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Advance Driver Assistance System for Indian Traffic Scenario: Literature Review

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Abstract: Intelligent Transportation System (ITS) is the propitious solution for sustainable and stable transportation in India. There are many genre issues in the execution of Intelligent Transportation System (ITS) for Indian chaotic traffic scenario, e.g. heavy transportation, tracking the drivable road and tracing cars, poor lane marking, road conditions etc. The Advanced Driver Assistance System (ADAS) is one of the promising applications which can be used to decrease the collisions and vehicle congestion. In the present scenario, ADAS system in India is only used in a fully loaded vehicle which is expensive and requires high maintenance. Using simple algorithms and high-quality low-cost cameras and sensors the ADAS can be implemented. The proposed paper provides a brief summary of available ADAS techniques including developed systems and research prototype.

Keywords: ACC, PCS, LKA, Region of Interest (RoI), Edge Detection, HV, HG

I. INTRODUCTION

The traffic congestion in India is very high these days. National Crime Records Bureau (NCRB) reports that every year more than 1, 35,000 traffic collision-related demises occur in India. India is a country with immense traffic and insufficient road space, the Advanced Driver Assistance System (ADAS) proves to be an aid for drivers. The reckless driving is one of the prime reasons for most of the road accidents. ADAS system will make the driving easy and safe for the drivers and thus, it might also be helpful in regulating numbers accidents. It is useful for amateur drivers who mostly commit traffic mistakes like turning the vehicle at high speed or crashing into the vehicle at a turn on the road etc. In India, ADAS technology is not developed completely, but there are some features of the ADAS that are available in some of the cars. In Chevrolet's Beat, there are alerts set for heat warning, seat belt, door-ajar warning, etc. These driver assistive features help the drivers. Hyundai's i20 featured with reverse parking assist which allows the driver to park the car without hitting into things. Another driver assistive feature is automatic gear transmission which automatically shifts the gear in case of a change in speed. [1]

ADAS are used for Intersection control, Incidence detection, vehicle classification, Monitoring etc. It also aids computers for Congestion maps and in calculation of estimate time, information of Public transport, Individual vehicle management and Accident handling [2]. According to statistic 93% of accidents are happened because of human error i.e. inexperience, distraction, driver fatigue and misjudgment [3].

II. LITERATURE REVIEW

The Advanced Driver Assistance System (ADAS) can be classified in 3 parts as follows:

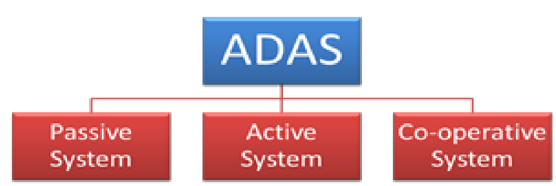

Fig.1. Classification of system

The aim of the Passive system is to minimize the damage after accident i.e. keeps airbags, seatbelts in working condition, while Active system aims towards collisions or accident preventions. In a Co-operative system, vehicle-to-vehicle communication takes place via custom messages and exchange information. The alert about the traffic ahead send to the driver to avoid an accident or busy routes using these messages and information. So that, the driver can takes alternate routes [3].

Comprehensive situational awareness plays salient role in the ADAS using which automobiles interact with each other [4]. The Contextual ADAS which is advanced multimodal driver assistance system used to boost up the present capabilities of ADAS. The functions like PCS (Pre-Crash System), LKA (Lane Keep Assist), and ACC (Adaptive Cruise Control) can be used for urban roads as well as on non-marked roads. Improvements in low level object detection and decision making and understanding in the high level scene is done to employ the contextual relation between the host car, other vehicles and the road.

The main challenges in India are the conditions of the roads and traffic management. Due to chaotic traffic the target recognition and edges detection become difficult and the changing appearance of the size and color of the car, road material, weather conditions also degrades the performance. Some ADAS uses the GPS for tracking and communication purpose. But GPS map data may be inaccurate or outdated that causes limitations on temporal and spatial resolution. Using high quality cameras and Graphic Processor Unit (GPU) the cost map can be generated to calculate the geological properties of the roads [4].

