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A Real-time Vehicle Seat Vacancy Identification System: A Review

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Abstract : In this proposal, face detection algorithm is developed to detect the number of faces present in a vehicle and corresponding to the detection system gives the count of the people. The images are captured using the webcam, which is installed in a vehicle and connected through a raspberry pi model B. As the vehicle leaves the station, the camera captures the images of the passenger in a seating area. The system is based on real-time application the camera will continuously capture the images and the count is also continuously modified. Then images that are captured are pre-processed via improved and adjusted to reduce the noise using software application. After pre-processing and post-processing steps are performed the images is send to the server using websocket protocol. The system obtains the maximum number of passengers in vehicle using face detection technology and thus gives the total face count of the passengers.

Index Terms **- Raspberry Pi, Face detection, PI Camera, Haar Features, Integral Image, SVM Classifier.**

I. INTRODUCTION

Nowadays, most of the face detection algorithms are designed in the software domain and with a high detection rate, but they often require several seconds to detect faces in a single image, so as the processing speed is not sufficient for real time application. A simple and easy hardware implementation of face detection system using Raspberry Pi model, which itself is a minicomputer of a credit card size and is of a very low price. In this project, we used Raspberry Pi board as hardware platform. Camera Pi is an excellent add-on for Raspberry Pi, to take pictures with the possibility to apply a considerable range of configurations and effects. In this research, image processing techniques are used to find the vacant seats. Webcam is connected with Raspberry Pi model B in the public vehicle for detecting the faces in vehicle and sending the data to the server by using websocket protocol. This system use Open Source Computer Vision (Open CV) to analyze and process the data then calculated the vacancy of the public vehicle by using the maximum face detection data. It is used for detecting the presence of vacant seats in vehicle. It enhances the speed of organization of people in a place and reduces the unwanted waiting time. The system plays a vital role in crowd monitoring and management. Helps in identifying if any of the seats with in a particular place is vacant or occupied and thus the number of vacant seats in that place could be easily identified [1].

Today, a lot of research has been published in order to resolve such problem which is count people using video camera. This is not an easy task, some situations are difficult to solve even with today's computer speeds (the algorithm has to operate in real-time which limits for the complexity of methods for detection and tracking). Maybe one of the most difficult tasks for face detection is people occlusions. While people entering or making exit of the field of view in group, it is very difficult to distinguish all the humans in this group.

The system fulfils the following outcomes such as:

I. Collect the information of the number of passengers travelling in the vehicle.
II. Control the ticket malfunctioning problem.
III. If passengers know both of the position of passenger vehicle & vacancy of seats, customer can plan their travel better.
IV. In case an accident happens, server will have the information about the passengers travelling in the vehicle.

II. RELATED WORK

Human detection in real world scenes is a challenging problem. In recent years a variety of approaches have been proposed and impressive results have been reported on a variety of data bases. The other ways to detect the seat occupancy is by wireless inductive sensor. The author presents a system used as a seat occupancy detector with adjustable weight threshold. System requires sensor which consists of inductor, steel springs and ferrite plat along with an antenna and a mechanical device for transferring the scaled weight to the sensor. Weight applied to the sensor causes the build-in-springs to compression which results in reduction of distance between the inductor and ferrite plate

which in turns changes sensors inductance and consequently the antenna sensor resonant frequency considering it as electric output. The obtained characteristics can be divided into three segments with following sensitivities: S1=0.9MHz/kg (range 0-20kg), S2= 0.86 MHz/kg (range 20-40kg), S3=0.19MHz/kg (range 40-50kg). Based on experimentation it gives highest sensitivity [2].

Dwarakesh T P et al. implemented a system for vacant seat detection and the count of vacant seat in crowded halls using video processing techniques. This system combines the adaboost and camshift techniques to track the head and shoulder ratio by dividing two black lines. The ratio between these two lines confirms that the detected object is human or not. Using both the techniques together will ensure the accuracy, speed and efficiency effectively. System overcomes the occlusion and interference of skin color. But suppose person head showing non-elliptical (wear a hat, accessories, special hairstyle), the system or method will no longer be able to detect the human presence [3].

