"HUMAN FACE RECOGNITION SYSTEM USING RASPBERRY PI"

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ABSTRACT: ***This research paper presents "Real Time Human Face Recognition System using Raspberry Pi". Face recognition is concerned with finding is there any face in a given image or not and, if it is present, return the image content of each face. With new developing technologies in many applications we have proposed system for human face recognition in real time using Raspberry pi module. In this paper, we propose human face recognition system that will capable of processing images very fast while acquiring very high true positive face detection rate using Raspberry Pi using various classifiers and algorithms. System is based on Raspberry Pi 3 which is uses Haar classifier and Linear Binary Pattern Histogram for extracting various parameters of face for face detection and recognition.***

Keywords: Face Recognition, features extraction, Haar classifier, LBPH (Linear Binary Pattern Histogram), Python Programming Language, Raspberry Pi.

1. INTRODUCTION

In modern digital era, for various kinds of application in many fields various biometric parameters are used. Unlike other biometrics, face recognition is non-invasive, and does not need physical contact of the individual with the system, making it a very acceptable biometric. Object detection is an important feature of now days and in this especially, face detection is becoming common place in many applications, such as face recognition, face tracking, facial feature detection and robotics, etc. Especially face detection and recognition is used for better security. There are various platforms or tools available for image processing such as MATLAB, etc. MATLAB is widely used in image processing but it comes with some limitations e.g. we can't use MATLAB on small portable device it comes with some special system requirements. PC/Laptop is compulsory in case of MATLAB. So to overcome these flaws we use Raspberry Pi on which various image processing techniques such as LBPH (Linear Binary Pattern Histogram), Haar Cascade Classifier using OpenCV for face detection and recognition process. It increases also increases frame rate and the efficiency of system. Different holistic methods such as Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA) and the more recent 2-D PCA have been studied widely but lately also local descriptors have gained attention due to their robustness to challenges such as pose and illumination changes. This paper is descriptor based on local binary pattern texture features extracted from local facial regions. As Raspberry Pi is small portable device so using Raspberry Pi with the help of openCV, we can train image processing classifiers for the detection of human face and comparing detected image features with stored database of the authorized persons. If match found this means detected person is recognized and green bounding box is drawn around recognized face which will be labelled with that person's information and if no match found then detected face then red bounding box is drawn and labelled with Person Not Recognized. This provides us high detection and recognition rate with high accuracy.

2. OBJECTIVES

1) The main objective of this system is to detect and recognize face from captured image or video frame.
2) Using LBPH, Haar Classifier on Low cost portable device like Raspberry Pi for single purpose use we can process and detect face with good positive efficiency at high frame rate.
3) To develop portable system works implementable to any environment at low cost and less complex network.

4) Helps to find an unauthorized person in any campus industry, office, etc.

3. SYSTEM WORKING AND ANALYSIS

Now in this section we will see how this human face recognition system works in brief.

The main base of this system is Raspberry Pi. We uses Raspberry Pi 3 model B which comes with some specifications as in figure 1. On this Raspberry Pi module we have installed Linux OS and Python as systems programming language. Then using Haar Cascade Classifier is trained for human face detection and recognition. LBPH is used for pixel to pixel calculation of image.

	Raspberry Pi 3 Model B
Introduction Date	2/29/2016
SoC	BCM2837
CPU	Quad Cortex A53 @ 1.2GHz
Instruction set	ARMv8-A
GPU	400MHz VideoCore IV
RAM	1GB SDRAM
Storage	micro-SD
Ethernet	10/100
Wireless	802.11n / Bluetooth 4.0
Video Output	HDMI / Composite
Audio Output	HDMI / Headphone
GPIO	40

Figure 1: Raspberry Pi 3 Model B specifications

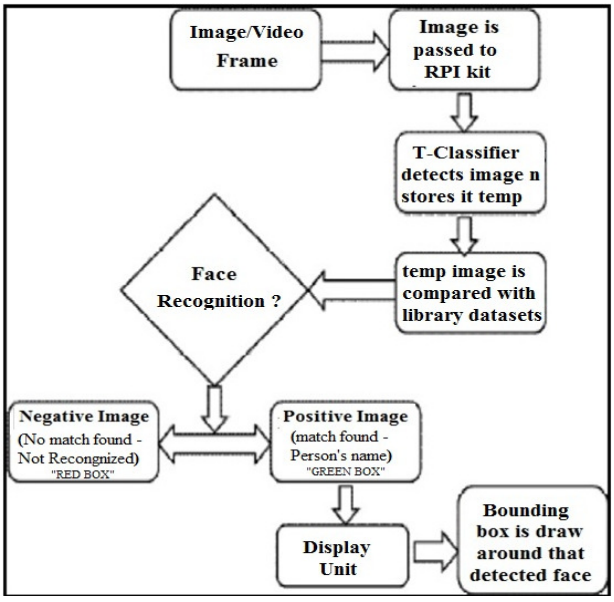


Figure 2: Flowchart of the system working

1) Image is captured by using camera and is forwarded to Raspberry Pi module.
2) Image is RGB format (binary image) which is converted to gray image using gray-scale converter for reducing calculation.
3) Now using object detection classifier trained for the detection of human face, image is checked whether human face is present or not.
4) If human face is present then we region of interest (ROI) of face is calculated.
5) Using LBP histogram of captured image is calculated and this value is compared with stored dataset value.
6) On the basis of this comparison, if captured image value is less than or equal to 75 then match is found i.e. detected person is recognised.
7) The result is displayed on output with "Green Bounding Box around recognized face with that person's information."
8) If detected face is not recognized then "Red Bounding Box around labelled as Not Recognized".

For training system for human face detection, one thousand positive human face images and one thousand negative human face images are provided to the system. Up to this point is system is trained to detect whether any human face is present in the captured frame.

