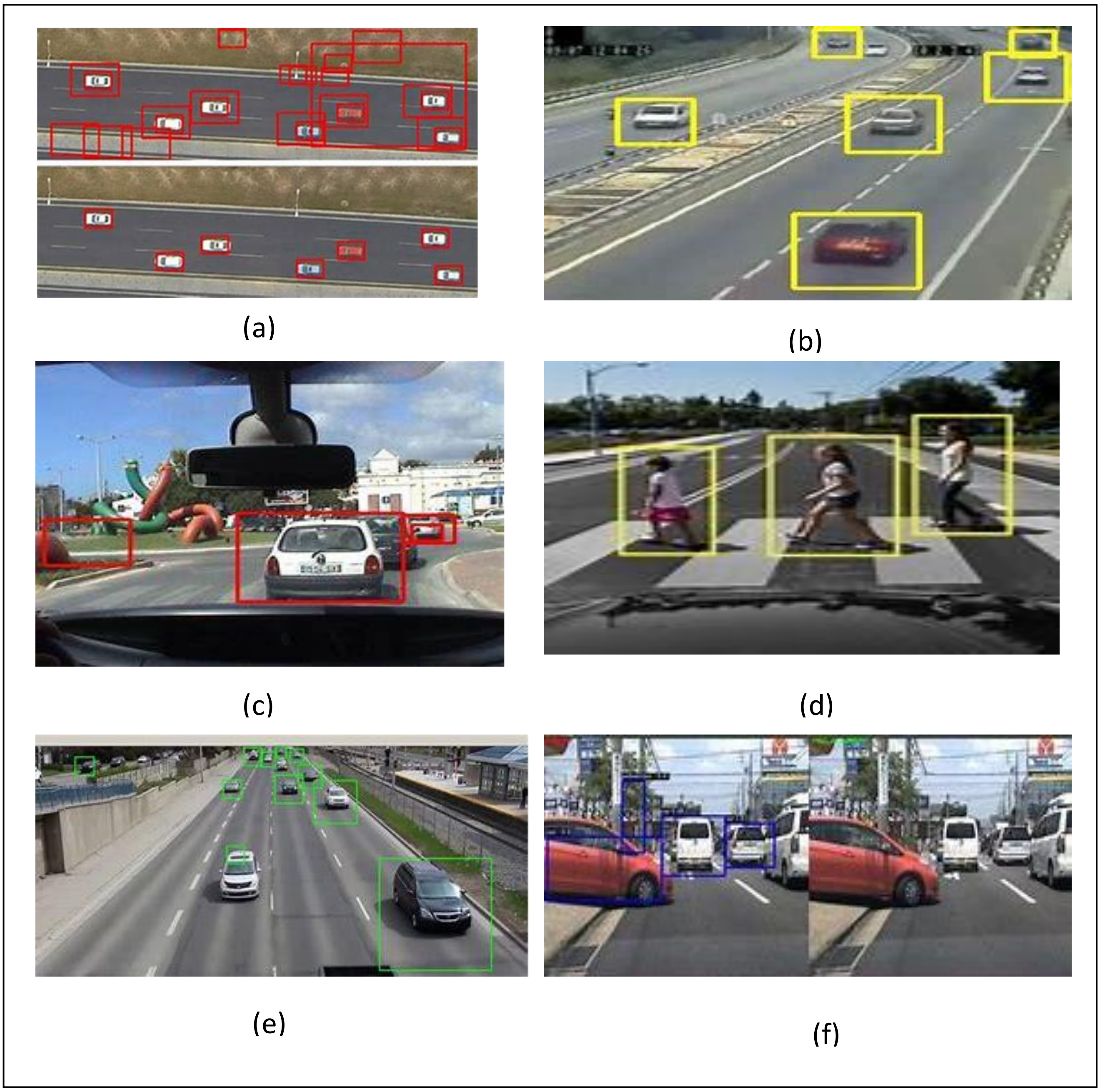

Fig 2: Haar Classification for Object detection

Fig 2 displays the object detection and classification in highways. The object may be vehicle, person, or any moving or immovable objects. Fig 3 shows the result based on HoG feature that acts in parallel with Haar

