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Lane Detection and Lane Change Warning as Advanced Driver Assistance Systems using Computer Vision

CH.Veerendra , K.B.R Prasad Reddy

ABSTRACT---Road ways are the life line of any economy, for a country like India where economy isgrowing rapidly it is putting its toll on every sector for meeting the needs of the growing economy. Good's and personal transport are becoming vital with time and money aspects and the roads and vehicles on the roads are expected to perform optimally drastically increasing the speed on the road network and constantly increasing and modifying the infrastructure needed to meet the demands. As the speed of the vehicle increases the accident rate and the damage caused by the collision will also increase. Safety of the road network is not to be compromised and proper systems to ensure the safe passage of the vehicle and proper warning systems are to be implemented. This system should be viable in all the condition and should be cost-effective. In this paper we are implementing a vision based system to identify the lane and other vehicles from the video it captures from a properly calibrated camera mounted on the front side of the vehicle. The system is designed to automatically and continuously detect the lines exploiting the new processing techniques and warning the driver if any other is in the breaking distance of the vehicle or if the vehicle is moving out of the lane. Cost effectiveness of the system is a major aspect as many of the available systems use equipment which very good at performing their task but are not affordable. Effort is put in making the system cost effective and not compromising with the reaction time and accuracy..

Keywords: Area Detection, tracking, vision based tracking, Hough transforms, Driver Assistance, Video Image Processing.

I. INTRODUCTION

For any growing economy having, utilizing and upgrading the road network is very important, as it is the only cost effective way to transfer goods and personal from one point to another. Any other transportation system cannot connect to every nook and cranny. Any other major form of transport needs to be connected to the road network for its optimal performance and further transporting the goods. Though road network is well connected and is necessary its accident rate is very high and always tops in the mortality rate. Driving is also a multitasking job where the driver should be vigilant at all the time performing different tasks with all his limbs and keeping an eye on the road on all four directions. Even if the driver is vigilant there is always a chance of an impending accident to occur if he blinks for a few moments.

This paper puts forward a system based on visually analyzing individual frames captured by the camera placed on the front of the vehicle and identifying the lane marker on the road over the breaking distance and intercepting any changes in the road colour detecting it as a different vehicle and warning the driver of a probable collision. Different methods and processes to design the system was done after reviewing a lot of work done before and modified based on the findings of the papers published. Identifying lane markers is easy as they are laid on the road and are always white in colour. They are always visible even in low visibility conditions subjected to the running headlights. They are always parallel to each other even on a curved section with a fixed distance between them. This distance between the lane markers is always fixed for a given road network but will be increase on a curved section. The system exploits the latest developments in the colour identification and masking the unwanted area in the frame reducing the view area for the system and reducing the processing time and increasing the response. The system will be programmed to identify the differentiatingcolour of the lane marker and breaking distance of the vehicle for the given top speed based on codal provisions for the conditions provided. Area coming under the breaking distance within the lanes will be identified. The system is programmed to identify only the breaking distance area and masking the remaining frame. This will reduce the stress on the program and reducing the processing time. As the road is of uniform colour any changes in the colour can easily identified by the program and will be tracked as obstacles and if they come into the viewing area of the camera i.e. within the breaking distance a warning signal will be sent to the driver to take action or to slowdown his vehicle.

II. LITERATURE REVIEW

Yue Wang, EamKhwangTeoh&DinggangShenproposed a B-snake lane based model to identify the lane markings in a wider range even at the curves of irregular shapes. A robust CHEVP algorithm to process the system was detailed and used to successfully identify the lane edges reducing the noise, shadows and distortions in the images captured.

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* Correspondence Author
Dr.CH.Veerendra, Civil Engineering, Marri Laxman Reddy Institute of Technology and Management, Hyderabad, Telangana, India. (Email: chalasaniveerendra@gmail.com)
K.B.R Prasad Reddy, Civil Engineering, MallaReddy Institute of Technology, Hyderabad, Telangana, India (Email: kbrprasadreddy@gmail.com)

Kim &ZuWhan presented a comparative study on the lane marking-classification performance and the computing cost and introduced a robust real-time lane-detection algorithm based on RANSAC combined with a particle-filtering-based tracking algorithm by a probabilistic grouping framework.

