Raspberry Pi and Image Processing Based Person Recognition System for Visually Impaired People

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Abstract – The implementation of image processing in today's world has done a lot in various field. Visually impaired or people with low vision always face difficulties recognizing a person while social interactions and regular activities. The proposed system is designed for blind people to reduce the complexity of blind people in regular activities and engage them. This paper represents a Raspberry Pi embedded system based person's face recognition system using local binary pattern algorithm of image processing aiming visually impaired people. This device detects and recognize human faces of pre-made datasets, fetches information from MySQL database on match and spells through a microphone applying text to speech method. In the experimental case, the system gives 96% accuracy recognizing single person and 92% accuracy in the case of recognizing multiple people and in complex background.

Key Words: Image processing, Raspberry Pi, LBPH, face recognition, MySQL database.

1. INTRODUCTION

According to an estimation there are 253 million individuals live with vision disability: 36 million are blind and 217 million have direct to extreme vision impairment. Among blind and have moderate or severe vision impairment, 81% people are aged 50 years and above. Sometimes loss of vision is related with a misfortune of freedom [1]. Blind and visually impaired individuals often face many challenging situations in their day to day life. One of the biggest problems blind people face is difficulty with navigation [2].

Individuals who are completely blind or have disabled vision as a rule have a troublesome time navigating outside the spaces that they're usual to. They had to depend on the external support system which can maintained by humans, guided dogs, or special electronic gadgets. Another major problem they had to face is identifying a person in a variety of social interactions [3].

In today's world many researchers has discovered some technological devices and tools to aid the blinds and prosopagnosia disordered individuals. A device Option is utilized by a blind person to read the printed page straightforwardly. It comprises of a camera, which is moved over the lines of print, and a small display comprising of lines of modest vibrating pegs which appear the shape of the letter specifically beneath the camera [4].

voice framework which is basically a customary eyeglasses including a camera by which different objects in a video image are identified and translated into sound or strategic maps with the assistance of GPS system. Another system is Eye Cane a flashlight like device which is consist of a pair of sensory substitution devices (SSDs), sends out infrared beams to interpret distance into sound-related and material prompts, letting the user sense objects inside a range of up to five meters.

This paper portrays a face detection and recognition system based on Raspberry Pi-3 that's able of processing image or video delivering a voice output. Using face recognition technology, the device identify classmates, relatives and colleagues by giving some identity persons who previously custom made dataset, and on match information are fetched from MySQL database.

2. LITERATURE REVIEW

Astler D. et al proposed a system which uses facial recognition and expression algorithms to relay nonverbal messages to visually Impaired people. The authors designs of a camera atop a standard white cane that contains a high speed IEEE-1394b camera to get images at a very high frame rate. In the software session, commercial software (FaceAPI; Seeing Machines Inc., Canberra, Australia) had been used to accurately track facial features in real time [5].

Dr. R.Naveen et al had recommend an Polaroid built visual aid structure to quick reading, movement about Questions and the sentiments for persons and so forth. It proselytes under an voice yield will help Visually impaired people groups. Framework starting with a absolute camera-captured picture and also a greater amount from claiming frames had been used as classifier [6].

Kwang K. et al proposed kernel principal component analysis (PCA) as a nonlinear extension of a PCA. It converted first map the input space into a feature space via nonlinear mapping and then compute the principal components in that feature space and the letter adopts the kernel PCA as a mechanism for extracting facial features [7].

3. PROPOSED METHODOLOGY

The proposed model implements an image processing system using OpenCV in Raspberry Pi 3 which has Linux based operating system named Raspbian OS. The handy device, developed for the visually impaired people, is

connected with internet via Raspberry Pi 3's built in Wi-Fi system that links the device fetching data from MySQL on recognizing a person.

Image processing system is divided into three parts: Detect face and store in database with preprocessing, Training images from dataset, Classify and recognize face using LBP algorithm. Based on the match, information is fetched from MySQL database, the text to speech method using python's library pyttsx is applied which gives a voice output from earphone. As a visually impaired person can recognize and get short information people in front of him. The flowchart of Fig-1 describes the working procedure.