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classification. The main trade off between Haar and HoG is to detect nearby objects irrespective of its identity. This classification is done based on the object detection range and its shown in the Fig 4

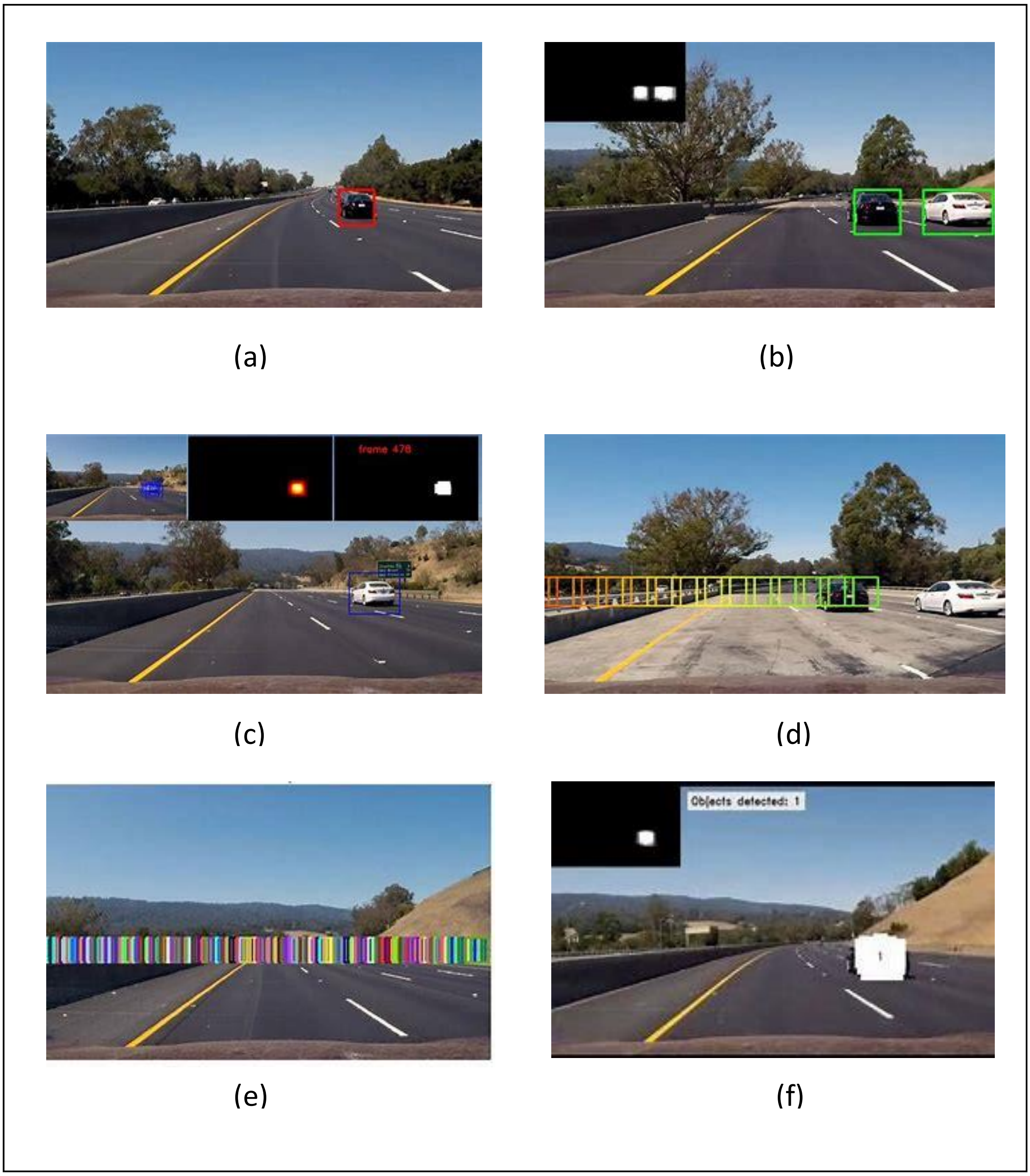

Fig 3: HoG Classification for Object detection

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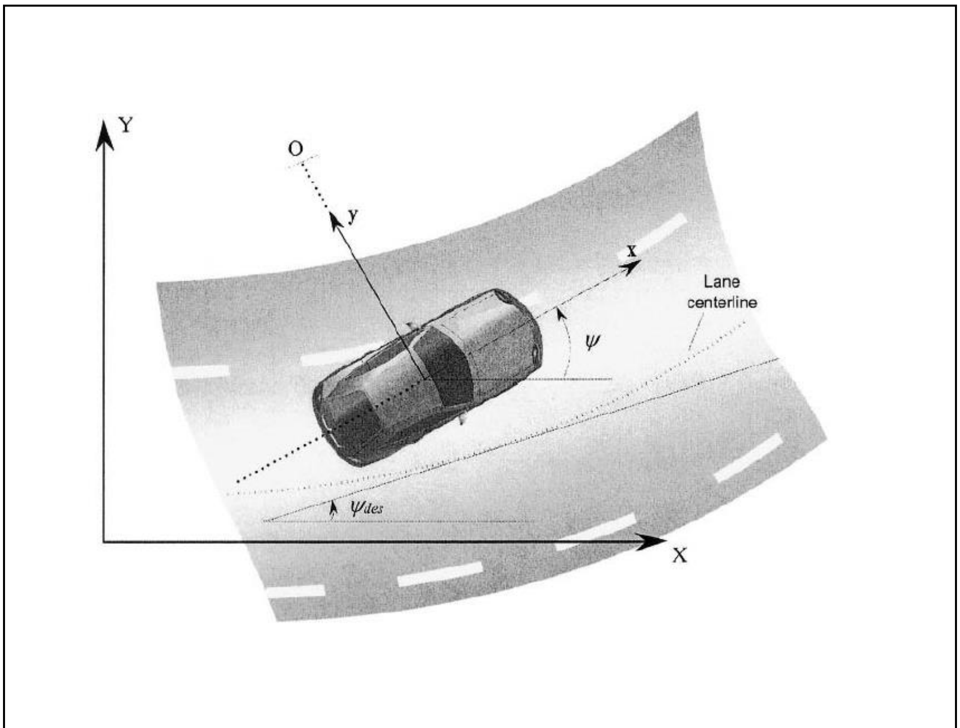

Fig 4: Fusion vehicle dynamics

Fig 4 focuses on the vehicle dynamics that uses sensor analysis for tracking vehicle movement and its positioning using trajectory [11]. All these classification methods creates an alert mechanism to induce driver when they go out of control.

Rather than evaluating and implementing different classification methods, the efficiency lies in its accuracy. The table below shows the comparison of all the three classification methods.

TABLE 1: OBJECT CLASSIFICATION FOR DRIVER ALERT SYSTEM

Type	No Of Obj	DR	FA	Time (sec)
HaaR	100	99.8	0.0310	1.32
HaaR	150	99.8	0.0150	3.41
HaaR	200	99.0	0.0050	4.52
HoG	100	99.9	0.0480	0.94
HoG	150	100	0.0250	3.41
HoG	200	99.9	0.0050	4.52
Fusion	100	99.7	0.0125	1.75
Fusion	150	99.4	0.0090	3.40
Fusion	200	99.2	0.0060	4.90

Table 1 differentiates 3 classification techniques for providing driver alert system based on time frequency.

Each classification methods gives optimized results based on its purpose and measures. HaaR classification method identifies all objects especially focused on fast moving vehicles, where HoG identifies all objects taking account of both movable and immovable objects and finally fusion classifies objects based on its position and close position of the associated objects. Table 2 combines the classification with the driver alert system in order to assemble smart [3] multi agent system as the system takes care of smart driving in highway with high alert mechanisms.

