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Face Recognition and Counting using Raspberry Pi with IOT

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***Abstract*— The work is this paper is focused on Face Recognition and Counting by using Raspberry Pi. To count the number of people in a selected area and recognition of faces to avoid duplicates is the main feature of the presented work.**

***Keywords*—** *Customer interest, people counting, OpenCV, raspberry pi, Face recognition.*

1. INTRODUCTION

The problem arises when customer interest needs to be calculated and quantified. One should focus on customer interest to increase the marketing level so that the customers target can be reached by revised marketing scheme. In this issue there are two major engineering aspects which need to be identified and described, namely Customer's interest and counting. Embedded system is the main objective of this work that allows possibility and simplicity of implementation and deployment.

2. RELATED WORKS

The research in the presented work is computer-vision based

A. Face detection

From the business viewpoint the customer interest raises the issue in terms of description and quantification. From this the product failure can be minimized [1]. Using Finite State Machine, the real time analysis of customer behaviour is carried out [2].

B. People counting

Computer vision based methodology is used for people counting. In terms of scale there are two types. Large scale and Small scale counting. Large scale counting estimates the number of people within the area [4]. The challenge arises when there is high density crowd including dynamic crowd motion [5] and background interference [6]. Small scale people counting are carried out within a group or store using various technologies. These technologies varied from senor-based system to vision-based system. People counting systems are in three main categories namely, Contact-type, System using sensors and Vision-based system using cameras [7]. The drawback is that it is difficult to differentiate people and their motion. In vision based more implementations can be done when compared with the sensor based system. We can keep track of people [9], their moments can be studied [10] and their interaction can also be studied [7]. Matching a face against a set of known faces is referred to as "Face Recognition". Finding a face in an image is referred to as "Face Detection" [11]. To detect the face any of these cascade classifiers need to be used and they are HAAR like feature and Local Binary Pattern (LBP) [12].

3. SYSTEM IMPLEMENTATION

Because of self-contained and low cost the system is designed using raspberry pi. The required accessory for this work is a Pi camera, which is %M sensor resolution. the model used in the present work is Raspberry pi 3 model B which has 1GB LPDDR2-900 SDRAM memory, 400MHz Video Core IV multimedia, Quad-core 64-bit ARM Cortex A53 clocked at 1.2 GHz and 4 USB ports.

Fig 1. Customer's point of view

Fig 2. Raspberry point of view

The software is written into the Raspberry Pi and Pi camera in such a way that it counts the number of people who comes and check the product. But if the same person comes for the second time and check the product then the count will be done for second time. So this will raise inappropriate count. Then next level is proceeded which is "Face Recognition". This process is available in OpenCV through which we will get the exact count without duplicates.

3.1 STEPS FOR FACE RECOGNITION

1. Grab a frame from the camera.
2. Convert the color frame to grayscale.
3. Detect a face within the greyscale camera frame.
4. Crop the frame to just show the face region (using cvSetImageROI() and cvCopyImage()).
5. Preprocess the face image.
6. Recognize the person in the image.

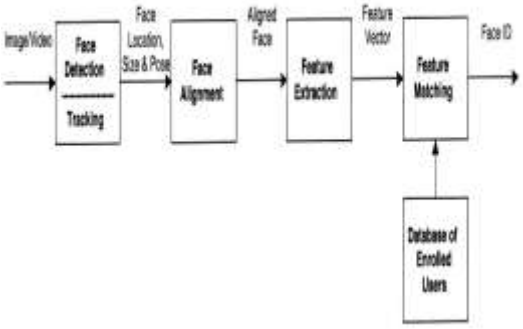


Fig 3. Process of Face Recognition

3.1.1. VIOLA JONES ALGORITHM FOR FACE DETECTION

Fig 4. Flowchart of algorithm

The Viola-Jones algorithm is commonly used object detection method. This algorithm's main property is that training is slow, but fast detection. This algorithm uses feature filters dependent on Haar, so multiplications are not used.
Although it can be trained to detect a variety of object classes, it was motivated primarily by the problem of face detection. This algorithm is implemented in OpenCV as cvHAARDetectObjects().

The characteristics of Viola–Jones algorithm which make it a good detection algorithm are:

i. Robust: very high detection rate (true-positive rate) & very low false-positive rate always.

ii. Real time: For practical applications at least 2 frames per second must be processed.

iii. Face detection only (not recognition): The goal is to distinguish faces from non-faces (detection is the first step in the recognition process).

The algorithm has four stages:

1. Haar Feature Selection
2. Creating an Integral Image
3. Ada boost Training
4. Cascading Classifiers

3.1.2. HAAR FEATURES

There are some similar properties in all human face s. Using hair characteristics, these regularities can be balan ed.

A few human like properties are

i. The eye vicinity is darker than the top-cheeks.

ii. The nose bridge location is brighter than the eyes.

iii. Composition of properties forming matchable facial features

iv. Location and size of eyes, mouth and bridge of nose

v. Oriented gradients of pixel intensities values.

The four features matched by this algorithm are then sought in the image of a face (shown at left). The difference between the sums of pixels of areas inside the rectangle is defined as the simple Haar-like feature.

Value = Σ (pixels in black area) - Σ (pixels in white area). There are three types namely, two-, three-, four- rectangles in which Viola-Jone used two-rectangle features. Each function is related to a special location in the sub- window.

