Feature Based Face Recognition for Identification of Persons using Raspberry PI

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Abstract-Detecting human beings accurately in a visual surveillance system is crucial for diverse application areas including abnormal event detection, human gait characterization, congestion analysis, person identification, gender classification and fall detection for elderly people. The first step of the detection process is to detect an object which is in motion. Object detection could be performed using background subtraction, filtering and feature extraction techniques. Once detected, object could be classified as a human being using shape-based, texture-based or motion-based features. A comprehensive review with comparisons on available techniques for detecting human beings in surveillance videos is presented . The characteristics of few benchmark datasets as well as the future research directions on human detection have also been discussed.

Keywords: Face recognition, face detection, Haar Detection, Raspberry Pi Module, Histogram Equalization, local binary pattern, ROI extraction.

I. INTRODUCTION

People Counting is a crucial and tough problem in visual surveillance. Vision-based real-time people counting comprises all techniques, which are able to extract the number of people who are present in an observed area of the real world, and which satisfy certain constraints of accuracy and performance. In recent years, this field has seen many advances, but the solutions have certain limitations, that people must be moving, the background should be simple, or the image resolution has to be high. However, real scenes always include both moving and still human beings, the background may be complex, and most videos in a computer vision system have a relatively low resolution. Occlusions exist everywhere with people walking, sitting, and standing. The video was taken by a static camera overlooking a large area. This scene is very common, but few results have ever been verified for such events. People counting has implications for safety, and allows to collect information about systems which can be used to recognize patterns in traffic by hours, optimize scheduling work, monitor the usefulness of events, and other applications.

Problems encountered in people tracking and counting:

The people counting model is composed of four subsystems (Background Process, Segmentation, Tracking and Counting). The major challenges of people counting involve background estimation, background subtraction, segmentation and tracking. Problems encountered in the above factors of people counting are explained below.

Background Model:

Background subtraction–Object detection can be achieved by building a representation of the scene called the background model, and then the decision deviates from the model for each incoming frame. Any important change in an image region from the background model signifies a moving object.

While tracking one person in a stationary background may be relatively simple, the problem becomes very complicated with many people. They may be crossing in front of each other, behind occlusions, through different lighting, with shadows, and in groups.

Occlusion Problem:

A large number of objects lead to some objects being fully visible and, many objects partly visible due to occlusions from other objects. The problem of detection and tracking partially visible or hidden objects becomes really challenging. The camera is not fixed and there is a lot of camera shake, which further increases the complexity of the problem. The poor resolution of the video also compounds the detection problem.

Blob Analysis:

Blob tracking may be easy and fast, but it does not work normally, particularly with people moving in groups. A number of candidate algorithms (Jeyakar et al 2007) claim to be capable of differentiating people in groups. People coming from grocery stores or other similar shops often push trolleys ahead of them. These trolleys are typically of an identical size as a human being. This makes splitting blobs by height or width a hard task, as it must take movement into account; it is hard to see if the blob is real or collected from many people. It becomes impossible to detect that in busy areas. Still, huge area blobs are expected to be groups of either people or something else that is moving. People standing in groups are tough to compact with, even for the human eye. When they stand close mutually or hold hands, they appear as one big blob

Lighting Conditions and Noise:

The first frame on the video should have a static background; apply that frame as a base frame and judge against the real video frames against this base frame. It is hard to believe that static background frames with similar lighting conditions for day, night and noon might be obtained. Light is limited according to the seasons and non-natural lighting conditions; so a more composite approach is needed.The image still contains a lot of noise and requires further processing. The subtracted resulting frame gives a pretty good approximation of the information. Noise should be eliminated in order to avoid its interference with the blob detection algorithm.

Colour Classification:

An object can be segmented based on its colour in RGB or HSV space. This is ideal if the object colour is distinct from the background. An object can also be recognized or classified based on its colour. In the given video sequence, object colours are not distinct as they take a large range of colours. Object recognition based on colour would work for some objects, like rickshaws having a distinct yellow colour, but would fail for cars that can take several colours.

Edge-based– Object Boundaries:

Edge-based– Object boundaries generally produce strong changes in image intensities. Edge detection is used to recognize these changes. A main property of edges is that, they are less sensitive to illumination changes compared to colour features. Algorithms that follow the boundary of the things generally use edges as the diplomat feature. This technique is not suitable when there are numerous cluttered objects in a frame.