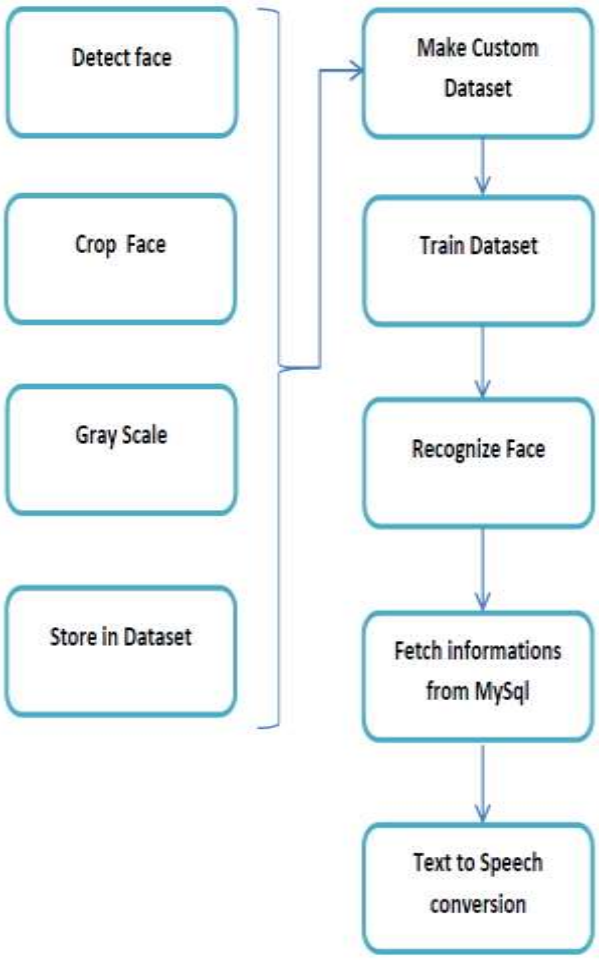

Fig -1: Flow chart of proposed model

3.1 Experimental Setup

Our proposed device is based on Raspberry Pi 3 B, which has Raspbian OS as operating and used as an portable computer. Raspberry Pi 3 has a quad-core 1.2GHz 64-bit ARM processor, 1 GB RAM, onboard Wi-Fi, Bluetooth, 4 USB ports, 40 GPIO pins, Ethernet port and micro SD space [8]. To get real time videos, Raspberry Pi Camera Module v2 which has a 8 megapixel Sony IMX219 image sensor, is used. This camera module is competent of taking 640 x 480 pixels videos. A 3.5mm ported earphone is connected with Raspberry Pi to get voice output.

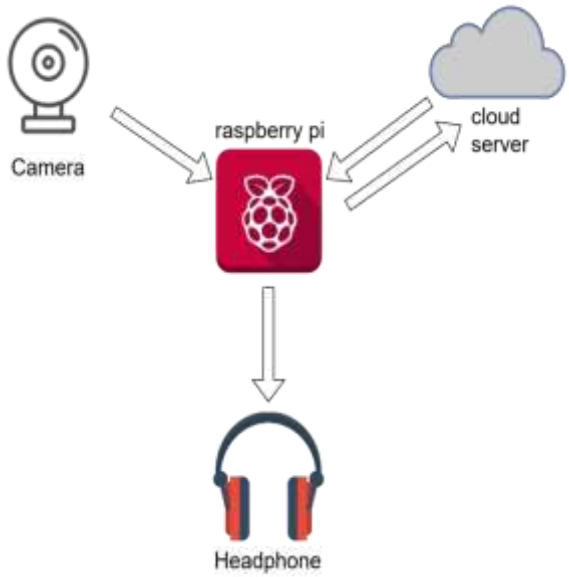

Fig -2: Block diagram of experimental setup

We used OpenCV 3.4 version with python programming language in Raspberry Pi for image processing and pyttsx library of python for converting text to speech that is gained from MySQL database. MySQL contains person's information of name, address and some previous records. Each person has unique ID number in database. On recognition of person, based on matched ID number, information will be faced from database.

3.2 LBPH Algorithm for Person Recognition

LBPH which stands for Local Binary Pattern Histogram, has widely used in many applications like texture analysis, face recognition, image retrieval etc. because of its robustness to monotonic illumination changes and computationally simplicity. LBPH is based on LBP operator which was firstly introduced by Ojala [9] as a local texture operator. The operator labels any pixel of image (center pixel) by thresholding it with the gray values of 3x3 squared neighborhood, and considering all thresholding results as a binary string. This square LBP operator later extended by Ojala to any size circular neighborhood [10]. A center (xc, yc) pixel point on image can be labelled as follow (1): where R defines the radius of circular neighborhood, P is the equally spaced sampling points on this circle and Pi refers to ith neighboring pixel on circle and pc is the center pixel. s function denotes thresholding operation which uses grey level intensity values of related pixels. It is 1 if s(pi-pc) is small or equal to 0, otherwise equal to 0 [11].

$$LBPH_{x,y,P,R} = \sum_{i=1}^{p=1} 2^i * \mathrm{s(pi - pc)} \quad (1)$$

The main of image processing here is to detect faces and crop to make dataset, train the images and apply LBPH classifier to recognize faces. To begin with, we use LBP classifier, implemented with openCV which doesn't scan whole image but search for local structure by comparing each pixels to the neighboring pixels. [12]. To get a face

from a image, detectMultiScale method is applied which return an iterator of tuples which contain row and column coordinates along with height and width of the face. Based on the values face is cropped to store in the dataset folder and a rectangle in drawn to mark the face. Theprocess starts by giving an unique ID for each persons and ends after taking 40 face images from various angle. All the images are resized and preprocessed by applying gray scaling method to reduce color complexity.
The dataset needs to be trained. While storing face images it gives a tracing number 1 to 40 with a dot and in this section images are spitted each images , train them and records a the features of individual person's face images in a xml format.

