PEDESTRIAN, LANE AND OBSTACLE DETECTION IN INTELLIGENT TRANSPORT SYSTEM

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Abstract: Due to increase in the number of vehicle in the resent years, the accident count has noticeably increased. Moreover whenever an obstacle is detected in the road it is not possible to stop the vehicle immediately due to forward force and fraction of time available to react to the scenario. So in this paper a new technique is proposed using the sensors and haar features to detect the obstacles present in the road which can include the pedestrians, Lane etc. The experimental results shows that the technique used as a better efficiency in detecting the obstacle and immediately providing the signal to the driver, so that more time is available for the driver to react to the obstacle . More or the less the worst situation is to bring the vehicle to the stop mode. The method implemented here shows the efficiency of above 80% when compared to the traditional method that is available.

Keywords: Pedestrians, Lane, Obstacles detection, smart sensor, haar feature

I. INTRODUCTION

About 350,000 people are injured and more than 4,000 people are killed by car accidents each year in South Korea [1]. Since the major cause of the traffic accidents is driver faults, the number may be greatly reduced when using smart sensor systems assisting vehicle drivers. Recently, there has been active research and development about Advanced Driver Assistance Systems (ADAS). Advanced driver assistance systems are basically developed to assist driver while driving, in the form of warning drivers, providing better visibility etc. so as to minimize human errors which causes serious issues like accidents, pedestrian protection systems helps in the same way.

To detect pedestrian is one of the fundamental task from the perspective of computer vision. Pedestrian detection system takes input images of stationary as well as moving people in the path of car using camera, in real time. And then warn driver accordingly if there are chances of collision in manual driving car. If car is in autopilot mode then accordingly break will get apply and necessary action will be taken.Researchers are facing the challenge of increasing computational speed, Increasing robustness of system and maximizing accuracy. To design robust pedestrian protection system needs to overcome challenges as:

- Appearance of pedestrian show high inconsistency in the form of pose, clothes, carries different objects in hand.
- Different environmental conditions affect badly on sensed image by camera, which may lead to increase miss rate.
- Different outdoor elements for example statues, parked vehicles, poster etc. lead to decrease performance of system.

The pedestrian detection techniques are based on feature extraction and classification.Lane detection is also an important issue for ADAS, and has received considerable attention since 1980s [2], [3].In this paper, we present an efficient approach to lane detection. The left and right lines of a lane are detected by scanning an image along sparse horizontal lines. The method is simple, automatic, and robust.

Object Detection is a technique in image processing that is based on change in the video.

The whole process of detection works in three phases:

1. Input streaming of images.
2. Image processing on it.
3. Output, as if the obstacle is present or not.

Road defects like cracks, bumpers on road and potholes can be detected by an algorithm of image processing. Object detection can be done by comparison of consecutive images on the scene. In most of the cases such of obstacle detection, it is quite hard to detect moving object as well as detection of shadow.

II. LITERATURE SURVEY

Several techniques have previously been proposed for pedestrian detection:

NavneetDalal [5] used HOG and SVM where HOG is used as feature extractor and SVM as classifier.

Jiang –tao Wang et al. Proposed method for pedestrian detection as well as tracking in infrared images. They used GMM background model is firstly apply for separation of foreground candidates from background and then a shape describer is used for constructing the feature vector for pedestrian , after this SVM is used for training the data.

If we consider vehicle as a moving object, then moving object detection techniques can be useful for obstacle detection.

Wang et al. [9] introduce moving object based on temporal information. It mainly works in 2 phases: 1) Motion saliency generation: by symmetry difference in continuous frames generates a temporal saliency map and 2) Attention seed selection: calculate the threshold by maximum entropy sum method to get max saliency in candidate area. Consecutive object cannot be recognized using the proposed approach.

Xia Dong et al. [10] present a method to detect moving object and shadow, the method based on RGB colour space and edge ration. After experiments they proved that the pixel that can be classified can be any of the 3 types : shadow , background , object . Disadvantage is that the system can be used for steady camera only.