Different Gray Levels and Image Quality:

These issues imposed problems specially for image segmentation and binarization techniques, where the foreground image is represented as black, and the background is white. They give high false alarms for images with high noise and uneven illumination. Although most images with a simple background and high contrast can be correctly localized and extracted, images with low resolution and complex background will be difficult to extract. Most digital images and videos are generally stored, processed and transmitted in a compressed form.

II. RelatedWorks

Many of the techniques of digital image processing, or digital picture processing as it often was called, were developed in the 1960s at the Jet Propulsion Laboratory, Massachusetts Institute of Technology, Bell Laboratories, University of Maryland. A few researches such as *application* to satellite images, wire-photo standards conversion, medical imaging, videophone, character recognition, and photograph enhancement were also carried out[1].SuezouNakadate*et al* [2] discussed the use of digital image processing techniques for electronic speckle pattern interferometry. A digital TV-image processing system with a large frame memory allows them to perform precise and flexible operations such as subtraction, summation, and level slicing. Digital image processing techniques made it easy compared with analog techniques to generate high contrast fringes.

SatoshiKawata*et al* [3] discussed the characteristics of the iterative image-restoration method modified by the reblurring procedure through an analysis in frequency space. An iterative method for solving simultaneous linear equations for image restoration has an inherent problem of convergence. The introduction of the procedure called “reblur” solved this convergence problem. This reblurring procedure also served to suppress noise amplification. Two-dimensional simulations using this method indicated that a noisy image degraded by linear motion can be well restored without noticeable noise amplification.

William H [4] highlighted the progress in the image processing and analysis of digital images during the past ten years. The topics included digitization and coding, filtering, enhancement, and restoration, reconstruction from projections, hardware and software, feature detection, matching, segmentation, texture and shape analysis, and pattern recognition and scene analysis.

David W. Robinson [5] presented the application of a general-purpose image-processing computer system to automatic fringe analysis. Three areas of application were examined where the use of a system based on a random access frame store has enabled a processing algorithm to be developed to suit a specific problem. Furthermore, it enabled automatic analysis to be performed with complex and noisy data. The applications considered were strain measurement by speckle interferometry, position location in three axes, and fault detection in holographic nondestructive testing. A brief description of each problem is presented, followed by a description of the processing algorithm, results, and timings.

S V Ahmed [6] discussed the work prepared by concentrating upon the simulation and image processing aspects in the transmission of data over the subscriber lines for the development of an image processing system for eye statistics from eye .P K Sahoo*et al* [7] presented a survey of thresholding techniques and updated the earlier survey work. An attempt was made to evaluate the performance of some automatic global thresholding methods using the criterion functions such as uniformity and shape measures. The evaluation was based on some real world images.

MarcAntonini*et al* [8] proposed a new scheme for image compression taking psycho-visual features in to account both in the space and frequency domains. This new method involved two steps. First, a wavelet transform in order to obtain a set of bi orthogonal subclasses of images; the original image is decomposed at different scales using a yramidal algorithm architecture. Second, according to Shannon's rate distortion theory, the wavelet coefficients are vector quantized using a multi resolution codebook. Furthermore, to encode the wavelet coefficients, a noise shaping bit allocation procedure was proposed which assumes that details at high resolution are less visible to the human eye. Finally, in order to allow the receiver to recognize a picture as quickly as possible at minimum cost, a progressive transmission scheme was presented. It is showed that the wavelet transform is particularly well adapted to progressive transmission.

Harpen MD [9] presented a wavelet theory geared specifically for the radiological physicist. As a result, the radiological physicist can expect to be confronted with elementsof wavelet theory as diagnostic radiology advances into teleradiology, PACS, and computer aided feature extraction and diagnosis.

