LIGHTWEIGHT SMART GLASS SYSTEMFOR VISUALLY IMPAIRD PERSON

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Abstract:—Face detection and recognition are key components in multiple camera-based devices and applications. Smart glasses are a type of optical head mounted displays that integrate first person cameras and hands-free displays with immediate access to processing power able to analysis first person images in real time with hands free operation. In this context, we have constructed an application prototype that detects and recognizes faces in real-time, and runs independently on the device. We provide a description of the embedded implementation at a system-level where we highlight the application development challenges and trade-offs that need to be dealt with battery powered wearable devices. The implementation includes a parallel pipeline that reduces the latencies of the application.

IndexTerms - Face Detection, Smart Glass, Haar Cascade features, Eigen-Vectors.

I. INTRODUCTION

According to the WHO (World Health Organization) report, as of 2012 there were 285 million people estimated to be visually impaired worldwide, of which 246 million had low vision and 39 million were blind. The majority of people with poor vision are in the developing world and over the age of 50. individuals with a visual disability are difficult to communicate effectively not only with ordinary people, but also with their environment. blind people can have difficulty interacting with their environment, because it can be hard top receive where someone is and to get from one place to another place. Movement can become restricted, leading to having little contact with the surrounding world. The blind or visually impaired rely largely on their other senses such as hearing, touch, and smell in order to understand their surroundings. Blindness is often a great obstacle of their living life.

It is pretty hard for them to go out alone, not to mention finding toilets, subway stations, restaurants and so on. However, there are not many products that can help the visually impaired people in city life. If the visually impaired people can “see” the world with the help of other devices, they will gain increased independence and freedom in city life, and this is precisely why we built such a smart glass system. With the explosive popularity of smart glasses, new technologies capable of extending their functionality and applications become extremely important.

Face recognition is a promising application for smart glasses due to its potential to assist a user in recalling names of people, whom the user has met before. It enables the user to compare a captured face image against a database of faces, determine the best match and return the associated information. The application can benefit law enforcing forces in tracking criminals, as well as help old people in reminding names of friends, relatives, and caretakers.

The proposed smart-glass face-recognition system uses a high-speed remote server and smart-glass processing device(client) with video camera and display allocated on glasses.

The server has access to data-base that contains face images labelled with corresponding information of the person. we assume that the server is activated before the user initiates face recognition application (from the smart-glass device). The client–server connection is wireless. It is based on Wi-Fi and controlled by operating system through a programming interface. The Wi-Fi connection is established before starting the data transmission and released after ending the data transfer.

II. RELATED WORK

Face detection and recognition are key components in multiple camera-based devices and applications. Smart glasses are a type of optical head mounted displays that integrate first person cameras and hands-free displays with immediate access to processing power able to analysis first person images in real time with hands free operation. Smart glasses are a type of Optical Head Mounted Displays (OHMD) that integrates a camera and a display in a very reduced form factor, allowing them to be wearable on top of a glass type object. Among the proposed uses for smart glasses are reading real-time notifications and visual instructions, instant connectivity access, instant photography or video capturing and augmented reality.[1]

new smart-glass-based face recognition system developed as a benchmark for comparison. unlike related formulations that limit face recognition to static images captured by smart glasses, the system runs face detection on smart glass processing device while offloading the computationally expensive face identification to the network server. The proposed smart-glass face-recognition system uses a high-speed remote server and smart-glass processing device(client) with video camera and display allocated on glasses. The server has access to data-base that contains face images labelled with corresponding information of the person.[2]

This article focuses on the design and implementation of smart wearable robot glasses for human visual augmentation, which take a role to provide the refined visual recognition result to users of wearing the proposed system. The proposed system consists of a glass-type wearable device with a front looking camera, an eye looking camera, and an earphone, and signal processing units. The scene-analyzing process on the input image acquired by the front view camera is supported by an eye view camera of monitoring the eye position of user for efficient information processing, which is used to catch the user’s visual intention and attention in given situations. The recognized results are transformed into the audio information for the user-friendly information service without obstructing the users own visual information gathering and processing, and then the result is transferred into the user earphone.[3]

Face recognition is one of the most popular research problems on various platforms. New research issues arise when it comes to resource constrained devices, such as smart glasses, due to the overwhelming computation and energy requirements of the accurate face recognition methods. In this paper, we propose a robust and efficient sensor-assisted face recognition system on smart glasses by exploring the power of multimodal sensors including the camera and Inertial Measurement Unit (IMU) sensors. The system is based on a novel face recognition algorithm, namely Multi-view Sparse Representation Classification (MVSRC), by exploiting the prolific information among multi-view face images. To improve the efficiency of MVSRC on smart glasses, we propose a novel sampling optimization strategy using the less expensive inertial sensors. Our evaluations on public and private datasets show that the proposed method is up to 10% more accurate than the state-of-the-art multi-view face recognition methods while its computation cost is in the same order as an efficient benchmark method (e.g., Eigenfaces). Finally, extensive real-world experiments show that our proposed system improves recognition accuracy by up to 15% while achieving the same level of system overhead compared to the existing face recognition system (OpenCV algorithms) on smart glasses.[4]