Fig 5. HAAR Features

Viola-Jones set of rules makes use of a 24x24 window because the base window size to start evaluating those capabilities in any given image.

If we consider all possible haar features the parameters such as scale, size and type we end up in this window measuring of about 160,000+ characteristics.

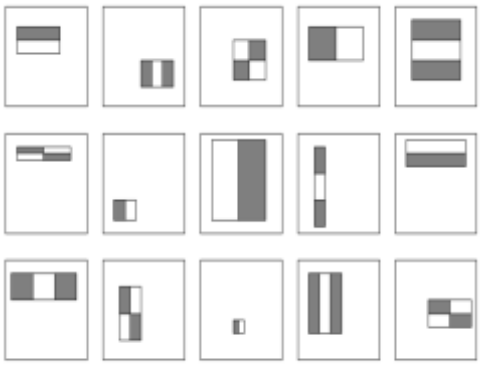


Fig 6: Measured result using Haar-feature

3.1.3 INTEGRAL IMAGE

Since it is clear that huge number of these rectangular haar features have to be evaluated each time Viola Jones have come up with a neat technique to reduce the computation rather than summing up all pixel values under the black and white rectangles every time.

They have introduced the concept of integral image to find the sum of all pixels under a rectangle with just 4 corner values of the integral image.

In an integral image the value at pixel (x,y) is the sum of pixels above and to the left of (x,y)

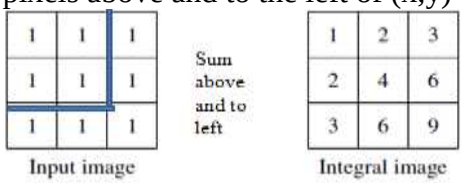


Fig 7. Integral image

Integral image allows for the calculation of sum of all pixels inside any given rectangle using only four values at the corners of the rectangle.

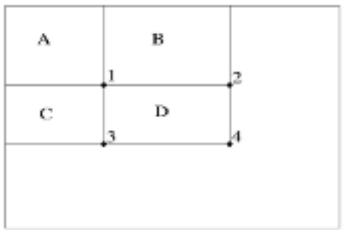


Fig 8. Integral image calculation

Sum of all pixels in
D = 1+4-(2+3)
= A+(A+B+C+D)-(A+C+A+B)
= D

3.1.4 ADABOOST TRAINING

AdaBoost algorithm is used to train node classifiers on a Haar-like feature set to improve the generalization ability of the node classifier.

As previously stated, ina 24X24 base resolution detector, there may be approximately 160.000+feature values that need to measured. But it must be recognized that among all these, only a few set of features will be useful in recognizing a face.

Fig 9. All features

Adaboost is an algorithm for machine learning that helps to find only best features among all these features of 160,000+charecteristics. After these features a weighted combination of this entire feature is found to be used to determine and assess whether or not any window has a face.
Each of the selected features is considered good if they can perform better at least than random guessing (detects more than half of the cases).
Such features are also referred to as weak classifiers. As a linear combination of these weak classifiers, Adaboost constructs solid classifiers.

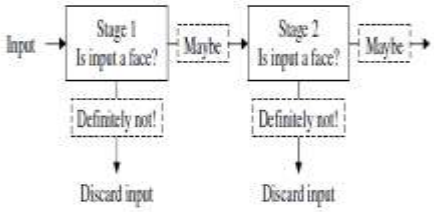
$$F(x) = \alpha_1 f_1(x) + \alpha_2 f_2(x) + \alpha_3 f_3(x) + \ldots$$

Strong classifier Weak classifier

3.1.5 CASCADING CLASSIFIERS

A cascade classifier is used which is composed of stages each containing a strong classifier. So all the features are grouped into several stages where each stage has certain number of features.

The job of each stage is used to determine whether a given sub window is definitely not a face or may be a face. A given sub window is immediately discarded as not a face if it fails in any of the stage.



4. EXPERIMENATL RESULTS

Fig 10: Face Detection and recognisation of staff

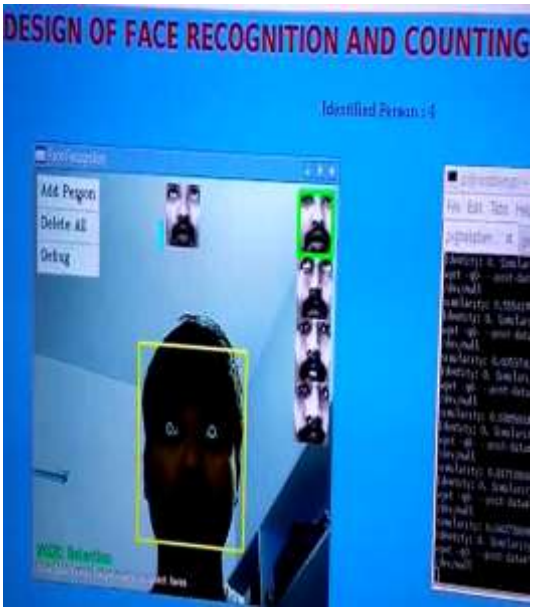


Fig11: Face Detection and recognisation of customers

Fig 12: Backend of Face Detection and recognisation of customers

5. CONCLUSION

The counter of system wil start when the person who comes to check the product is neither staff nor the same old customer in the database.

The limitation of reference praper has been identify and overcome with minimum distance of 50cm that will guarantee 90% accuracy become a limit to our system in terms of proximity of customer**.** This Module that suited for the task of counting customer.

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