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Design and Development of System for Identification of Vehicle Seat Vacancy

G. S. Gawande[1], K. O. Gurbani[2*], A. N. Dolas[3]

[1,2,3]Department of E and TC Engineering, SSGMCE, Shegaon, Maharashtra, India

**Corresponding Author: khushbugurbani@gmail.com*

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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.

Keywords**—** Raspberry Pi, PI Camera, Haar Features, Contrast Limited Adaptive Histogram Equalization, 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, a processing speed that is insufficient 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 are using 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, the seat vacancy identification system is designed by using image processing technique. 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 using websocket protocol. This system use Open Source Computer Vision (Open CV) to analyze and process the data then calculate 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. It also 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 a simple task, there are some situations difficult to solve even with today's computer speeds (the algorithm has to operate in real-time so it makes 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:

1. Collect the information of the number of passengers travelling in the vehicle.
2. Control the ticket malfunctioning problem.
3. If passengers know both of the position of passenger vehicle & vacancy of seats, customer can plan their travel better.
4. 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].

III. METHODOLOGY

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

- Haar features
- Integral image
- SVM Classification

Haar Features:
The Haar feature applied to the face the sum of black pixel and sum of white pixel are calculated and they are subtracted to get a single value. If this value is more in that region, then it represent a part of the face and is identified as eyes, nose, cheek etc. Haar features are calculated all over the image which will be almost 160000+ features per image.

Figure 1. Relevant features with Haar features

Summing up the entire image pixel and then subtracting them to get a single value is not efficient in real time applications. This scaling of the pixels makes it possible to detect and extract objects with varying sizes.

Integral image:
This principle is very well known in the study of multi-dimensional probability distribution functions, namely in computing 2D (or ND) probabilities (area under the probability distribution) from the respective cumulative distribution functions

$$II(y,x) = \sum_{p=0}^{y}\sum_{q=0}^{x} Y(p,q)$$

The integral image allows integrals for the Haar extractors to be calculated by adding only four numbers. For example, the image integral of area ABCD (Fig.2) is calculated as

$$II(yA,xA) - II(yB,xB) - II(yC,xC) + II(yD,xD)$$

The sum of the pixels within rectangle D can be computed with four array references. The value of the integral image at location 1 is the sum of the pixels in rectangle A. The value at location 2 is A + B, at location 3 is A + C, and at location 4 is A + B + C + D. The sum within D can be computed as (4 + 1) − (2 + 3).A two-rectangle feature can be computed in six array references – for any scale

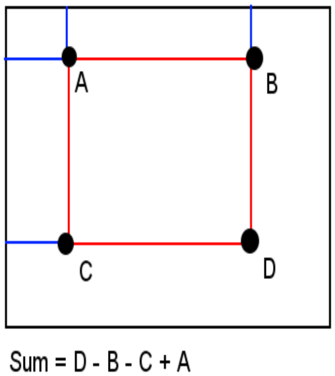


Figure 2. Integral image

Support Vector Machine Classifier:
The illustration in below figure 3 shows the basic idea behind Support Vector Machines. Here we see the original objects (left side of the schematic) mapped, i.e., rearranged, using a set of mathematical functions, known as kernels. The process of rearranging the objects is known as mapping (transformation). Note that in this new setting, the mapped objects (right side of the schematic) is linearly separable and, thus, instead of constructing the complex curve (left schematic), all we have to do is to find an optimal line that can separate the GREEN and the RED objects.

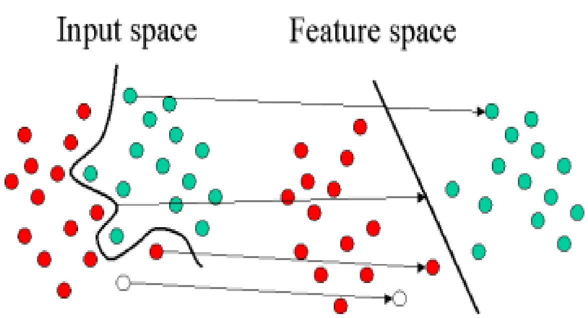


Figure 3. SVM classifier

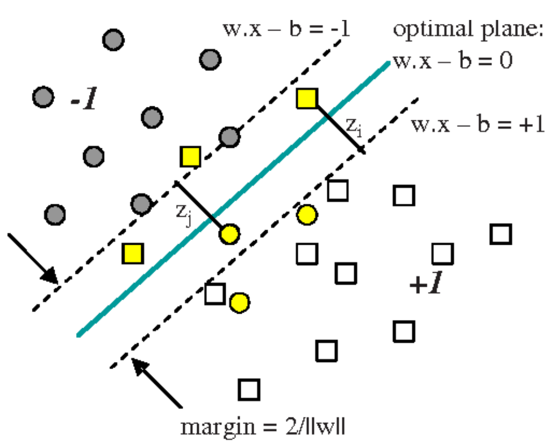


Figure 4. SVM margin

The principle of Support Vector Machine (SVM) relies on a linear separation in a high dimension feature space where the data have been previously mapped, in order to take into account the eventual non-linearity's of the problem. Support Vector Machines are based on the concept of decision planes that define decision boundaries. A decision plane is one that separates between a set of objects having different class membership. In logistic regression, we take the output of the linear function and squash the value within the range of [0,1] using the sigmoid function. If the squashed value is greater than a threshold value (0.5) we assign it a label 1, else we assign it a label 0. In SVM, we take the output of the linear function and if that output is greater than 1, we identify it with one class and if the output is -1, we identify is with another class. Since the threshold values are changed to 1 and -1 in SVM, we obtain this reinforcement range of values ([-1, 1]) which acts as margin.