Paul Viola and his team has described a machine learning approach for visual object detection which is capable of processing images extremely, rapidly and achieving high detection rates. System is based on real-time, the first contribution was new image representing called integral image that allows very fast feature evaluation. Second contribution was method for constructing a classifier by selecting a small number of important features using adaboost [4].

SHU CHANG et al. implemented HOG method for face recognition. The histogram of oriented gradient feature is widely used in application like pedestrian detection and tracking but has rarely been used in face recognition. A fact Computational method was developed and many different factors that affect the HOG's performance were evaluated to develop a HOG Descriptor with fine scale gradients, time orientation binning relatively small spatial binning (cell size) and overlapped cells over the entire image which succeed in achieving almost the performance but with a lower time cost compared to Gabor descriptor and better accuracy than the LBP descriptor [5].

In [6], the problem of seat occupation detection inside vehicles is addressed. The Proposed approach consist of four steps: correction of distortions followed by an epipolar rectification of stereo images, features extraction and feature based matching. Object classification techniques are categorized into shape-base, motion-base and texture-base methods. As image obtained from video has low resolution so it is challenging to process those images.

Principal component analysis (PCA) is an approach to reduce the computation steps. The principle of divide and conquer strategy had applied through image decomposition. Each image had divided into sub-images and then each one had tested separately by using a single fast principal component analysis processor. In contrast to using only fast principal component analysis, the speed up ratio had increased with the size of the input image when using fast principal component analysis and image decomposition. Simulation results demonstrated that this method was faster than the conventional and fast PCA. The implementation of principal component analysis (PCA) was used for fast face detection. The implementation was based on cross correlation in the frequency domain between the input image and eigen values (weights) [7].

Nose, eyes and mouth are the most prominent facial features which help in detecting the face. Based on the luminance and chrominance values we can locate the boundaries for eyes, nose and mouth from the image. Luminance (Y) represents the brightness in the image i.e. the black and white (gray scale image) portion of the image. It represents the details of image without any of its color information whereas the chrominance represents the color information. Chrominance is represented as two color difference: where Cb is defined as Blue-Y' and Cr is defined as Red-Y'. Research related to the computer vision on YCbCr space have established that pixels that fits as the skin region display similar values for chrominance and luminance. Using chrominance and luminance values in skin color model can provide good result for detecting skin of different ethnicity and human races. Based upon the threshold value of that pixel, the face portion in color image is retrieved using the skin color distribution. This algorithm also has similar restriction that whole image should have only one face as the skin region [8].

Janewit Wittayaprapakorn et al. proposed the system for real-time face detection to find the vacant seat in an electric vehicle. The webcam is installed to capture the real-time images. The camera is connected to a raspberry pi model. The images acquired are improved and processed using image processing techniques such as histogram equalization and morphological operation. Further, the images are send to the server using 3G communication. Using face detection technology the server processes the images and gives the count of the passenger. For feature extraction, the haar features are used. The system provides an accuracy of 91.67% working well at 200-300 images [1].

Manoranjan Paul et al. describes the system that is based on human detection in surveillance videos and it's applications. Human detection in a smart surveillance system aims at making distinction among moving objects in a video sequence. The detection process deals with two steps: object detection and object classification. Object detection techniques are characterized into background subtraction optical flow and spatio temporal filter methods [9].

Sujata G. Bhele et al. made an attempt to review a wide range of methods used for face recognition comprehensively. This include PCA, LDA, ICA, SVM, Gabor wavelet, Soft computing tool like ANN for recognition and various hybrid combination of this techniques. New face recognition method based on PCA, LDA and neural network consists of four steps as 1) Pre-processing 2) Dimension reduction using PCA 3) Feature extraction using LDA 4) Classification using NN. Algorithm has to evolve using hybrid methods of soft computing tools such as ANN, SOM, and SVM may yield better performance [10].

Yao Jiunn chen et al., presented algorithm for rapid and accurate face cetection. This algorithm detects human face by geometric corelation between location of faces and hairs. The algorithm takes the advantages not only of geometric relations between a human faces and hair, but also a precise skin colour extraction. The face detection accomplished ragardless of the viewpoints no matter it is a front view. For instance, detection error may occure if anything other than human faces but skin colour stayed in the image [11].

