Perspectives in Communication, Embedded-Systems and Signal-Processing (PiCES) – An International Journal
ISSN: 2566-932X, Vol. 1, Issue 12, March 2018

Real Time Rear Vehicle Monitoring & Detection System

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Abstract: The purpose of this project is to design and develop real-time vision based systems which can identity vehicles approaching from the rear and alert the driver in order to prevent a possible collision. The camera placed on the rear side of the vehicle, which captures images at a rate of 30 frames per second and then sends it to the processor via transceiver systems such as Wi-Fi. These images are analysed by various images processing and video processing techniques, the processor finds whether the vehicle behind is in a danger position or not. If a danger is sensed then an alert is given to the driver in the form of beep or voice based alerting system. A beep sound is given before a dangerous situation arrives, so that the driver is mentally prepared so do the right manoeuvres. The proposed system will also guide drivers while taking turns, if suppose the driver wants to take a left turn, the area of interest of camera will concentrate on the left portion and if the driver wants to take a right turn the camera area of interest shifts towards the right portion.

Keywords: Collision; Image Processing; Video Processing; Voice-Alert; Transceiver System.

I. INTRODUCTION

The population of the world has tremendously increased in the past few centuries due to advancement in medical and health facilities; the population of the world has clocked around 7 billion approximately. Out of which India's population is around 1.3 billion. Nowadays at least each family owns vehicles and hence the population of vehicle on road is also increasing rapidly. Due to more number of vehicles on roads today we face problems such as air pollution, noise pollution, traffic jams, road accidents etc. According to a report published in Times of India dated 18th August, 2016 which states that around 53,700 vehicles are added daily to Indian roads, which highlights the complexity of the problem. Since human life is more precious than anything on earth we would like to concentrate only on road accidents issue. Road accidents have led to 3%-4% loss in our country's gross national product (GNP). The effect of road accident has become a serious concern since more than 1.2 million people are losing their life every year. Road traffic injuries are one of the top three causes of death for people aged between 5 and 44years.

According to a survey report road accidents are caused due to the following reasons:

1. Fault of driver.
2. Mechanical defect of vehicle.
3. Bad road condition.

Bad road condition can lead to serious accident especially during night duration as the driver drives the vehicle assuming that the road is smooth. Even due to uneven and unscientific speed breaker lead to loss of control of the vehicle by the driver.

Mechanical defects such as brake failure, puncture, non-alignment of wheels also leads to loss of control of vehicle and thus leads to road accidents.

Coming to the faults of drivers, there are various faults of drivers which lead to road accidents, some of them are:

1. Driving while intoxicated.
2. Falling asleep on wheel.
3. Overtaking from wrong side.
4. Non-visibility of certain area due to blind-spots.
5. Taking turn or stopping without prior signaling.

Due to consumption of intoxication the driver's mental health condition is not stable, and hence decision taken by the driver while driving is completely wrong and thus leads to road accidents. Sometimes driver drive the vehicle without taking proper sleep and rest or sometimes the driver work overtime which thus lead to lack of concentration and finally lead to road accident.

Many projects have come up during these years which are useful in improving the safety while the driver is drunk or asleep. Such as a camera is placed on the dash board which monitors the driver blinking rate, if the eye is closed for more than a certain period of time, an alert is generated and even the engine is switched off.

Non-visibility due to blind spot plays a major role in many road accidents; many regions are not properly covered by the mirror. For example see fig 1.1 a truck is shown negotiating a curve, but when a truck takes a sharp turn its engine part is titled but the trailer part remains to be straight. Hence whenever the driver looks at the mirror, he can see his own truck trailer part but not the road. Hence these regions are classified to be the blind-spot of the truck. In order to eliminate such blind-spots we require a system which can identify the objects in blind-spots and inform the driver whether there is any obstacle or not.

Fig 1. Photo of a truck finding difficulty in negotiating a turn.

Not many projects have come up in order to eliminate blind spot present around the vehicle. The systems which are currently available in the market are rear fish eye camera based system wherein a monitor display is placed at the dashboard from which the driver can have a look of the scene behind. But these system works only in reverse gear and they don't give any alert to the driver if suppose there is any obstacle.

Another system which is available in market is the parking sensors, even these sensors works only in reverse gear, and they produces a beep sound , hence the exact position of the obstacle cannot be determined.