The algorithm for classification consists of the following steps:

Given a trained cascade of classifiers, where F is the false positive rate of the cascaded classifier, fi is the false positive rate of the ith classifier. Selects target overall false positive rate as Ftarget, and n is the number of features of each stage.

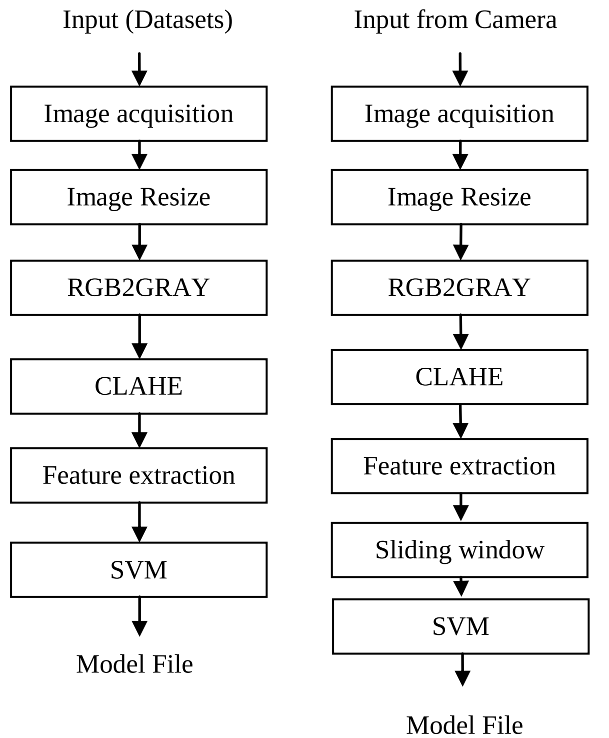
Step 1: F0 = 1
Step 2: i = 0
Step 3: While Fi > Ftarget and i < nstages
i = i + 1
Step 4: Train Classifier for stage i
- Initialize Weights
- Normalize Weights
- Pick the (next) best weak classifier
- Update Weights

Step 5: Evaluate fi
- if fi > f
- Go back to Normalize Weight
- Combine weak classifier to form a strong stage classifier

Step 6: Evaluate fi and repeat the step 5 until the strong classifier is built.

IV. EXPERIMENTAL FLOWCHARTS

Figure 5a and 5b illustrate the flowchart for training and testing mode in which different pre-processing and post-processing steps are involved. Figure 6 demonstrate the overall all process to identify the face.



a) b)

Figure 5. a) Flowchart of the Training Mode b) Flowchart of the Testing Mode

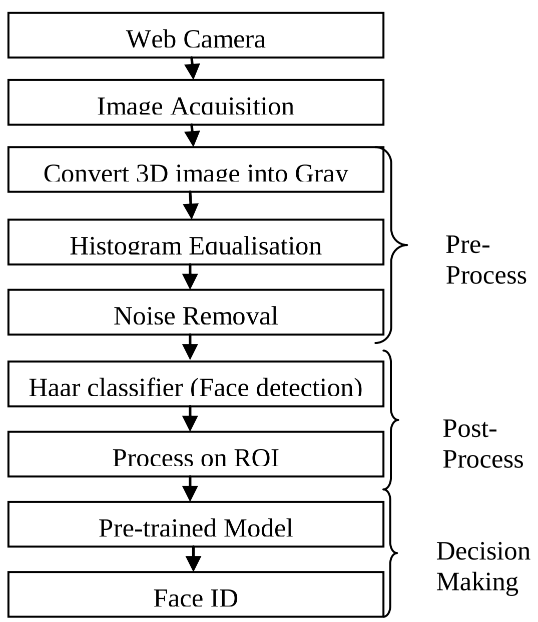


Figure 6. Overall Process Flowchart

V. EXPERIMENTAL RESULTS

It is very much essential to test the images with different conditions. The results are taken as to detect faces such as in night vision, group images, images by wearing hat, goggle, stole, etc. If a person is sleeping in a vehicle so that faces are detected or not it is also checked. Taking into account all the above conditions the images are tested and the results are obtained.