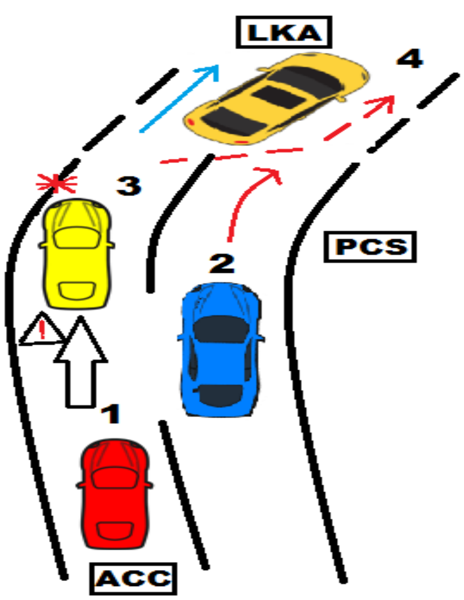

Fig.2 Illustration of the ADAS systems

In Figure 2 illustration of a system is shown, where blue line shows the drivable lane while a red line shows the error. As shown in figure Car 1 is approaching towards Car 3. If Car 3 slow down or Car 1 suddenly increases the speed the collision may occur. The Adaptive Cruise Control (ACC) is used to avoid collisions by automatically adjust the speed of host vehicle and maintain the safe distance. When the vehicles will be at safe distance from each other, the system will re-accelerate vehicle back to the normal speed. If Car 3 accelerates the speed it may bump into the road boundary. Pre-Crash System (PCS) will alert Car 3 when it goes near the edges of road. If driver unnoticed the alerts then system will apply emergency breaks. Lane Keep Assistance (LKA) is use to keep track of the drivable lane and alert the driver if car crosses lane boundary. In figure Car 4 is getting into wrong lane, the LKA system will alert the driver by sending alert signals like small vibrations in steering wheel. With the help of this information the system can distinguish between the moving cars and the roadside (parked) cars. The Driver's behavior is an important factor in road safety. The driver's eye tracking is done using a camera and the gaze counting. It will only work when if driver needs any help [5].

Fig. 3 Eye's tracking [5]

As shown in figure 3, two cameras are mounted on the dashboard of car which consists of infrared emitters to illuminate user's face. The camera keeps extracting information such as frequency of eye blinking, pupil size and opening of eyelid, position and orientation of eye and head etc. Using this information the system will help the driver [5].

The detection of cars and edges of road is comparatively difficult in night. Many illuminations like lights of vehicle, street lights, and road reflector plates (as shown in fig. 4) may cause interference in the detection and tracking of the road boundaries and edges. It is also difficult to differentiate between the moving and non-vehicle illuminations in dark. The vision-based intelligent driver assistance system is effectively sense and processes tracking and detection of vehicle and road at night [6].

Fig.4. Night time road scene [6]

The captured images used to locate the position of front and side vehicles. The bright object segmentation is done in which the images are converted into grey scale to minimize illuminations of lights and extract maximum information. The brightness of street lights is eliminated by detection region. The detection region only covers the road and other vehicles. Using this information the preceding and approaching vehicles are detected. Spatial analysis is done to separate bright object pixel and other different illuminations pixels [6].

III. METHODOLOGY

Since the traffic scenario is totally different in India as compare to other countries, the methodology varies according to it. Figure 5 shows the difference in traffic scene.

Fig. 5(A) [2] Fig. 5(B) [2]

Fig. 5(A) shows the other country's traffic scene where Fig. 5(B) shows Indian chaotic traffic. Hence the by using ADAS the intensity of collision or traffic jam could be minimize.

The high-quality cameras come at very low prices, can mount both forth and backward facing camera in the vehicle, which will enable 360^o view [7]. Using Stereo-vision based method detection of nearby cars, drivable roads and the relationship between them can be calculated in order to run ACC, PCS and LKN for non-marking roads. (See Fig. 6)

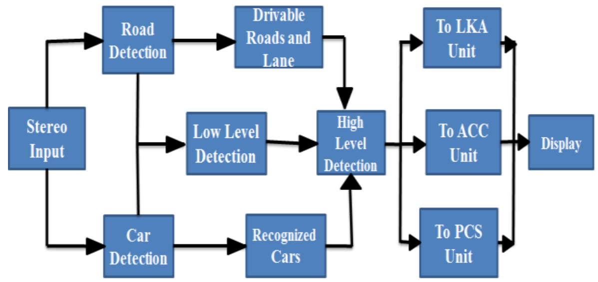

Fig.6. Block Diagram of ADAS system

Using Semi-global Matching stereo (SGM) the disparity map is generated and Graphical Processing Unit generate cost map. The disparity map is a difference in the left and right images between corresponding pixels of all the images where cost map accounts with the geographical properties of the road from stereo input data. Hidden Markov Model (HMM) based scheme by using the Viterbi algorithm is used to found the boundary of a real physical road. This data is used as road contextual information with boost the performance of vehicle detection. Deformable Part-based Model (DPF) based Felzenszwalbfs state-of-the-art object detector is used to detect car candidates in a region of interest [4]. The Region of Interest (RoI) is a pre-define region where a focus is only on road and nearby vehicle. All these information is used in low-level detection to detect cars and road separately. In high-level detection, the collaboration of both data is done and the normal driving lane and emergency driving lane also calculated. Using low level and high-level detection results system generate appropriate input for PCS, LKA, and ACC.