Cristina et al. [11] give idea of the See -Through System (STS): A Vehicular Ad-hoc Network (VANET) enabled assistant for overtaking Maneuvers. To improve driver's visibility and overtaking decisions STS allow the vehicle who wants to overtake, to have a video of preceding vehicle travelling in opposite lane. STS system will be automatically disabled when traffic signs don't allow overtaking. As vehicles are in direct communication timing delay should be minimum. Blind spot is when the vehicle enters or leaves from the Area of Sight, the camera is recording. As a vehicle in front is near and full in area of sight, the both vehicles must be in direct communication.

DipaliShahare et al. [12] present moving object detection with fixed camera and moving camera for automated video analysis. By optical flow method, from a current frame, the feature points are extracted. In consecutive frames subtraction, the difference of neighbouring frames is calculated and then moving region and background are recognized by improved Expectation-Maximization (EM) algorithm. In background subtraction each input image frame is compared with the background model obtained from the previous image frames. By that, foreground and background can be obtained.

III. IMPLEMENTATION

3.1 Feature extraction and classification of pedestrian detection

Feature extraction is necessary to identify targeted object. There is several feature extraction algorithms get developed for pedestrian detection, some are summarized as below:

A. SIFT (Scale Invariant Feature Transformation)
SIFT algorithm [4] transforms image into a large collection of local feature vectors. These local feature vectors are invariant to any scaling, translation or rotation of the image. This algorithm works in following four filtering stages.

1. Scale Space Extrema Detection:

Detection of those locations as well as scales those are identifiable from various view of same object is get achieved in this stage. Scale space function is used here.

2. Key point Localization:

Removal of additional points from the list of key points which have low contrast else weakly localized on edge. Laplacian is calculated for removal of excess key points.

3. Orientation Assignment:

The aim of this stage is that to assign a consistent orientation to the key points depending on local image properties.

4. Key point Descriptor:

It basically uses a set of 16 histograms, aligned in a4x4 grid, each with 8 orientation bins, one for each of the main compass directions and one for each of the mid points of these directions. This result in a feature vector containing 128 elements.

3.2 HOG (Histogram of Oriented Gradients)
Histogram of Oriented Gradients is implemented by Dalal and Triggs [5] for detection of pedestrian. This algorithm works in two stages: in first stage Descriptor formation and in second stage Training and classification.Descriptor formation stage includes functions like normalization of gamma and color, computation of gradients, formation of histograms of gradient orientations over spatial cells, grouping of cells into overlapping blocks (RHOG or C-HOG) and then normalize after this descriptor get form by collecting HOG's for all blocks within selected detection window. Training and classification includes splitting of dataset into training as well as test sets.

- Image classification:

Image classification aims to categorized detected object are Positive or negative i.e. if detected object is pedestrian then it is positive otherwise negative by comparing it with various standard datasets.

BLOCK DIAGRAM OF PEDESTRIAN DETECTION

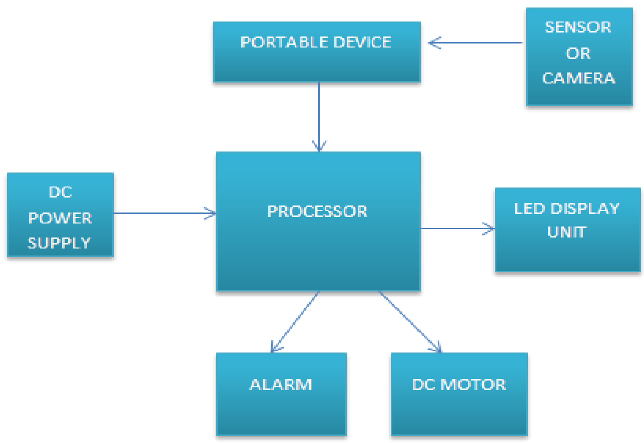

Figure 3.1: Block Diagram of Pedestrian Protection System

The block diagram of pedestrian detection system is as shown in fig.3.1. It includes Friendly Arm Board S3C2420, Regulated power supply, Display Unit, USB device, USB Camera, Buzzer, DC motor. When any pedestrian is get detected, it alerts driver by providing alarm sound and also it stops vehicle automatically. The display unit in vehicle provides details about position of pedestrian either right or left.