III. PROPOSED WORK

Blind people can have difficulty interacting with their environment, because it can be hard to perceive where someone is and to get from one place to another place. Movement can become restricted, leading to having little contact with the surrounding world. The blind or visually impaired rely largely on their other senses such as hearing, touch, and smell in order to understand their surroundings.

- Blindness is often a great obstacle of their living life. It is pretty hard for them to go out alone, not to mention finding toilets, subway stations, restaurants and so on. However, there are not many products that can help the visually impaired people in city life. If the visually impaired people can "see" the world with the help of other devices, they will gain increased independence and freedom in city life, and this is precisely why we built such a smart glass system**.**
- Public signs in cities can act as guides for people. Following the public signs, people can find public infrastructure, such as public toilets, bus stations, subway stations, hotels and so on. so, finding and recognizing the public signs outsides would help someone who is blind or visually impaired gain increased independence and freedom. so, we have implemented an application of public signs recognition in this developed smart glass system with sign detection SVM algorithm.
- Smart Glass system uses graph matching for face Detection.Fig2:(a) and (b) It creates a face bunch graph from multiple face models to obtain a general representation called an object-adapted grid. The system then matches a given image to the face bunch graph to find the fiducial points. It creates an image graph using elastic graph matching and then compares that image to a database of faces for recognition
- This application can automatically detect, analyse and recognize all kinds of public signs around the blindness and visually impaired and give corresponding voice hints through wireless bone conduction Pi-headphones. With the help of this smart glass system, the blindness may find toilets and known persons and traffic signs. The blindness may even go for a trip alone.

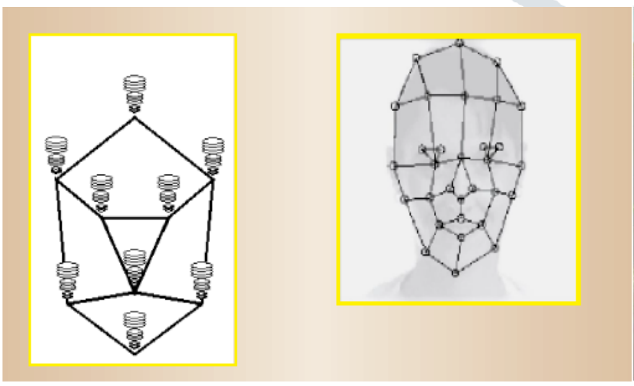


Fig.1: (a) face detection graphical view.

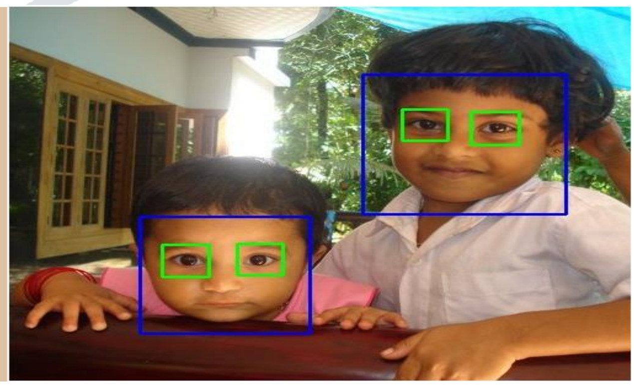


Fig1: (b) proposed face detection.