Xi Zhao et al., presented a video based counting approach based on face detection, tracking and trajectory classification. The face detector allows to assure that the counted objects are only people. The Kalman filter with Kernel based object tracking algorithm uesd to handle face occlusions. The system also proposed a strategy to count people by automatically classify face tracjectories, which are characterized by an angle histogram of neighbouring points [12].

GUAN-CHUN LUH presents a human face detection scheme by combining a novel hybrid color models and Viola-Jones face detector. A hybrid skin color model RGB-CbCrCg was developed for classifying skin and non-skin pixels. There are three primary steps for color-based skin

detection in an image: representing the image pixels in a suitable color space, modeling the skin and non-skin pixels using an appropriate distribution and classifying the modeled distributions.The extraction of skin region is carried out using a set of bounding rules optimized employing multi-objective differential evolution method. Next step is segmentation in which the face region are identified using Viola-Jones algorithm. The evaluation of performance for skin and face detection is done using ECU face and ski database [13].

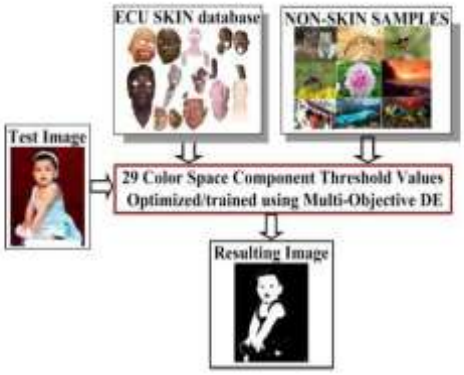

Figure 1:The schematic diagram for skin detection employing MODE [13].

Boby George et al. proposed a simple and efficient seat occupancy detection scheme based on a capacitive sensing principle. Parameters such as presence, position and type of seat occupant are essential for successful airbag control in vehicles. In the absence of such information, on an accident, the airbag may be inflated to a vacant seat leading to its wastage and hence the associated repair and reinstallation. Also, if moved, it can cause fatal injuries to infants in rear-facing infant seats. The capacitive sensor system that is proposed detects presence of an occupant and provides information about the occupant position. The developed system takes 200 ps to complete a full set of measurements hence promises dynamic operation of the air bag system. The presented method employs a carrier frequency method and lock-in-amplifier technique to measure the capacitances. So as, the influence of external electromagnetic fields on the final result is minimal. A prototype capacitive sensing system has been developed and installed on an automobile seat. Transmitting electrodes, 10 cm in length and 5 cm in width, were fabricated using 100 micron thick copper plates. Receiver electrode was made iden- tical to the transmitter segment. Transmitter and receiver electrodes were stitched to a cotton cloth material and placed on sitting and back rest areas of the seat as shown in Figure 2. A prototype capacitance measurement system has been developed using a capacitance-to-digital converter IC implemented in a 0.25 ,um CMOS technology[14].

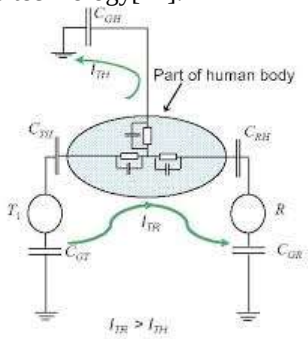

Figure 2: Capacitances CTH and CRH are larger than CGH when human body is very close to the sensor vicinity. In this condition, coupling effect is more dominant than the shielding effect [14].

John Canny described a computational approach for edge detection. Also it defined detection and localization criteria for a class of edges in mathematical form to find optimal operators for roof and ridge edges. Then the third criterion is added to ensure that the detector has only one response to a single edge. A detector proposed which used adaptive thresholding with hysteresis to eliminate streaking of edge contours. A general method called 'feature syntheses used for the fine-to-coarse integration of information from operators at different scales [15].

K. Sreedhar et al. develop a method to enhance the poor contrast and detect the background of an image. To solve an optimization problem a methodology is used that maximizes the average local contrast of an image. Morphological transformation (opening by reconstruction, erosion –dilation method) and block analysis is used to detect the background of gray level and color images. The basic idea is to select a set of training images, next a Gaussian mixture model for the color distribution in the face region is built, and for any given input image, a color tone mapping is performed so that the color statistics in the face region matches the training examples [16].