They suggested grouping framework for other object detection and tracking problems.

Joel C. McCall and Mohan M. Trivedipresented a frameworkfor comparative discussion and evaluation of existinglane-tracking systems. They introduced VioLET lane-tracking system, for multiple environments. Their system introduces steerable filters to the lane detection-and-tracking problem by allowing greater robustnessto different visibility conditions, without compromising response time. They evaluated different road conditions like visibility, marking condition at different visibility conditions of the day under varying situations to test their approach.

SergiuNedevschi, Rolf. Schmidt, Thorsten Graf, RaduDanescu,DanFrentiu, TiberiuMarita, Florin Oniga, CiprianPocolsuggested a method merges and modifies several detection and filtering techniques to get an accurate and more practical lane model matching. The image is represented asa 3D surface, and the assumptions are eliminated due to the availability ofthe 3D information.

Abel Mendes, Luis Conde Bento and UrbanoNunes used a DATMO system to track target and estimate the collision time for the vehicle. They used the center of trajectory from anKalman filter to predict the trajectory of the vehicle.

Chris Kreucher, Sridhar Lakshmanan, and Karl Kluge suggested using a new model for determining the lane shape at any point and used LOIS model to identify the lane in a frame. He suggested that his LOIS-based lane detection system provides a reliable algorithm for lane departure warning system. He suggested and used Kalman filter to predict the trajectory and reduce computational time.

Karl Kluge and Sridhar Lakshmanan suggested a better and reliable model for lane detection depending the visibility conditions and lane marking. He used a new model to implement the gradient of the road and estimate the lane trajectory over a simplified gradient.

MargritBetke, EsinHaritaoglu, Larry S. Davis Introduced a system to identify the object in a frame and compute a combination of vision based parameterto analyze the it. Vehicles in the frame were detected andtracked using a recursive least squares filter. The frame was issegmented into regions of interestfrom which vehicle templates are created and evaluated for symmetry in real time. From the trackingand motion history of these frames, the detected featuresand the correlation and symmetry results, the systeminfers whether a vehicle is detected and tracked.

Nicholas Apostoloff and Alexander Zelinskyused a distillation algorithm to tarck a vehicle with respect to a point on the captured frame. They suggested using a different model for further improving the tracking model by taking a reference point from the road and reduce the time for computing and better accuracy in tracking the trajectory of the object.

III. STRATEGY& RESULTS

Several strategies or methods are available to track a moving target in our case a vehicle, some of the well known strategies are

a. **Model Based Tracking**:This system uses a model of the vehicle intended to be tracked by processing unit. The unit will be fed with data and will be trained to identify similar patterns for tracking. One major problem with this model is the dependence on the geometry of the model data provided. This model was deemed to be unrealistic as the vehicle geometry is not set and may vary. It is assumed to be unrealistic for not having all the data for real time processing. But because of leap in the computational ability and development in AI technologies we can use this system to better implement for any process.

b. **Region Based Tracking:** This model considers a set of frames from a video or a set image as the background and will track any changes in the new frames compared to the set ones and the changes will be identified as moving objects. We use background subtraction techniques for this model. The frames with modified or changed pixels will be identified by a properly set filter and represented as change in the overall frame. This model needs small variations as it depends on the initial frames or images any changes in the visibility or other factors might affect the outcome. A Kalman filter based adaptive background model will be able to adjust itself for such minor issues.

c. Contour Based Tracking: This model analyses the frames or images for a pixel area of a certain colour or intensity of light. In RGB, HSV or on GREY this model is very effective and can be adapted for any kind of visible conditions as long as the colour intensities are identified. The system will identified the contour of a minimum threshold as an identifiable object on the frame and will keep on tracking it further.

