Vision Based Detection of Occupants Inside Vehicle

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Abstract- *Improvement of safety and comfort of the passengers is an important research domain in the automobile industry. Currently vision system is used in parking assistances system. The vision based occupant detection inside the vehicle open up new ways to improve safety, security and comfort of the passengers. In this paper we proposed a novel method to detect and classify the occupants inside the cabinet using face recognition based detection classification method are concatenated to identify occupants more effectively. We have successfully demonstrated this type of system operating in a test vehicle at a real time video rate (30 fps) with high accuracy for different weather as well as lighting conditions.*

Keywords- Occupant Detection (OD), Camera, Classification, Suffocation, Blower

I. INTRODUCTION

Surveillance systems are increasingly used in automobile industry for monitoring occupants for various applications such as airbag deployment, climate control, and safety. There are number of systems developed by various authors using vision based system. Accuracy of the system depends upon the type of camera, the position inside the cabinet and types of algorithm used for detection as well as classification. Performance of different detection systems can be increased by using multi step frame work. Each step can detect a particular region of the human body and finally classification can be performed using motion based detection to distinguish between human and non human object [4].

II. LITERATURE SURVEY

There are number of systems developed for occupant detection inside the cabinet using the vision system. The accuracy of the system depends upon position of the camera, type of camera and other supplementary sensors used in the system. The highest accuracy can be achieved by introducing IR sensors in the system.

In this section, a review of conventional and newer techniques for occupant detection and the classification will be discussed. the key motivation behind the survey is to find a more adequate method to analyze the detection and classification in detail.

Sidharta Gautama et.al [1] developed stereo matching algorithm for occupant detection and skin tone is also taken into consideration for detection of occupant. the problem with this system is the accuracy and cost. This system is less accurate and cost is also more for the system as there are two cameras used. N. Srinivasaet. al [2] had used fusion architecture for vision based occupant detection gives up to 98% of accuracy irrespective of lighting conditions but this system requires lot of training data.

Bruno Mirbach et.al [3] used 3D vision technology for most robust design system. But this system cannot detect occupant facing reverse facing. 3D clear class separation is required to get more clear results. Same authors [4] had designed Reeb Graph technique to detect occupant head for low resolution camera. Armin Sutzet. Al [5] designed capacitive design model for detection of occupant. the principle behind this system is, the current path changes by influence because of human presences. This system has grounding problems.

Zhenhai Gao et. Al [6] uses Legendre moments and State Vector Machine for classification of living and non-living objects and accuracy of 90% is achieved. Tatsuya Izumi et. Al [7] used FIR cameras for detection of occupants. The skin temperature of occupant is used to detect the presence of occupant. the cost of this system is more as compared to other system.

Mahamuni P.D. et. Al [8] used background subtraction algorithm with motion detection. This system produced very good results compared to other but the continuous video input is required for this system. Peter Hofmann [9] has used Radar for detection of objects. This system gives comparatively good results but this system cannot have used for small cars as cost increases a lot. Reza Oji [10] has developed a model based on ASIFT algorithm and gives very efficient and accurate data.

III. MATERIALS AND METHODS

The detection process generally occurs in two steps 1. Object Detection and 2. Object Classification. The following Fig 3.1 explains the flow of the object detection and the object classification. There are various methods for object detection

like background subtraction, optical flow, HAAR like feature extraction etc. among of all the background subtraction is well suit for the current application.

Object classification is the next step after the object detection. According to application system need to classify between living and non living things. Fig 3.1 shows various object classification techniques used. Object classification based on motion based method gives more accuracy considering the application as compared with the other techniques. [9]

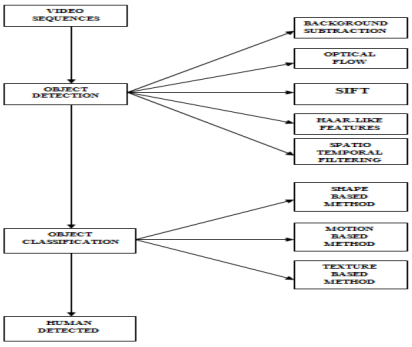

Figure 1. Object detection and classification flow

1. Object Detection:

An object is generally detected by segmenting motion in a video image. The different object detection techniques are explained in the following sub sections.