Hence to overcome these drawbacks we have designed and developed a system which can monitor the traffic behind the vehicle and also inform the driver about the exact position of the vehicle which is in danger zone.

II. Literature Survey

Paper title: - Real time vision based vehicle detection for rear-end collision mitigation system.

Author: - D. Balcones, D.F. Llorca, M.A. Sotelo, M. Gavil´an, S. ´Alvarez, I. Parra, and M. Oca˜na

Year of publication: - 2009

Publisher:-Springer's

This paper describes a real-time vision-based system that detects vehicles approaching from the rear in order to anticipate possible rear-end collisions. They have used various image processing techniques such as top hat transform with intensity and edge based symmetric. Once the candidates have been successfully identified as vehicle, then by using non-rigid grid based tracking mechanism the candidate is monitored continuously till it safely overtakes the vehicle.

The system is divided into four major blocks:

1. Rear-lane detection
2. Candidate selection
3. Single-frame classifier
4. Multi-frame validation and tracking

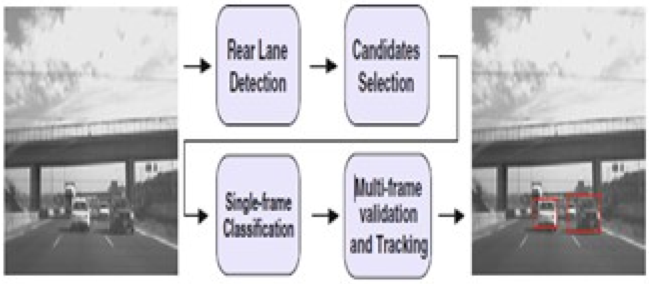

Fig 2. Block diagram of rear-end vehicle detection system

Paper title: A Blind-Zone Detection Method Using a Rear Mounted Fisheye Camera with Combination of Vehicle Detection Methods

Author: Damien Dooley, Brian McGinley, Ciaran Hughes, Liam Kilmartin, Member, IEEE, Edward Jones, Senior Member, IEEE, and Martin Glavin, Member, IEEE

Year of publication: 2015

Publisher: IEEE

This paper proposes a novel approach for detecting and tracking vehicles to the rear and in the blind zone of a vehicle, using a single rear-mounted fisheye camera and multiple detection algorithms. A manoeuvre that is a significant cause of accident involves a target vehicle approaching the host vehicle from the rear and overtaking into the adjacent lane. As the overtaking vehicle moves toward the edge of the image and into the blind zone, the view of the vehicle gradually changes from a front view to a side view. Furthermore, the effects of fisheye distortion are at their most pronounced toward the extremities of the image, rendering detection of a target vehicle entering the blind zone even more difficult.

The proposed system employs an Ada-Boost classifier at distances of 10–40 m between the host and target vehicles. For detection at short distances where the view of a target vehicle has changed to a side view and the Ada-Boost classifier is less effective, identification of vehicle wheels is proposed. Two methods of wheel detection are employed: at distances between 5 and 15 m, a novel algorithm entitled wheel arch contour detection

(WACD) is presented, and for distances less than 5 m, Hough circle detection provides reliable wheel detection.

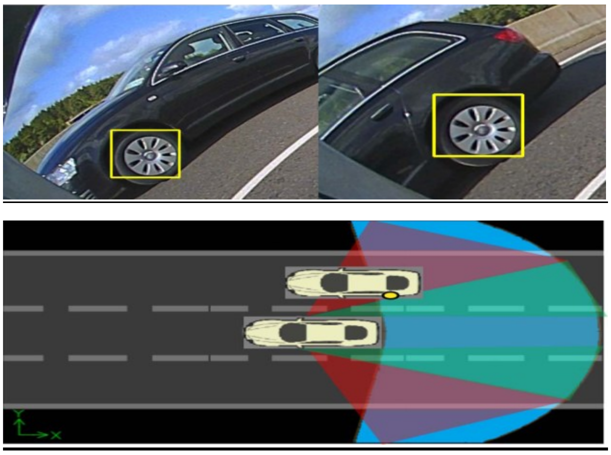

Fig 3. Detection of rear wheel of a target vehicle with respect to the host vehicle in the context of visible-zones

III. WORKING PRINCIPLE

The proposed system consists of following blocks.