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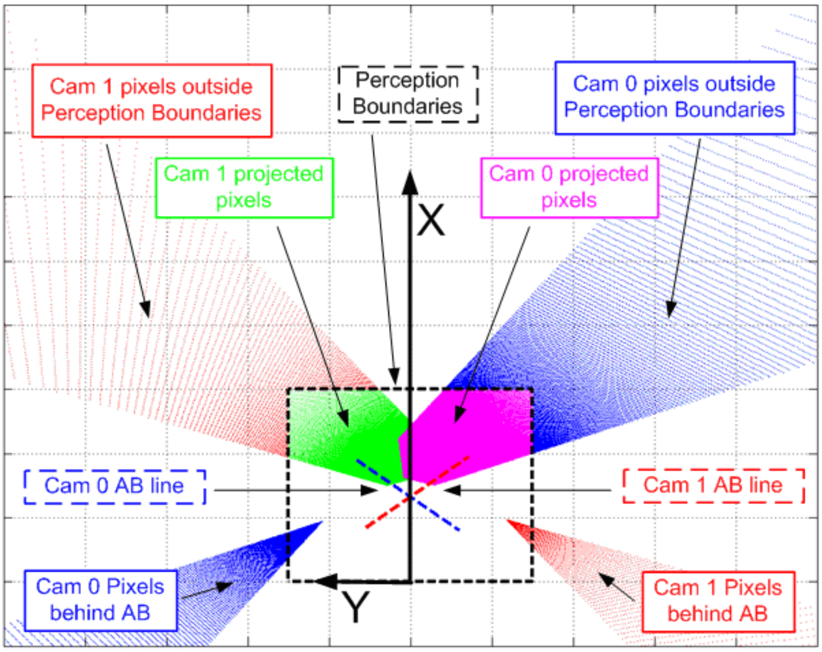

Fig 5: Driver alert Sensor to identify nearby vehicles

Fig 5 uses vehicle sensor to identify nearby vehicles and provide alert mechanism to the driver in case of any close association with the vehicle due to driver lack of attentions. The information is passed to the alert mechanism kept on the vehicles and alert the driver in case of any close encounters faced. Few countermeasures are set for the alert system like

(a) Improper vehicle movement [4]
(b) Ideal Steering movement
(c) Vehicle problem

The above problem are quite common for any mislead that happen in the highway as the vehicles are moving swiftly in super highway where drivers are highly focused on speed [12] rather than safety [5]. The system is set for alert for every second and passes message to the multi agent for ensuring safety in every minute of the drive. The system also set to have close attention when the vehicles are moving in over speed and its done by speed monitoring governanance that also plays a vital role in smart multi agent [6].

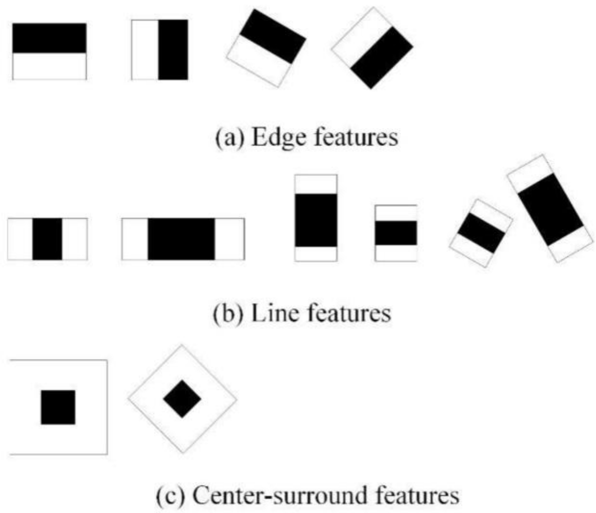

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Fig 6: Vehicle position gestures

Fig 6 gives the vehicle positioning system for identifying nearby vehicles and its associated with the multi agent for providing based results with the various classification methods shown in Table 1.