III. Methodology:

The proposed system consists of both hardware units and software. A general block diagram of the system is as shown below

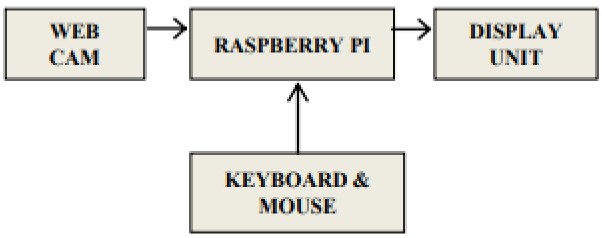

Fig.1. Block diagram of the proposed system

Hardware structure

The Raspberry Pi is the heart of the system. We make use of a Model B Raspberry Pi which has a size specification as 85.60 mm × 53.98 mm (3.370 in ×2.125 in), and around 15 mm deep. It has a 512 MB built in RAM and operates at 700MHz. It has 2 USB ports and an Ethernet port.

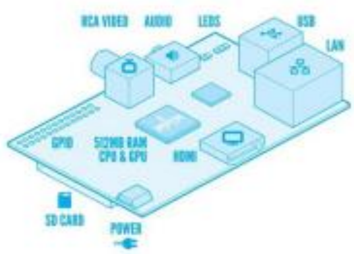

Fig. 2.Raspberry Pi Model B

Raspberry pi

The **Raspberry Pi** is a credit card sized single-board computer developed in the UK by the Raspberry Pi Foundation with the intention of stimulating the teaching of basic computer science in schools. Raspberry Pi contains a comprehensive amount of features packed in a very reasonable price. Raspberry Pi is constructed for Broadcom's BCM2835 system around the circuit, which includes a 700 MHz ARM11 family processor and include 250 MHz clock -frequency Broadcom's Video Graphics Core IV. Memory B-model is 512 MB, and it is divided into the graphics card.

Raspberry pi Camera

The camera module used in this project is Raspberry PI NOIR (No IR) CAMERA BOARD as shown in the Figure 6.3 The camera plugs directly into the Camera Serial Interface (CSI)**connector on the Raspberry Pi. It's able to deliver clear 5MP resolution image, or 1080p HD**video recording at 30fps.

The module attaches to Raspberry Pi, by way of a 15 pin Ribbon Cable, to the dedicated 15 pin MIPI CSI, which was designed especially for interfacing to cameras. The CSI bus is capable of extremely high data rates, and it exclusively carries pixel data to the BCM2835 processor.

The system is programmed using Python programming language.We have developed three algorithms, for face detection from a given image, from a folder of images and for real time face detection.

A. Face detection from a given image Histogram equalization is done on the input image. Haar classifier is used for image calculation process and once face is detected, a red bounding box is drawn on the detected face. Detected face and sub faces are saved and time taken for detection is printed.

B. Face detection from a folder of images After Histogram equalization of the given image, Haar classifier is again used for image calculation process. The difference from the first algorithm is that in addition to saving the detected face to a specified folder, the algorithm also checks if each image belongs to the source directory. If yes, the current file is named as a valid image with the file name. Otherwise, the file is named as an invalid image.

C. Real time face detection Video is captured real time using the webcam. As long as a face is detected, a red bounding box is drawn and the video is displayed in the output window. The algorithm is efficient enough to detect multiple faces also.

Enabling the camera

1. Open the *raspi-config* tool from the Terminal:
2. sudoraspi-config
3. Select Enable camera and hit Enter
4. then go to Finish and you'll be prompted to reboot.

This camera board which has no infrared filter making it perfect for taking infrared photographs or photographing objects in low light (twilight) conditions.Other features of this camera board are Automatic image control functions Programmable controls for frame rate 32 bytes of embedded one time programmable (OTP) memory and Digital video port (DVP) parallel output interface Excellent.

Take a picture

The following code will take a single picture and save it to 'foo.jpg'.

import time

importpicamera

withpicamera.PiCamera() as camera:

camera.resolution = (1024, 768)

camera.start_preview()

Camera warm-up time time.sleep(2) camera.capture('foo.jpg

Storage (Memory)

The design does not include a built in hard disk or solid state drive, instead relying on an SD card for booting and long term storage. This board is intended to run Linux kernel based operating systems. This Raspberry Pi module has a Samsung class 4 micro SD card preloaded with the official Raspberry Pi NOOBS (New Out of Box Software) package, and a beautifully screen printed Micro SD card adaptor.