This paperuses ARM9 board which is having in built memory where we store program. The ARM9 board uses a 1.8V power supply. The 3G module is connected to internet by using point to point protocol. In networking, the Point-to- Point Protocol (PPP) is a data link protocol commonly used in establishing a direct connection between two networking nodes. It can provide connection authentication, transmission encryption and compression.

The webcam is continuously captures the images and given it to micro controller. These continuous images can be uploaded to internet by using FTP protocol. File Transfer Protocol (FTP) is a standard network protocol used to transfer files from one host or to another host over a TCP-based network, such as the Internet.The proposed pedestrian detection system makes use of CMOS camera which is interfaced to lower power consumptive and highly advanced micro controller like S3C2440.

The system uses USB webcam which is connected to ARM9 board through USB device. The webcam draw one region before capturing the pedestrian. The webcam captures the pedestrian present in the region only in the form of frames by using Open CV library later it retrieves image pixel data. It compares the captured image with Haar features of a pedestrian image which is stored in the form of .xml file. If the Haar features are matched with captured image buzzer will turn on as well as the controller apply break point to stop the DC motor through L293D driver IC to indicate the vehicle is in danger condition. If any pedestrian is not detected by webcam in the region, the motor will run in normal way.

3.3 SYSTEM STRUCTURE OF LANE DETECTION

The first step in our system is detecting the road lane. The lane in front of a vehicle is detected by determining the left and right lines of the lane. A region of interest (ROI) is set in the image, and the pixels in ROI are investigated along multiple horizontal scanning lines. Bright pixels detected from the scans, which may belong to the lane lines, are connected to detect a lane. In the second step, the detected lines are tracked in sequential images. Four points where left and right lines of the lane meet the boundary of ROI are tracked. The tracking and detection processes are in a closed loop: The tracking predicts current line positions so that the detection process can be performed within a narrow region. The detected line positions are then used in the tracking process again.

In the third step, pedestrians in front of a vehicle are detected by the use of HOG features and SVM (Support Vector Machine). Although HOG plus SVM is popularly used for pedestrian detection, this approach is computer intensive. We first find candidate regions in an image where humans may exist with high possibility. Then, a sliding HOG window is applied only around the selected regions. Fig.3.2 shows the structure of the proposed system.