Facial expression is one of the most powerful and immediate means for humans to communicate their emotions, cognitive states, intensions and opinions to each other. Different techniques available for face detection can be broadly classified into four categories: Knowledge based, feature invariant based, template based and appearance based. For analysis they have used five most commonly used image scaling algorithms. These are Nearest Neighbor, Bi- Linear, Bi-Cubic, Extended Linear, and Piece-Wise Extended Linear image scaling algorithm. Nearest neighbor is the simplest interpolation from a computational standpoint, where each interpolated output pixel is assigned the value of the nearest sample point in the input image. In Bi-linear interpolation each output image pixel is computed by two linear interpolations done on 2x2 image window in order to find out the target pixel location which reduces the blocking and blurring effect. In Bi-cubic interpolation the target pixel is computed by 2-D interpolation using 4x4 neighboring pixels. Extended linear use 16 weighted coefficients which are generated from 16 neighboring pixels input image to calculate the value of the target pixel. Piece-Wise Extended Linear Interpolation uses 4 piecewise linear function to calculate the value of the target pixel. The results are obtained using all scaling algorithm and after comparison Piece-wise extended linear image scaling technique gave the best result compared to all other algorithms [17].

Cyrel O.Manlises et al. composed a system for studying the traffic light for pedestrian that wants to cross the street. System includes the hardware such as web camera which is connected to raspberry pi module to capture the images, raspberry pi analyses the captured image. Gizduino was programmed with the traffic light system If the face is found, it played the recorded voice and sent a signal to the Gizduino. If the pedestrian cross the street they press the button and wait for traffic light. If CCTV detects the face of pedestrian, the system will set the red light to show for 45 second. On the other hand if CCTV does not detect the face, the red light will show for only 30 second. The system can detect a pedestrian's body and face at success rate of 87.33% [18].

III. SYSTEM OVERVIEW

The devices that include webcam, microcontroller model, and 3G module are installed in vehicle at the top-front of the vehicle. When the vehicle leaves from the station, the system will capture the image in the passenger seat area (1 image per 1 second) and send to the server. The server processes the images that receive from microcontroller in vehicle by using Open Source Computer Vision (OpenCV).

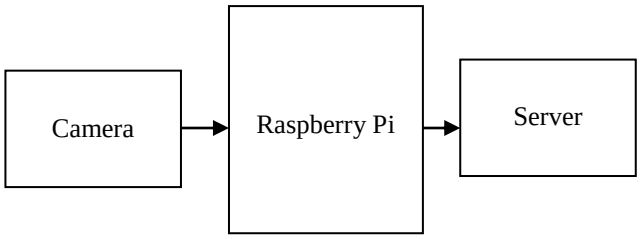

Figure 3: Block diagram of proposed system

The implementation of the entire system is done in three steps i.e. face detection algorithm (Viola –Jones algorithm):

- Haar features
- Integral image
- Classification

The algorithms proposed focuses on the frontal human faces. For humans, it's not a difficult task to do as they know how a face looks like for their brain has been collecting data since childhood. But for machines on the other hand, it's a lot difficult task. Also, the difficulty arises due to exaggerated facial expressions, visual variations in images, large area to find face in, etc. Machines work on the instructions given by the user it needs specific and clear instructions as what to do. Differentiating a face from a given image is a challenging task and in order to accomplish it we need to train machines. Given a digital image, it needs to find faces in it. Viola Jones is a framework for detecting faces proposed by Paul Viola and Michael Jones in 2001. Viola-Jones detector which is used as face detection algorithm because it has advantages of high detection rate, and its ability to run in real time. Detector works efficiently on frontal images of faces and it can cope with 45° face rotation both around the vertical and horizontal axis.

IV. CONCLUSION

The objective of this system was to detect the faces which are being achieved. When the electric vehicle leave from the station, webcam captured the images and send to the server by using Raspberry Pi and Websocket protocol. The images were sent completely. This system can give the accuracy of 80%. As system is based on real-time, the count is continuously changing so we can assure that we can obtain better accuracy by capturing the continuous images. This system improves the quality of images with the help of contrast limited adaptive histogram equalization giving the enhanced image. This system can also be used in many applications such as to count the number of students present in a classroom, hall and auditorium.

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