Face Recognition Algorithms:

Image Acquirement:

The first step includes procuring an image i.e. receiving an image using the digital camera connected to the computer. These captured images are in RGB format and then processed for the number plate extraction.

Image Pre-Processing:

The image captured by camera needs some pre-processing as it contains an optical system distortion, system noise, lack of exposure or unwanted motion of camera or vehicle etc. which lowers the image quality. Thus, Image preprocessing is conversion from RBG to grayscale. It also removes noise and improves border for correct brightness.

Face Localization:

The initial phase in face localization involves determining the size of the number plate. The algorithm requires determining the rectangular regions in the number plate popularly called as Region of interest (ROI). For this purpose, Sobel vertical edge detection is used to detect that number plate [15].

Face Recognition

Face recognition involves a one-many matching by comparing the image of query face with a database of pre-stored images of faces and find out the identity of query face as shown in Fig. 3.

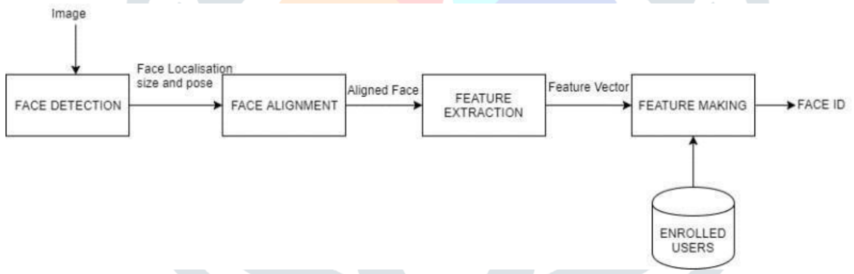

Fig. 3. Steps involved in face recognition

It is a three step process which include detection of face, feature extraction and face classification.

Face Detection: In face detection step (also known as face localization) a raw image is captured and position of face in that image is extracted from the background. Noiseisremovedfromtheimage.Iftheimageistakenincontrolledenvironmentthen simple edge detection technique is sufficient. [18].Initially image was converted into grey scale [19] but now work also being done to recognize faces on the basis of skin color[20].

Feature Extraction: Feature extraction is performed. Instead of directly comparingthequeryfacewiththeimagesoffacesavailableindatabase,wereducethe dimensions of the image and then we compare it with the database. It removes redundant information. It also reduces complexity and computational power. It is done by PCA, LDA or a combination of both the techniques. Eigen faces are generally used in case of face recognition using PCA. After applying PCA, LDA is applied for further dimensionality reduction.

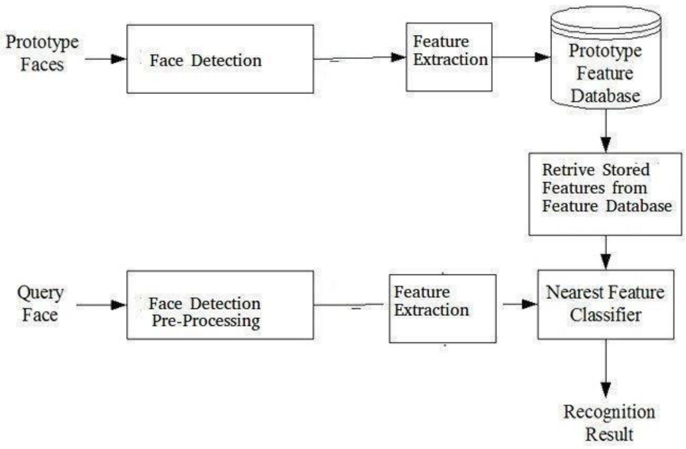

Fig. 4. Feature Extraction in face recognition

Face Classification: In the final step classification is done to obtain a match for the query image of face. The query face is compared with the faces already registered in the database. If the query face matches with any face then that face is the output of this step. It is the classification algorithm used in the final step that decides efficiency of the system. So in our paper we will specifically focus on this.

Different algorithms involved in face recognition:

PRINCIPAL COMPONENTANALYSIS(PCA)

Turk and Pentland first used PCA for recognizing human faces [21]. Eigen face method was used but it doesn't work well in case of poor illumination. Later PCA was combined with Linear Discriminant Analysis (LDA) to improve performance [22]. In [23] a detailed study was presented in which frontal face images were filtered by Gabrol filter and PCA as used to reduce the dimension of filtered feature vectors and then feature extraction was done using LDA.