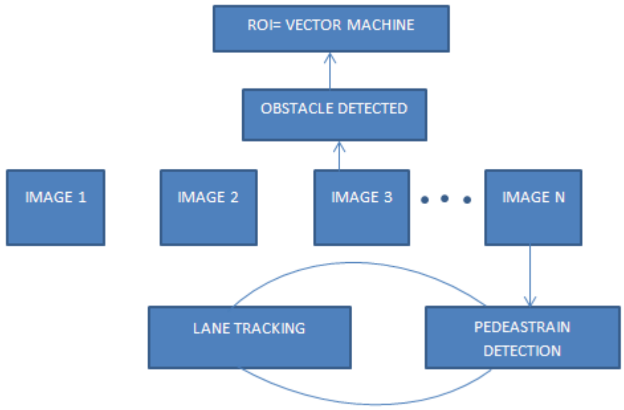

Figure3.2: Structure of the Proposed system

3.4 LANE DETECTION TECHNIQUE

- Image Processing for Lane Detection

A Region of Interest (ROI) is selected within a close distance in front of a vehicle. After smoothing the ROI image by a 3x3 averaging mask to reduce noise, we scan the image region with following horizontal lines. Figure 3.3 shows an example of a scan line. The gray scale variation along the scan line is shown in Figure 3.4 This graph shows that the lines of a lane are much brighter than other road surface. Pixels belong to the lines can thus be detected by comparing the intensity values of pixels with a threshold. The brightness of a road image however can vary by some reasons including shadow cast and road conditions. We select the threshold value adaptively by k*m, where k is a constant and m is the mean of the pixel intensity values along a scan line. We found that 1.2 is a good value for k in many road images in our experiment. Fig. 3.5 shows horizontal positions of the detected pixels belong to the lane lines, which are represented by their center points, C_L and C_R.

Figure3.3: Lane Detection by Horizontal Scanning- Scan Line

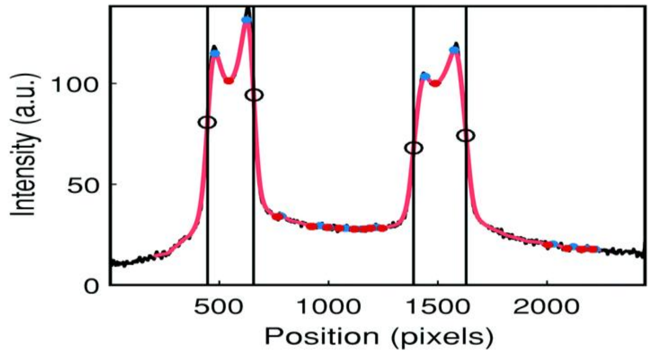

Figure3.4: Pixel Intensities along the Scan Line

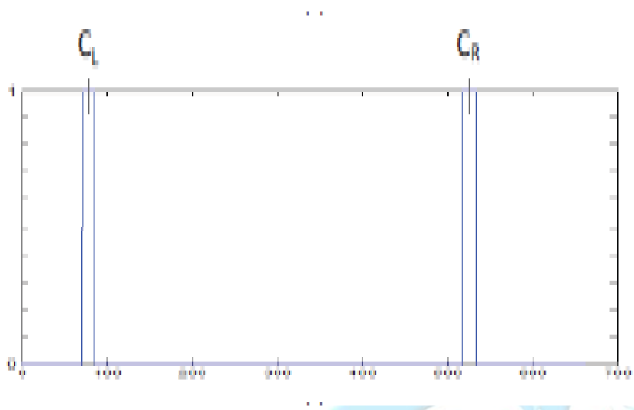

Figure3.5: Detected Line Points

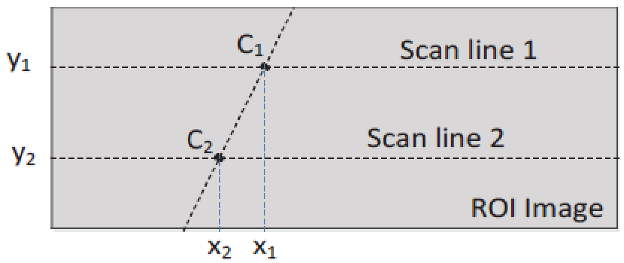

Figure3.6: A line can be determined by connecting points of high Intensities detected by multiple horizontal scans

If two horizontal scans are done by the way described above, we can determine a line on the image by connecting the two center points for a lane line as illustrated in Figure 3.6. The accuracy of detection against noise can be increased if more than two horizontal scans are made. For a set of multiple center points detected for a lane line at image coordinates $\{(x_1, y1), (x_2, y_2),\ldots,(x_N, y_N)\}$, parameters of a line y=ax+b minimizing the distances to the points from the line can be determined from

$$\begin{bmatrix} A1 & 2 \\ A2 & 2 \\ A3 & 2 \\ . & . \\ AN & 2 \end{bmatrix} \begin{bmatrix} W & X \\ Y & Z \end{bmatrix} == \begin{bmatrix} B1 \\ B2 \\ B3 \\ \\ BN \end{bmatrix}$$

Which can be represented in a shorter form as, LP=RThen, the unknown parameter vector P is computed by pseudo inverse of L,

$$P=(L^TL)^{-1}L^TR$$

If most x coordinates are close to a certain value h, then the slope of the line is infinity and a vertical line is determined as x=h.