1. Camera
2. Transceiver system
3. Processor (Personal computer)
4. Arduino board
5. DF player
6. Audio system.

As shown in Fig 3.1 the camera captures images at a rate of 30frames/sec, and sends it to transceiver system. This resolution ensures great quality images sufficient for detecting vehicle at the rear. At the same time a frame rate of 1/30th of a second ensures no loss of data and is equivalent to human eye sight itself. With the help transceiver system the images are relayed to the processor. Here the transceiver system is basically Wi-Fi system. Since the bandwidth of Wi-Fi system has a higher bandwidth, transferring the live-feed information from camera to processor takes place at a higher speed.

The image are received by a computer system which processes and analyze the images by applying various image processing techniques, after analyzing the images if there is any danger then an alert is send from the computer system, here the information is transferred via Bluetooth device. The Bluetooth receiver system present in the vehicle receives the alert and sends information to the speaker via the arduino board.

The resultant information is a voice based alert which is played by the audio system through the DF Player. Arduino board relays the audio information to the DF player via serial communication. An audio files are previously recorded and stored in micro SD card which is inserted in the DF player. The audio files are in mp3 format.

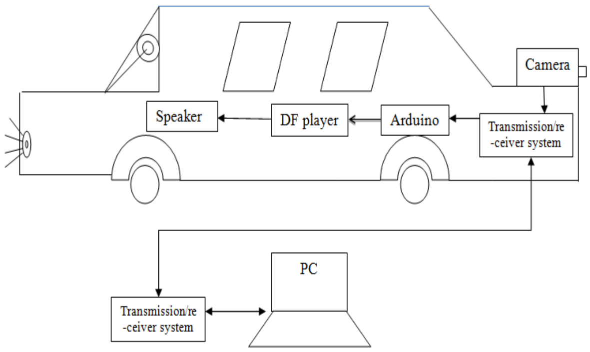

Fig 4. Block diagram representation of proposed system.

IV. FLOW CHART

A. Image Acquisition

The images are acquired using a RGB camera whose resolution is 640 X 480, with a frame rate 30fr/s. The images are initially in RGB format. Some of the captured images are as follows.

B. Image Masking

A mask has been prepared in order to eliminate unwanted information present in the images. This unwanted information can be artifact from nearby building, trees etc. The purpose of the mask is to focus our images only to road behind our vehicle and to prevent unwanted noise while processing images. The masks are logically AND'ed with images in order to obtain region of interest (ROI).

C. Colour Image Processing

Colour image processing helps in changing the colour models from one format to another format. Each colour components are segmented and observed. RGB colour models is used for colour monitoring, video cameras etc. CMYK colour models are used for colour printing. HSI models are used for image analysis, as it separates colour components. The images from RGB format have been converted to YCbCr format using the formula as shown in equation below.

$$[Y\ Cb\ Cr] = [R\ G\ B]\begin{bmatrix} 0.299 & -0.168935 & 0.499813 \\ 0.587 & -0.331665 & -0.418531 \\ 0.114 & 0.50059 & -0.081282 \end{bmatrix}$$

Now after color conversion, each colour component of image is segmented. Since an RGB, YCbCr and HSV format occupies 24 bits of memory by each pixel of an image, the size of the whole image is higher for processing. In order to speed up the process we segment the images and use only the colour component which occupies 8 bits.

Colour saturation refers to the intensity of colour in an image. In technical terms, it is the expression of the bandwidth of light from a source. The term hue refers to the colour of the image itself, while saturation describes the intensity (purity) of that hue. When colour is fully saturated, the colour is considered in purest (truest) version. Primary colours red, blue and yellow are considered truest version colour as they are fully saturated. As the saturation increases, the colours appear to be more pure. As the saturation decreases, the colours appear to be more washed-out or pale.