Background Subtraction. Background subtraction is commonly used in the surveillance systems, motion is capture where it needs in the first step to detect the moving objects. In this technique the motion foreground objects are more accurately detected [5]. The main disadvantage of this technique is not suitable for sudden background changes like changes in environment and lighting conditions.

Mixture Of Gaussians. Stauffer and Grimson introduced an adaptive Gaussian mixture model in which the sensitive to the changes in dynamic scenes derived from various things are modeled over time. The modeled values of each pixels are considered as a mixture of Gaussian [1]. The change in pixel is updated using K mean approximation. This technique is very useful if the background and foreground ratio is already known or it is constant.

Optical Flow. A sequence of image showing motion can be good source of information about moving object. The feature extraction and classification is based on features of image or intensity of the image.

Table 1. Working Principle of Air Quality Sensor 1

Technique	Accuracy	Comment
Frame Difference	Low	It require background without moving object
Mixture of Gaussian	Medium	Simple Implementation and good performance
Optical Flow	Medium	Good with camera in motion

The above table summarizes the different object detection techniques among these techniques mixture of Gaussian and optical flow gives better result but considering the application frame difference is useful.

2. Object Classification:

The detected objects need to be classified clearly between living and non living things. The available classification methods could be divided into three main categories: shape-based method, motion-based method and texture-based method.

Shape-based method. The first step is to set initial shape model then the various levels of shapes need to initialize. After the detection of the object, the shape of model is adjusted by current level set functions from this the contour shape is determined. These steps are repeated until the object is clearly classified.

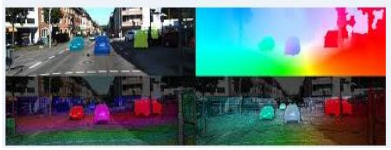

Figure 2. Shape based detection

Motion Based Method. This classification method is based on object motion characteristics and patterns are used to distinguish between moving objects. Author had developed a view-based approach for the recognition of human movements by constructing a vector image template comprising two temporal projection operators: binary motion-energy image and motion-history image. This classification suits better for the application.

Texture Based Method. Local binary pattern (LBP) is a texture-based method that quantifies intensity patterns in the neighborhood of the pixel [5]. The multi-block local binary

pattern (MB-LBP) encodes intensities of the rectangular regions by LBP. Author introduced another texture-based method which uses high-dimensional features based on edges and then applies SVM to detect human body regions.

The Above Fig 3.3 Shows the working principle of the Air quality sensor 2 i.e. CO2 sensor. The sensor is placed inside the vehicle cabin to detect the amount of Carbon Dioxide exhaled by the living thing. The increment in the Carbon Dioxide indicates the presence of human or living things inside the cabinet.

IV. THE VIOLA JONES ALGORITHM FOR FACE DETECTION

The entire process is divided into 3 stages of Data acquisition, Feature extraction and the feature classification as shown in below figure 4.1.The data is captured from the camera which was placed on dashboard with camera lens of 120 Deg

Figure 3. Block Dig for Face detection

1. Feature Extraction

The Viola-Jones algorithm uses Haar-like features, that is, a scalar product between the image and some Haar-like templates. let I and P denote an image and a pattern, both of the same size N by N. To compensate the effect of different lighting conditions, all the images should be mean and variance normalized beforehand. Those images with variance lower than one, having little information of interest in the first place, are left out of consideration.