- Practical problems in lane detection:

The simple method described will collapse if line detection fails on an image due to various causes such as bright objects on the road. To avoid this problem we predict the lane on a current image by tracking lane lines in the video image sequence. If the line detection and tracking do not correspond within a tolerance, we ignore current detection.For a road scene image, we usually have four points where left and right lines of a lane meet the boundary of the ROI as illustrated in Fig 3.7 Since the y coordinates of the points are fixed in an image (i.e., known), the tracking process is done for each of x coordinates, x1, x2, x3, and x4 independently. A certain x coordinate is tracked by moving averaging for *n* number of image frames as

$$\hat{x}_{i(t)} = \hat{x}_{i(t-1)} + (x_{i(t)} - x_{i(t-n)})/n$$

for i= 1,2,...4 .

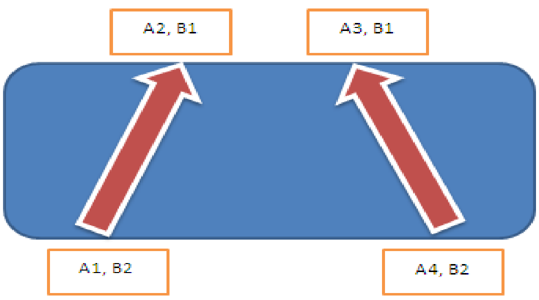

Figure3.7: Two lane lines are represented by four points where the lines meet the boundary of the ROI image

Another difficulty comes from road markings. Characters, numbers and signs are marked on road surface to provide information to drivers. However, these markings can be a cause of error in image processing for automatic lane.

IV.RESULTS ANALYSIS OF PEDESTRIAN DETECTION

As soon as pedestrian enters in camera range is get detected. But this detection get affected by different environmental conditions, occlusion etc. Table 1 illustrates accuracy of system in different environmental conditions. Response time for system is 10sec. Accuracy of pedestrian detection system is 99% for good environmental conditions. Fig.4.1 shows detection on OpenCV.

TESTED TIME =30 MIN	
ENVIRONMENT CONDITIONS	**EFFICIENCY**
NIGHT	84%
FOG	52%

GOOD (DAY)	92%
CLOUDY	67%

TABLE 1: RESULT TABLE

4.1 RESULTS OF LANE DETECTION

To test our system, we collected a number of images, with and without road markings and pedestrians. The system was prototyped using MATLAB, and ran on a PC. Fig.4.1 shows some examples of test results.

Figure4.1: Examples of Test lane detection

V. CONCLUSIONS

A perfect pedestrian detection system needs to work at all environmental conditions and also at night without fail. This system should not disturb the driver if there is no risk is involved. Cost of this system should be comparably lower than that of car. Proposed system with ARM 9 has low cost and also it has good accuracy in good environmental conditions. But still there is lots of works have to be done on system for example work at night time, and also at all environmental conditions.The lane detection is done by determining the left and right lines of the lane. The processing is in a closed loop that consists of detection and tracking. By moving averaging past detections, line positions are predicted on the current image. The lines detected about the predicted positions are then used again to make a prediction on the next image.

Obstacle detection is very important research area for ITS for safety purpose. The purpose of this paper is to study the research work carried out in this field along with their limitation. Meanwhile, environmental topology and geographic condition along with lack of road quality are some of the major causes for accidents. Addressing these issues in ITS is still in primary stage. Most of the moving object detection techniques use stationery single camera for video sequence recording, and each of them has its own limitations. The review provides clear understanding using different methodology and shows the issue/future scope. The paper may prove to be useful for researchers carrying out research in the area of moving object detection.

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