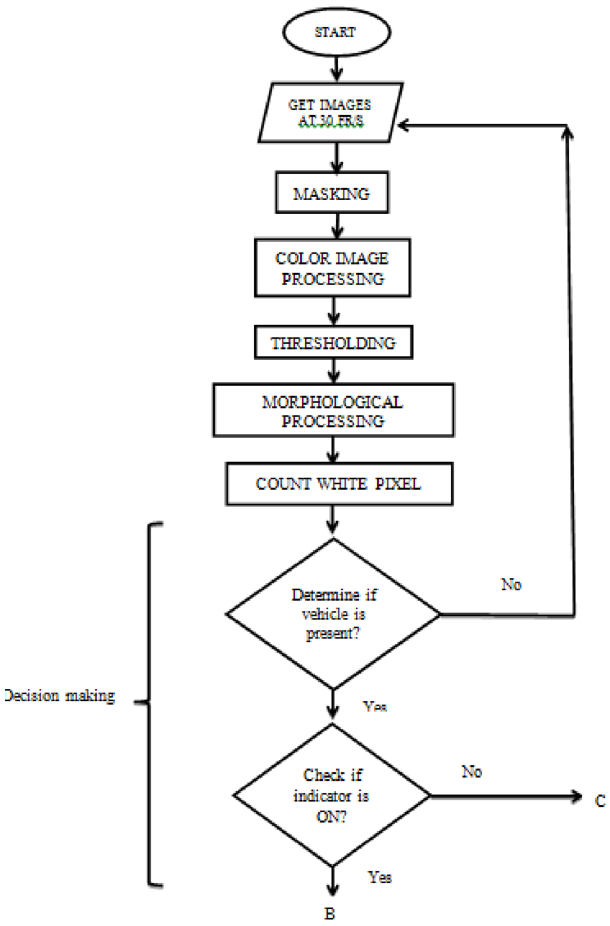

Fig 5. Flow chart

D. Image Thresholding

Thresholding is the simplest method of image segmentation. From a grayscale image, thresholding can be used to create binary images.

$$\text{Thresholded image} = \begin{cases} 0, & I(i, j) \leq T \\ 1, & I(i,j) > T \end{cases}$$

Since Otsu's method occupies more processing time and overhead as it involves 10 to 13 steps hence we move on towards intensity level slicing or double thresholding, which is the easiest way to threshold an image without causing overhead on the processor.

$$Threshold\ image = \begin{cases} 1\ if\ a \leq r \leq b; \\ 0, otherwise; \end{cases}$$

where a and b are minimum and maximum value of pixels for which we are interested.

After comparing images in R, G, B, Y, Cb, Cr, H, S, I we found that Cb and Cr were brightness independent but still we could identify vehicles on the road. A tables been formulated which compares all colour component.

Images	R	G	B	Y	Cb	Cr	H	S	I
Capture1	☑	☑	☑	☑	☑☑☑	✗	☑	☑☑☑	☑
Capture2	☑	☑	☑☑	☑☑☑	☑☑	✗	☑☑	☑☑☑	☑
Capture3	☑	☑	☑	☑☑	☑☑☑	✗	✗	☑☑☑	☑
Capture4	☑	☑	☑	☑☑	☑☑☑	✗	☑☑	☑☑☑	☑
Capture5	☑	☑	☑	☑	✗	✗	☑☑	☑☑☑	✗
Capture6	☑	✗	☑	☑☑	☑☑	✗	☑	☑☑☑	☑
Capture7	☑	☑	☑	✗	☑	✗	☑☑	☑☑☑	☑
Capture8	☑	☑	☑	☑	☑☑	✗	☑☑	☑☑☑	☑
Capture9	☑	☑	☑	☑	☑	✗	☑	☑☑☑	☑
Capture10	☑	☑	✗	☑☑	☑☑	✗	☑☑	☑☑☑	☑
Capture11	☑	☑	☑	☑☑	✗	✗	☑	☑☑☑	✗
Capture12	✗	☑	☑	☑	☑☑	✗	☑	☑☑☑	✗
Capture13	☑	☑	☑	✗	☑	✗	☑☑	☑☑☑	✗
Capture14	☑	☑	☑	☑☑	☑	✗	☑	☑☑☑	✗
Capture15	☑	☑	✗	☑	☑☑	✗	☑	☑☑☑	✗

☑☑☑→Best, ☑☑→Good, ☑→Satisfactory, ✗→Poor

Table 1. Comparision of all colour space component

As seen through table 4.1 we can conclude that vehicles can be identified easily from the road only in S colour space. Hence further image processing must be done in S colour space.

E. Morphological operation

In order to remove noise from the images we perform certain morphological process such as erosion.Since the candidate (vehicle) gets faded out while performing noise removal, It is recovered by performing dilation. The output obtained after performing erosion and dilation are as follows.

F. Count White Pixels

In order to find out whether a object is near or far, we rely on the principle such that if an object is near then it appears to be bigger in size and hence will occupy large number of white pixels similarly if an object is far then it will look smaller in size and the amount of white pixels will be low. Hence we compare all types of condition and then formulate a generalized threshold value for count such that if the number of white pixel is greater than predefined threshold then the object is said to be near otherwise far.