IV. METHODOLOGY

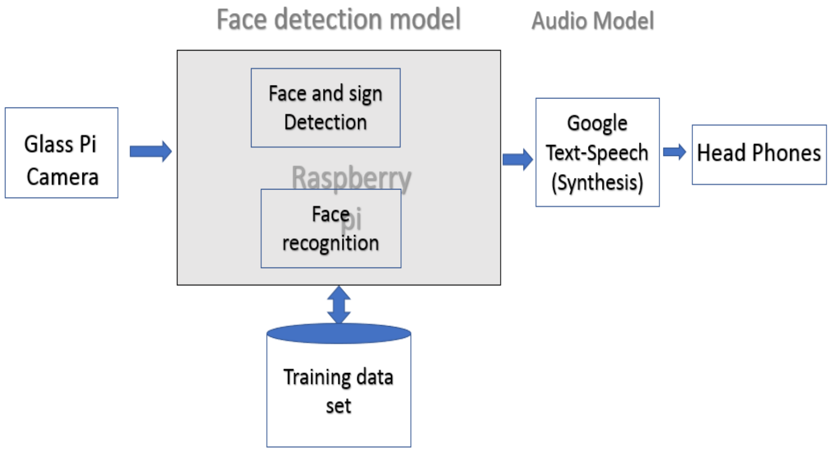


Fig.2: Architecture

Architecture of the smart glass system is as shown in Fig 2. The smart glass system design contains two parts: hardware design and software design. And The block diagram of the system is in Fig. 6.2.1 As the system block diagram shows, the HD camera on the glass catches the video stream around the blind, and then transfers it to the Raspberry chip. pi kernel calls the OpenCV functions to analysis and process the images. When the system matches the public signs, pi kernel would give corresponding instructions according to the matched signs. And the system would call the Bluetooth module and TTS audio module to transform the instructions to voice through wireless bone conduction headphones.

4.1Data collection from Pi camera

Collection of the face is the initial stage where the camera has to detect the appropriate face and using the OpenCV and Haar cascade features.for every 10 seconds the data obtain from the camera so it easy to detect the multiple face faster within the expected time.

And further the admin has to store some additional images and sign in order to train the system. Once the data is collected further it will go to the face detection and recognition process.

The hardware components used in the device areas are: Raspberry-Pi v3Processor speed ranges from 700 MHz to 1.4 GHz for the Pi 3 Model and Pi CameraPi Camera Board v2 is a high quality 8-megapixel Sony IMX219 glass holder for raspberry chip.

Fig.3: Raspberry-Pi v3

models feature a Broadcom system on a chip (SoC) with an integrated ARM-compatible central processing unit (CPU) and on-chip graphics processing unit (GPU).Processor speed ranges from 700 MHz to 1.4 GHz for the Pi 3 Model B+; on-board memory ranges from 256 MB to 1 GB RAM. Secure (SD) cards in MicroSD form factor (SDHC on early models) are used to store the operating system and program memory. The boards have one to four USB ports. For video output, HDMI and composite video are supported, with a standard 3.5 mm sleeve jack for audio output. Lower-level output is provided by a number of GPIO pins, which support common protocols like I²C. The B-models have an 8P8C Ethernet port and the Pi 3 and Pi Zero W have on-board Wi-Fi 802.11n and Bluetooth.

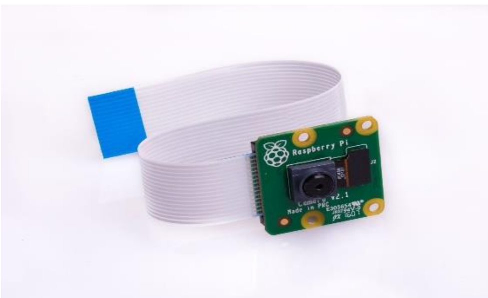


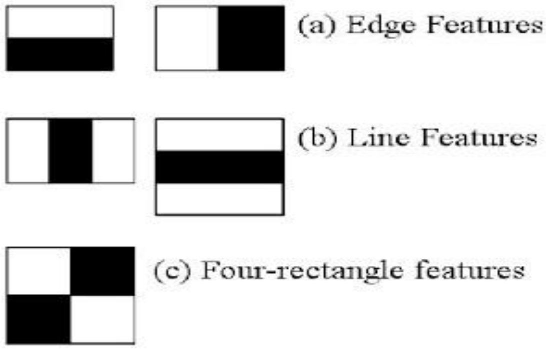
Fig.4: Pi Camera Board

The Raspberry Pi Camera Board v2 is a high quality 8-megapixel Sony IMX219 image sensor custom designed add-on board for Raspberry Pi, featuring a fixed focus lens. It's capable of 3280x2464-pixel static images, and also supports1080p30, 720p60, and 640x480p90 video.

4.2 Face Detection using Haar feature-based cascade classifiers

Viola and Jones Haar-like features and cascade ClassifiersThe typical cascade classifier is the very successful method of Viola and Jones for face detection. Generally, many object detection tasks with rigid structure can be addressed by means of this method, not limited to face detection. The cascade classifier is a tree-based technology, in which Viola and Jones used Haar-like features for human face detection.