Fig 7 shows the multi agent results based on speed with various classification methods for proving driver alert mechanism when there is close encounter with any object in the national super highway.

TABLE 2: DRIVER ALERT SYSTEM WITH CLASSIFICATION METHOD

Driver alert system	Classification Type	No Of Obj	DR	FA	Time (sec)
Improper vehicle movement	HaaR	100	99.8	0.0310	1.32
	HaaR	150	99.8	0.0150	3.41
	HaaR	200	99.0	0.0050	4.52
	HoG	100	99.9	0.0480	0.94
	HoG	150	100	0.0250	3.41
	HoG	200	99.9	0.0050	4.52
	Fusion	100	99.7	0.0125	1.75
	Fusion	150	99.4	0.0090	3.40
	Fusion	200	99.2	0.0060	4.90
Ideal Steering movement	HaaR	100	99.7	0.0210	1.27
	HaaR	150	99.8	0.0150	2.14
	HaaR	200	99.0	0.0050	2.38
	HoG	100	99.9	0.0580	1.14
	HoG	150	100	0.0750	2.61
	HoG	200	99.9	0.0950	3.43
	Fusion	100	99.7	0.0325	1.75
	Fusion	150	99.4	0.0290	3.40
	Fusion	200	99.2	0.0160	4.90
Vehicle problem	HaaR	100	99.8	0.0310	1.32
	HaaR	150	99.8	0.0150	3.41
	HaaR	200	99.0	0.0050	4.52
	HoG	100	99.9	0.0480	0.94
	HoG	150	100	0.0250	3.41
	HoG	200	99.9	0.0050	4.52
	Fusion	100	99.7	0.0125	0.75
	Fusion	150	99.4	0.0075	1.50
	Fusion	200	99.2	0.0055	2.97

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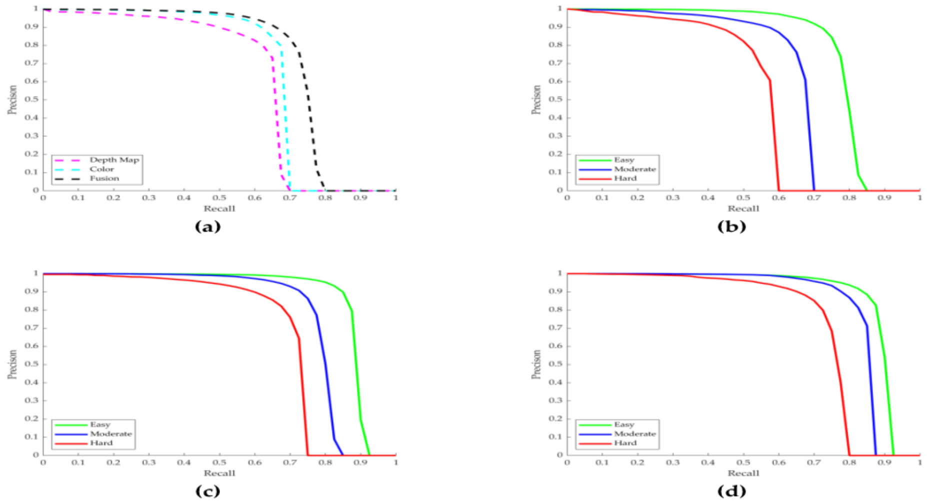

Fig 7: Multi agent alert mechanism

Based on the comparison of different classification methods HaaR classification gives best result for improper vehicle movement, HoG gives best result for Ideal steering control and Fusion gives best optimized solution for vehicle problem based on the vehicle positioning at highway.

CONCLUSION

This survey attempts to compare different classification methods with driver alert system in order to enhance vibrant multi agent for providing driver alert mechanism. The results are compared with the online highway traffic data available online to provide the best results. The extension of this work will address every driver affecting factors independently to provide the best optimized solutions.

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