Now after this system is trained with some authorised persons face and their information. For every person we capture and stores 100* (*this value is based on run time experiment for better accuracy. It is not fixed value and can vary) images stored in Raspberry Pi memory as datasets for recognition purpose. While recognizing system compares a captured image with stored dataset and gives result as per comparison.

Face Recognition considers both shape and texture information to represent face image based on Local Binary Patterns for person independent face recognition. The face area is first divided into small regions from which Local Binary Patterns (LBP) histograms are extracted and concatenated into a single feature vector. This feature vector forms an efficient representation of the face and is used to measure similarities between images.

The captured image from camera is forwarded to Raspberry Pi module. Pre-trained classifier installed in this module helps to detect whether any face is present in captured image or not. For detecting face from image, we are considering two features of human face, first is face edges (boundary of face) and then we check eyes position. Region of Interest (ROI) is calculated for particular face. These features are extracted from detected face from image and stored in temp file. Then recognition purpose we have stored already stores authorised persons information as dataset. These dataset are compared with captured image. LBPH is use for comparison of captured image and dataset.

1) Linear Binary Patterns

The LBP operator was originally designed for texture description. The operator assigns a label to every pixel of an image by thresholding the 3x3-neighborhood of each pixel

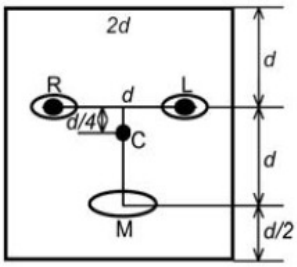
with the center pixel value and considering the result as a binary number. Then the histogram of the labels can be used as a texture descriptor. The basic histogram can be extended into a spatially enhanced histogram which encodes both the appearance and the spatial relations of facial regions. As the m facial regions R0, R1, R2...Rm-1 have been determined, a histogram is computed independently within each of the m regions. The resulting m histograms are combined yielding the spatially enhanced histogram. The spatially enhanced histogram has size m x n where n is the length of single LBP histogram. In the spatially enhanced histogram, we effectively have a description of the face on three different levels of locality: the LBP labels for the histogram contain information about the patterns on a pixel-level, the labels are summed over a small region to produce information on a regional level and the regional histograms are concatenated to build a global description of the face. It should be noted that when using the histogram-based methods, despite the examples, the regions R0, R1, R2...Rm-1 do not need to be rectangular. Neither do they need to be of the same size nor do shape and they not necessarily have to cover the whole image.

The idea of a spatially enhanced histogram can be exploited further when defining the distance measure. An indigenous property of the proposed face description method is that each element in the enhanced histogram corresponds to a certain small area of the face. Based on the psychophysical findings, which indicate that some facial features (such as eyes) play more important roles in human face recognition than other features, it can be expected that in this method some of the facial regions contribute more than others in terms of extrapersonal variance. Utilizing this assumption the regions can be weighted based on the importance of the information they contain.

2) Haar classifier

The face detection algorithm proposed by Viola and Jones is used as the basis of our design. The face detection algorithm looks for specific Haar features of a human face. When one of these features is found, the algorithm allows the face candidate to pass to the next stage of detection. A face candidate is a rectangular section of the original image called a sub-window. Generally this sub-window has a fixed size (typically 24×24 pixels). This sub-window is often scaled in order to obtain a variety of different size faces. The algorithm scans the entire image with this window and denotes each respective section a face candidate. The algorithm uses an integral image in order to process Haar features of a face candidate in constant time. It uses a cascade of stages which is used to eliminate non-face candidates quickly. Each stage consists of many different Haar features. Each feature is classified by a Haar feature classifier. The Haar feature classifiers generate an output which can then be provided to the stage comparator. The stage comparator sums the outputs of the Haar feature classifiers and compares this value with a stage threshold to determine if the stage should be passed. If all stages are passed the face candidate is concluded to be a face.

Landmark detection is important not only to generate a geometric face model, but also can be used for face detection compared different algorithms for facial landmark localization and proposed a set of tools that ease the integration of other face databases. Proposed technique for face segmentation using Active Shape Model based on border landmarks of the face. Used a facial geometrical model based on the distance of the eyes to estipulate the position of other landmarks for face segmentation, is shown in figure below.



Geometrical model of the face (Liu, Z et al – 2008)

Figure 3: Geometrical model of the face

4. RESULT AND DISCUSSION

The result of this "Human face recognition system using Raspberry Pi for security" is based on experimental analysis. Figure 4 shows us result in terminal window.

1. Result will be displayed on screen in numeric values and on video output on laptop/PC screen.
2. When person is recognized information of that person is displayed with "Green color bounding box".
3. On successful recognition it also display by how much value it finds match with that person (yellow circle in figure).
4. Red circle indicates (x, y) coordinates of face in a frame.
5. Green circle indicates RGB index as per result.
6. If detection value exceeds **75** will not be recognized. It will be treated as negative image.
7. When person is not in database "Not recognized" will be displayed with "Red color bounding box".

Figure 4: Output of a system on terminal window

5. CONCLUSION

As face recognition has become very handy approach in many applications because of its usefulness many tools and algorithms are available for image processing using Raspberry Pi. Using Viola-Jones algorithm, Haar classifier and LBPH on Raspberry Pi module we can easily detect and recognize authorized persons. Instead of using any other complex technique for facial recognition this Raspberry Pi with Haar classifier and LBPH provides us excellent performance efficiency, better accuracy, and at higher frame rate, nearly double frame rate as compared to Principle Component Analysis technique in real time face recognition system. Also LBP is done by dividing an image into several small regions from which the features are extracted data lost is negligible LBP operator achieves a highest accuracy of 38.46% which is much better than Principle Component Analysis.

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