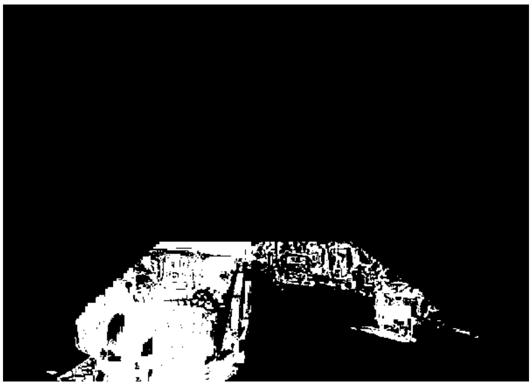

Fig 6. Thresholded image

G. Decision making

Comparing the white pixel count present in that region we determine whether the object is in danger zone or not. Further if the driver wants to take a left turn or a right turn then the region of interest (ROI) of the camera shifts to that particular region, thus reducing the system overhead. Practically speaking if a driver wants to take a left turn it is useless to know about the vehicle which are coming towards the right portion.

H. Alert generation

After all these processes finally an alert is generated and given to the driver via a voice alert or beep sound. If the vehicle is far enough and is predicted to reach us after a while then only a beep sound is played. If the vehicle is in moderately danger portion then a voice alert warning the driver to be careful is played. If the vehicle is in danger zone, then a voice alert stating danger is played. All these voices are already stored in Micro SD card in mp3 format. The corresponding audio file to be played is decided by the Arduino board. Information to Arduino board is given by Simulink software via Bluetooth.

V. RESULTS

The complete algorithm was designed and developed using SIMULINK tool which comes bundled with MATLAB R2013a software. The input to the model developed in SIMULINK was given using wireless communication. The indicator switch state was passed through RF transmission and the camera input was given through Wi-Fi medium, the output information which was played in audio system was passed through Bluetooth device.

The system was tested at ground level with real-time on road conditions and was found to be highly significant in highways and also city roads conditions .Whereas on mud roads (khacha roads) the system showed non-significant. The system however was found to be a great boon to the drivers while driving a vehicle. The efficiency of the system was found to be 95% and the response ratio was around 0.6sec. Since the system would take in input such as indicator conditions it proved to be helpful since system could understand the need of the driver and would focus itself only to the particular region of interest.

VI. APPLICATION

It proves to be most helpful to truck drivers who are not able to get the complete view of the rear side and also at the side while taking turns and reversing. The system also provides assistance while reversing and also while taking turns. Even for two wheeler rider it proves to be helpful since when a two wheeler rider wears a helmet, the visibility of area towards the sides are covered, hence increases the blind spot, thus the proposed system can help in such situation.

VII. ADVANTAGES

The proposed system helps the driver while reversing and negotiating a turn. The system is fast and provide correct results. It eliminates the need of parking sensor.It works in both reverse and forward gear. Cost is very less to implement this module. Software used in this project is very simple. Provides assistance while reversing and taking turns. Hardware requirement is also very less. As technology improves in future we can implement a driver less vehicle by using this project.

VIII. CHALLENGES

The system faces difficulty during night, since the availability of adequate light source is present. This could be overcome by utilizing the headlight of rear vehicle as a source of reference or an infrared camera could be utilized in order to detect vehicle coming at the rear.

IX. CONCLUSION

The system is proved to be effective in evading the blind-spot present around the vehicle. The proposed system is a great boon in enhancing the safety of a vehicles. The system is compatible with any type of vehicle and can be implemented on two wheeler vehicles as well. This system benefits mostly the truck drivers, who find difficulty while reversing and taking turns. Overall in this way, merging a Smartphone which has both Wi-Fi transmitter as well as camera proves to be cost effective. The cost incurred in assembling the system is also cheap thus providing a plus point to the proposed project. With this novel methodology a huge number of fatalities due to rear end collision can be avoided and a million precious lives can be saved

X. FUTURE SCOPE

Since the system fails to work during night, due to absence of lighting condition, an infrared camera can be implemented which can detect vehicle even in low lighting conditions. The whole algorithm could be implemented in a single chip in order to improve portability of the system.

As technology improves in future we can implement this system in a driver less vehicle, this proposed system could be utilized in order to help the machine know about the vehicle behind the car and do the manuvare accordingly.

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