A. Car Detection

In car detection, the input images need to process at real-time or close-to-real-time. To avoid time consumption the Region of Interest (RoI) is defined which will eliminate the unwanted part of a road. When the nearby cars will enter the RoI the system will detect the vehicle using edge detection and will calculate the distance between host car and other cars. But some properties such as symmetry, a color of cars, shadow etc. can degrade the performance. To avoid this problem the input images will convert into greyscale images which will reduce the impact of different colors and shadow by adjusting the threshold value. As the strong relationship exists between road and cars, the context information like object interruption in background, reposition of the cars, structure of road etc. plays an important role in detection. The false detection due to an environmental factor (variation in illuminations, noises, roadside lamps, vehicle lights) can be minimized by using a combination of this spatial contextual information provided by the detector for both high-level and low-level detection [4].

B. ROAD DETECTION

While driving, the unwanted details come in the field of the view may distract driver's attention. The RoI is generated to avoid the unwanted part of road to help the driver to locate the drivable path and guide along the route [5]. The camera can be mounted on windshield of car. At first, the images captured by camera will be converted into greyscale as shown in figure 7. Using these images the edges and the boundaries of road will calculate. If lanes are not properly marked, using road boundary calculation the system will help to locate a drivable route. The disparity map is obtained by the real-time geographical properties of cost map process by GPU. The boundaries of non-road and drivable road can be found by performing Viterbi algorithm in HMM [4].

C. DRIVER'S BEHAVIOR

Using infrared emitters the movement of eye and head will be detected. If the system finds the variation in numbers of blinks or gaze, it will send alert messages on the display. If driver fall asleep the head movement will change and system will send messages with alarm to alert the driver [5].

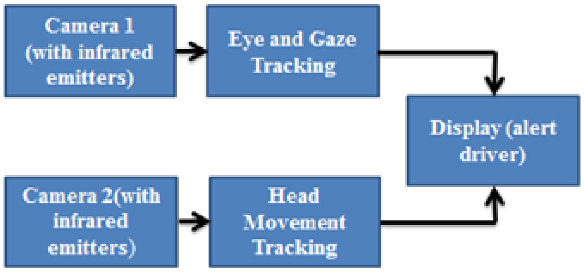

Fig.8. Flow diagram of eye tracking system

In Many On-vehicle tracking and detection techniques the monocular camera and millimeter wave radar is used. If these two radar and camera used separately it may give inaccurate results. The efficient way to solve the problem is the fusion of these two sensors [8]. The MMW radar mounted in the front of vehicle behind the grills and Monocular camera mounted on the windshield of the vehicle. MMW radar will detect and track the vehicle and monocular camera will captures the images and will generate RoI and detection will take place. The methods such as Hypothesis Generation (HG) and Hypothesis Verification (HV) are commonly used for present time or close to present time detection [7]. The HG is where the positions of prospective mobile objects in an image are concluded, and HV is where trials are executed to identify the existence of a moving object in a picture.

Real-time on-road vehicle detection is challenging. There are challenges like Vehicle classification, Feature selection, Sensor fusion, Failure detection, Hardware implementation. The autonomous or self-driving vehicles are effectively used for real-time road and vehicle applications. Autonomous Driving technique reduces congestion, improves safety and also has greater mobility and lower emission. The model vehicle consists of one front and on rare wheel. The vehicle will follow define path and moves on the plane in which the co-ordinates are define by the vector (x,y,h) where x, y is the position of the center of gravity and h is the orientation of the vehicle [9]. The vehicles state transaction depends on the input actions such as steering angle acceleration etc. As it is computationally intensive task there is one limitation i.e. it requires high memory utilization.

IV. CHALLENGES AHEAD

ADAS technology is not fully implemented in India. Most of system failed because the environmental differences throughout the country. The unwanted factors like rain, storm, heat, road condition, improper traffic managements can degrades the performance of the system. Despite of so many algorithms, protocols and researches, the reliable and accurate detection techniques are yet to be built. The roads of rural side are small and congested, the mid-range or distance region detection become difficult as full view of road is unavailable.

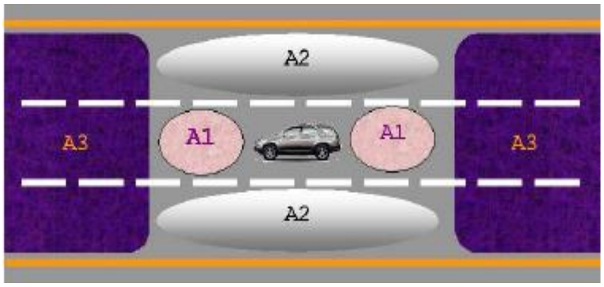

Fig.9. Detection of vehicle in different region [7]

The vehicles could be on any position as shown in fig.8 where A1 is Close-by regions, A2 is overtaking region and A3 is mid-range/distance region [7]. In close- region due no free space makes edge detection based algorithm inappropriate. The stable ADAS system is not successfully passed all the requirements.

V. CONCLUSION

The brief survey on Advanced Driver Assistance System (ADAS) is done. The study represents the different types of algorithms, prototypes and models using different methods. According the critical survey for the Indian Roads and traffic, the main focus should be on Pre-Crash System (PCS), Lane Keep Assist (LKA) and Adaptive Cruise Control (ACC). In coming days the ADAS system will be the fast growing technology.

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