After training the images, each histogram represents each image from the training dataset. To recognize the person's face with the live streaming video coming from Raspberry Pi camera we just need to compare histograms and return the image with the closest histogram. The image processing system calculate the Euclidean distance between two histograms applying LBPH algorithm [13-16] using the following equation 2,

$$D = \sqrt{\sum_{i=1}^{n}(hist1_i - hist2_i)} \quad (2)$$

Finally, based on recognized image's matched ID number, a python program fetches data from MySQL database using sqlite3 library [17,18]. It makes connection with program to connect with particular datatable on given database name, hostname, and password. The strings that come from database is converted into voice using pyttsx library.

4. RESULT AND ANALYSIS

The proposed Raspberry Pi based device executes image processing to classify person after finishing training. Using the 8 megapixel with openCV, the system detect and store face images in custom made dataset shown in Fig 3.

Now based on the features of each person's images gained from data training section, the LBPH algorithm recognizes faces in real time. Fig-4,5,6 represent the single and multiple person recognition based on face classification.

Fig -3: Detected and cropped face images stored in dataset

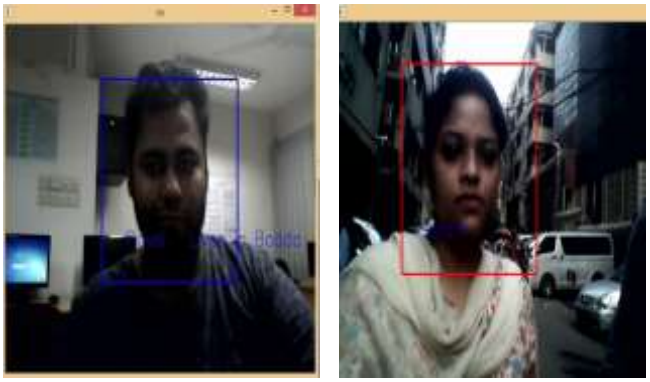

Fig -4: Face recognition of Single Person

Fig -5: Face recognition of Multiple Persons

Fig -6: Face recognition from side view

The performance and accuracy vary from single or multiple person in background, side of view of person's face. Table-1 shows the performance analysis of the recognition process comparing with other existing face recognition algorithms like Eigen faces [19] and Fisher faces[20] .The accuracy is gained by calculating total wrong recognizing along with total number of appearances in a certain amount of time, here 1 hour.

$$Accuracy = \{100 - (\frac{Total\ wrong\ recognition}{Total\ appearances})\} \quad (3)$$

Table -1: Performance analysis and comparison

Classifier and Recognition Algorithm	Side view (%)	Single Person (%)	Multiple Persons (%)
LBPH	96	96	92

Eigenfaces	88	94	84
fisherfaces	91	94	89

Beside accuracy and performance analysis, one of the main reasons to implement LBPH algorithm is that it faster than many other recognizing algorithms. Using python's built in library "time" to get execution duration, the comparison of algorithms are given in Fig 7.

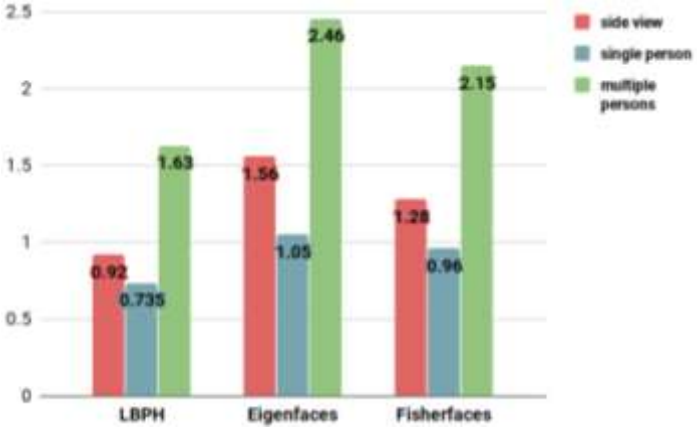

Fig -7: Execution time comparison

5. CONCLUSION

We have projected a style on face recognition supported raspberry pi that is especially designed aiming visually impaired people. The system is develop in a way so that it can recognize faces to classify people, then fetch matched people's information stored in dataset and spell through a voice out using earphone or headset. Our future work can specialize in detective as recognizing a lot of sorts of indoor objects and icons on assemblage additionally for indoor method finding aid to help blind individuals travel severally. We are going to additionally study the many human interface problems together with additive output and special change of object location, orientation, and distance. With time period updates, blind users are able to higher use special memory to grasp the encompassing atmosphere, obstacles and signs. The projected system achieved each high accuracy and quick response. Additionally, as the equipments are cheap in price, lightweight weight and quick software package processor, it can be good way to remove obstacle between normal and visually impaired people.

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