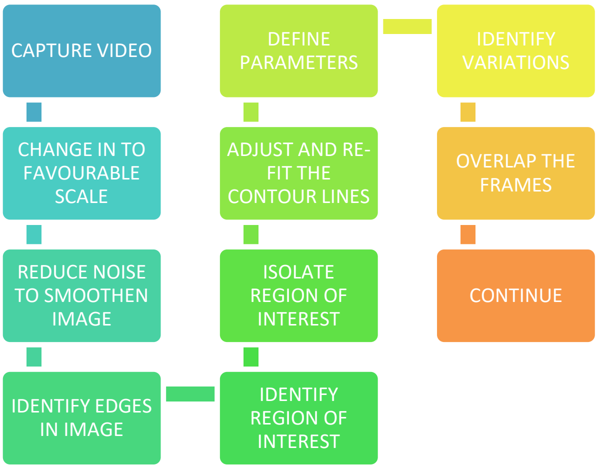
d. **Feature Based Tracking:** This model deals with a totally different approach of tracking using the unique features of an intended object. In our case the lane lines are always parallel to each other most of the time and are spaced based on the characteristics of the road. This is the best way to track an lane on the road for any kind of visibility condition.

In this paper we are using a combo of contour based tracking system and feature based tracking system to exploit the features of both the systems. Both the systems are comparable when it comes to accuracy of the result, but we are expecting a very steep drop in computation time and better lane identification when we are merging both the systems. We will be tracking the lanes on the road both for their features and for the white colour of the lane marking generally on the threshold of about (255,255,255) on the RGB scale. The position of the video capturing camera is fixed and the initial frames of the video will be analyzed for breaking distance and width of the lane. The lane markers will be identified and as contour of a specific colour and will be drawn on the initial image or frame.

The area which is not covered in the breaking distance and in the lanes i.e. area on the outside of the lane will be masked to reduce any unnecessary computations. The frame will be set for a threshold range in which the lanes are supposed to be, if the contour area of the lane marking is crossing the threshold a warning signal will be sent to the driver that the vehicle is deviating from the lane. If any vehicle or object enters the area of interest which was masked before then a warning will be sent to the driver to slow down as a objection is present within the breaking distance.

REGION OF INTEREST: Area on the frame where our system will be looking and identifying the changes in pixel colour is determined. This area is the area that excludes other lanes, high intensity sky area and only includes the current lane width upto the breaking distance for the specified speed. The shape will be of a trapezoid.

Program Flow Chart:



System and Implementation:

We use different module of python to setup the system. This program follows the algorithm and execute. It will keep on following the lane markings even when it is turned-on.

Fig. 1 Image before processing

Fig. 2 Image with lane detected on a straight lien

Fig. 3 Image of a curved road before processing

Fig. 4 Image with lanes detected on a curved road

IV. FUTURE SCOPE& CONCLUSION

1. Due to the usage of advanced computational methods the processing speed is 0.005 seconds which is almost instantaneous to warn the driver.
2. The lane can be detected if the curvature of the road is less than 3 degree.
3. The processing speed is not enough if the speed of the vehicle is crossing 86kmph.
4. The performance of the system can be still improved with moderate computing methods.

- Lane markings of other colors like yellow or shades of yellow are also detectable

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AUTHORS PROFILE

I Dr.CH.Veerendra has completed my Ph.D from USC Columbia in 2011. I worked as Assistant Professor in BIET, SCET. I worked as Associate professor in MRIT and presently working as Associate Professor in MLRITM. I have published 3 international journals and attended 2 international and 6 national workshops and attended 1 international conference.

I K.B.R Prasad Reddy has worked in Irrigation department of state of Andhra Pradesh and retired as chief engineer. Later I joined in MRIT, JNTUH and working as professor till date. My specialization in M.Tech is Water resource engineering. I published 5 papers in various national and international journals