SUPPORT VECTOR MACHINE(SVM)

They are useful in face recognition. SVM was successfully applied by Vapnik [24]. Main advantage is that it provides better generalization performance over traditional neural network but It cannot be used in case of missing entries in feature space.Forfacerecognition,wewillfollowahybridapproachconsistingofPCA,LDAand ArtificialNeuralNetwork.ThebasicapproachisshowninFig.6below:

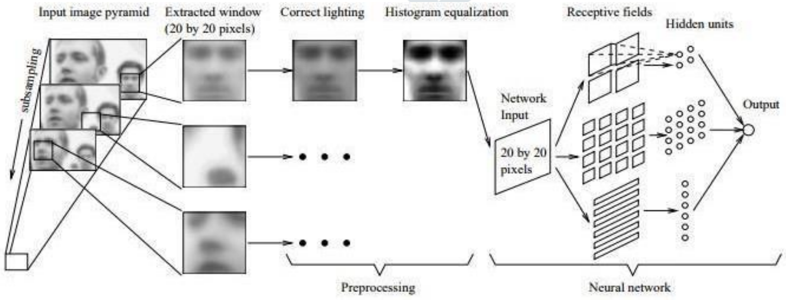

Fig. 6. Face Recognition using Neural Network

Fig. 7 shows the face detection steps.

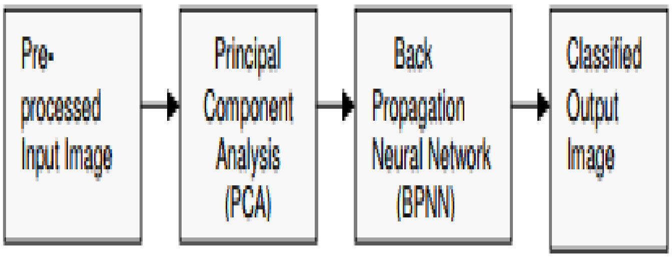

Fig. 7. Process for Face Detection

The final workflow is shown in Fig.8:

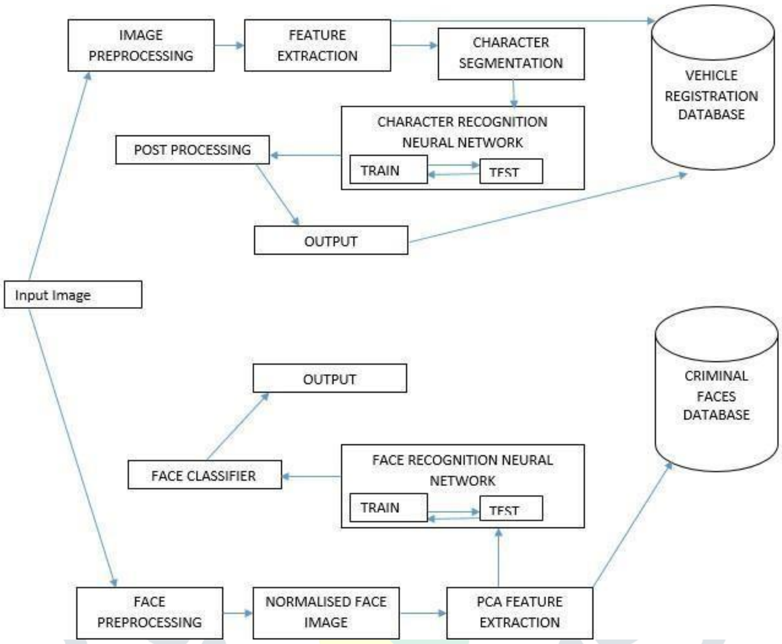

Fig. 8. Flow Diagram for Proposed Method

IV. Conclusion

A face detection system using Raspberry Pi was developed. The system was programmed using Python programming language. Both Real time face detection and face detection from specific images, i.e object recognition, was carried out. The proposed system was tested across various standard face databases with and without noise and blurring effects. The efficiency of the system was analyzed in terms of face detection rate. The analysis revealed that the present system shows excellent performance efficiency and can be used for face detection even from poor quality images.

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