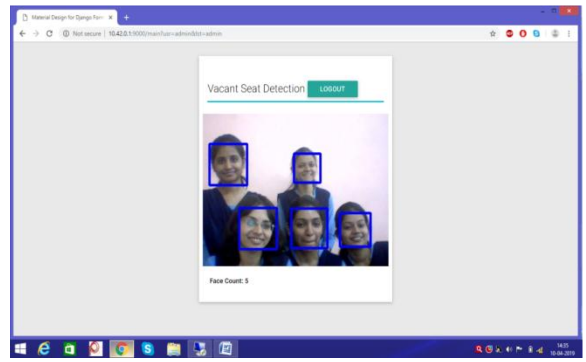


Figure 7. Group Image

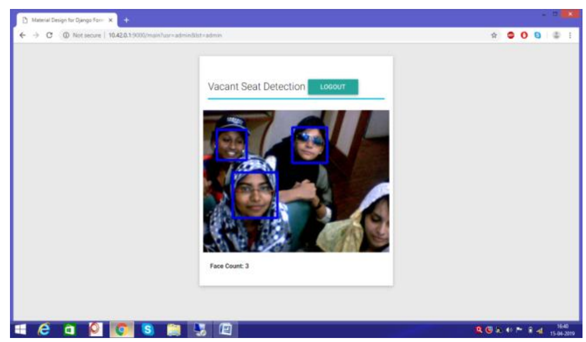


Figure 8. Image with Goggle and Hat

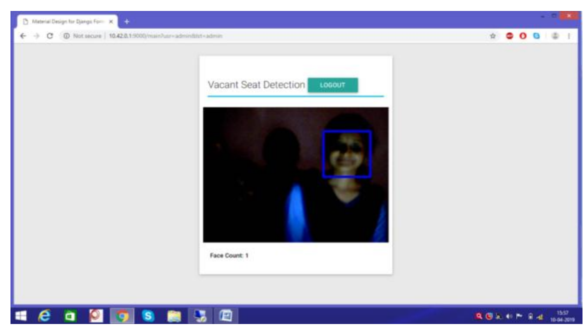


Figure 9. Image with Night Vision

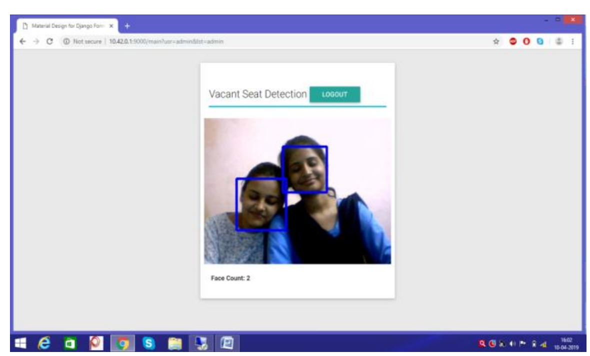


Figure 9. Sleepy Faces

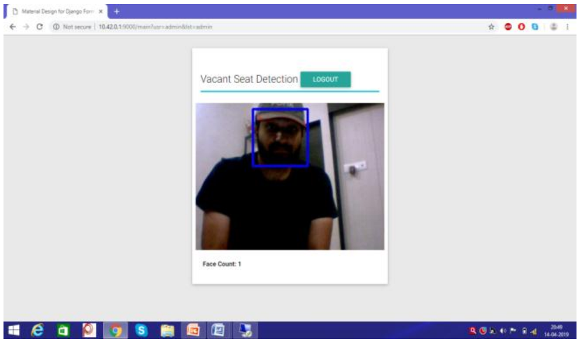


Figure 11. Image With a Hat

Figure 7 illustrate that person sitting in a group all the faces are detected and the count is displayed as 5. Figure 8 shows the group image in which person is wearing the google, hat and stole, there are 4 person and the 3 faces are detected. Figure 9 demonstrate the night vision click, and the girl face is detected. Figure 10 illustrate the two girls having sleepy faces and both the faces are detected. Figure 11 shows a man wearing hat and his face is detected.

VI. CONCLUSION AND FUTURE SCOPE

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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Authors Profile

Dr. Gopal S. Gawande received his Master of Engineering and Ph.D. from Sant Gadge Baba Amravati University, Amravati, India. He is currently working as Head of Department and Professor in Department of Electronics and Telecommunication Engineering at Shri Sant Gajanan Maharaj College of Engineering, Shegaon, India. His research intersets include VLSI and Digital Signal Processing.

Ms. Khushbu O. Gurbani is a student of Master of Engineering in Digital Electronics of Shri Sant Gajanan Maharaj College of Engineering, Shegaon. She received her Bachelor of Engineering from Shri Sant Gajanan Maharaj College of Engineering, Shegaon. Her areas of interest are Digital Electronics, Digital image Processing and Embedded systems.

Mr. Amit N. Dolas completed his Master of Engineering from Shri Sant Gajanan Maharaj College of Engineering, Shegaon and currently pursuing his PH.D. in Electronics Engineering from Sant Gadge Baba Amravati University, Amravati, India. He is currently an Assistant professor in SSGMCE College of Engineering, Shegaon. His research interests include Robotics & automation , Signal & Image Processing