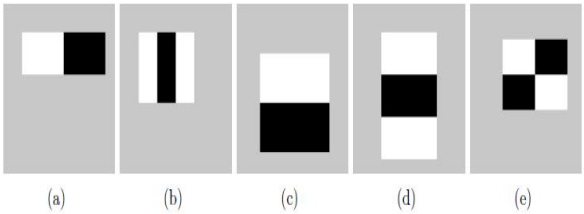

Figure 4. Haar patterns for feature extraction

The above Fig 4.1.1 shows Five Haar-like patterns. The size and position of a pattern's support can vary provided its black and white rectangles have the same dimension, border each other and keep their relative positions[5].

The derived features are assumed to hold all the information needed to characterize a face. Since faces are by and large regular by nature, the use of Haar-like patterns seems justified. There is, however, another crucial element which lets this set of features take precedence: the integral image which allows calculating them at a very low computational cost. Instead of summing up all the pixels inside a rectangular window, this technique mirrors the use of cumulative distribution functions.

2. Classifier

The basic principle of the Viola-Jones face detection algorithm is to scan the detector many times through the same image – each time with a new size. Even if an image should contain one or more faces it is obvious that an excessive large amount of the evaluated sub-windows would still be negatives (non-faces). The job of each stage is to determine whether a given sub-window is definitely not a face or maybe a face[1]. When a sub-window is classified to be a non-face by a given stage it is immediately discarded. Conversely a sub-window classified as a maybe-face is passed on to the next stage in the cascade. It follows that the more stages a given sub-window passes, the higher the chance the sub-window actually contains a face this in mind a detector consisting of only one (strong) classifier suddenly seems inefficient since the evaluation time is constant no matter the input. Hence the need for a cascaded classifier arises

3. Results

By fixing the temporary location of the camera the occupant algorithm is tested in the MATLAB 2013b version. The occupant is detected from the face detection method. The algorithm is used for face detection uses eyes, Mouth and Nose detection to recognize the face of the occupant.

The eye, mouth and nose detection provides accuracy for the face detection. By fixing the threshold values in the algorithm the accuracy of algorithm can be increased

Figure 5. Results for eyes, nose and mouth detection

The above Fig 4.3.1 (a) is the original image taken for further processing. Fig 4.3.1(b) is the result of the eye detection

in original image. Fig 4.3.1(c) is the result of the mouth detection in original image

In this case the camera is kept on the dash board near clock and captured the image. It is found that the occupants seating front side are able to detect. The Voila Johns algorithm is used for the human recognition. in this algorithm if the human eyes, nose and mouth are detected then the system recognized the object as a human. The eyes, mouth and nose all these parameters are in OR logic so any two of these parameters detected then the object is considered as a human.

Figure 6. Eyes detection

The above figure shows the result of face detection. The face is detected based on eyes, nose and mouth detection. The algorithm clearly identifies the faces of the occupant and classified the object as human but the position of the camera is not suitable to detect all the occupants seating inside the cabin.

Table 2. Result table

No of Occupants	No Detected Occupants	Lighting Condition	Occupant Position (Detected)	Occupant Position (Not Detected)
5	5	Sunny	On seats	----------
4	3	Cloudy	Facing Towards camera	Not Facing Towards camera
3	2	Very Dark	Facing towards camera	Not Facing Towards camera
2	2	In cabin lights on	Seating on front facing towards rear side	----------
1	0	Dark	----------	Blind Location for camera

The above table 1 shows the results of occupant detection for various light conditions as well as considering the different positions of the occupant. The detection accuracy is higher than 85%.

V. CONCLUSION

Camera positioning inside vehicle is very crucial for occupant detection. Occupant detection in the car can be done using Voila Jones algorithm that detects face based on eye, nose and mouth identification. The detection of eyes and nose shows less variation in the results when compared to mouth detection; the threshold values for mouth varies person to person resulting in less detection accuracy. Out of the 165 test cases that were applied, occupants were detected 140 times; hence we achieved accuracy up to 85%. The accuracy can be increased by increasing training data or increasing the number of cameras along with other supplementary sensors like proximity, weight etc. The Occupant detection inside the vehicle can be used for various applications in future like airbag deployment, climate control applications.

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