Face Detection using Haar feature-based cascade classifiers is an effective object detection methodthe algorithm needs a lot of positive images (images of faces) and negative images (images without faces) to train the classifier. Then we need to extract features from it. Particularly For this, Haar features shown in the Fig are used. They are just like our convolutional kernel. Each feature is a single value obtained by subtracting sum of pixels under the white rectangle from sum of pixels under the black rectangle.all possible sizes and locations of each kernel are used to calculate lots of features. Even a 24x24 window results over 160000 features. For each feature calculation, we need to find the sum of the pixels under white and black rectangles. To solve this, they introduced the integral image. However large your image, it reduces the calculations for a given pixel to an operation involving just four pixels. It makes things super-fast.



4.3 Face recognition

The face recognition system is similar to other biometric systems. The idea behind the face recognition system is the fact that each individual has a unique face. Similar to the fingerprint, the face of an individual has many structures and features unique to that individual. An automatic face recognition system is based on facial symmetry. Face authentication and face identification are challenging problems. The fact that in the recent past, there have been more and more commercial, military and institutional applications, makes the face recognition systems a popular subject. To be reliable, such systems have to work with high precision and accuracy. In a face recognition system, the database consists of the images of the individuals that the system has to recognize. If possible, several images of the same individual should be included in the database. If the images are selected so that they account for varying facial expressions, lighting conditions, etc., the solution of the problem can be found more easilythe basis of the eigenfaces method is the Principal Component Analysis (PCA).It calculated the best vector system for image compression. Then Turk and Pentland applied the Eigenfaces to face recognition problem. The Principal Component Analysis is a method of projection to a subspace and is widely used in pattern recognition. An objective of PCA is the replacement of correlated vectors of large dimensions with the uncorrelated vectors of smaller dimensions. Another objective is to calculate a basis for the data set. Main advantages of the PCA are its low sensitivity to noise, the reduction of the requirements of the memory and the capacity, and the increase in the efficiency due to the operation in a space of smaller dimensions.

- The strategy of the Eigenfaces method consists of extracting the characteristic features on the face and representing the face in question as a linear combination of the so called ‘eigenfaces’ obtained from the feature extraction process. The principal components of the faces in the training set are calculated. Recognition is achieved using the projection of the face into the space formed by the eigenfaces as shown in the Fig. A comparison on the basis of the Euclidian distance of the eigenvectors of the eigenfaces and the eigenface of the image under question is made. If this distance is small enough, the person is identified. On the other hand, if the distance is too large, the image is regarded as one that belongs to an individual for which the system has to be trained.

Fig 5(a)Input Images Fig 5(b) face recognition patterns

4.4 Alert Notification

Google Text-to-Speech is a screen reader application developed by Google for its Android operating system. It powers applications to read aloud (speak) the text on the screen which support many languages. Text-to-Speech may be used by apps such as Google Play Books for reading books aloud, by Google Translate for reading aloud translations providing useful insight to the pronunciation of words, by Google Talkback and other spoken feedback accessibility-based applications, as well as by third-party apps. The sign and the face data from the trained data is converted into to the text speech through earphone it will give the alert messages to the visually impaired person as shown in the Fig 6Alert Notificationmobile app which give the alert information with respect to that additionally reminder option also built-in to remind the person.

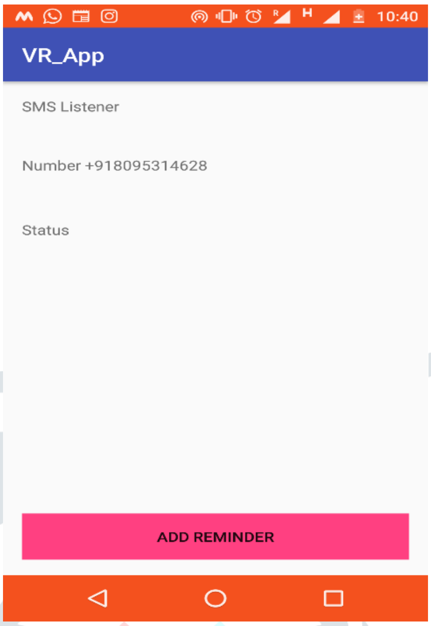


Fig 6Alert Notification

V. RESULTS AND DISCUSSION

Eigenfaces method consists of extracting the characteristic features on the face and representing the face in question as a linear combination of the so called ‘eigenfaces’ obtained from the feature extraction process. The principal components of the faces in the training set are calculated. Recognition is achieved using the projection of the face into the space formed by the eigenfaces as shown in the below where almost 93% percent of accuracy is been achieved through this method and the accuracy which achieved more when the data input and as well as training data collection is more with respect to the output Fig 7 eigen face recognition result and detecting the object from the Pi camera is shown in Fig 8 Camera object detection.Fig 9. Data management where the data is been stored into the data base server and each admin has there own mail-Id and the password which makes the data server more secure .

Fig 7eigen face recognition result

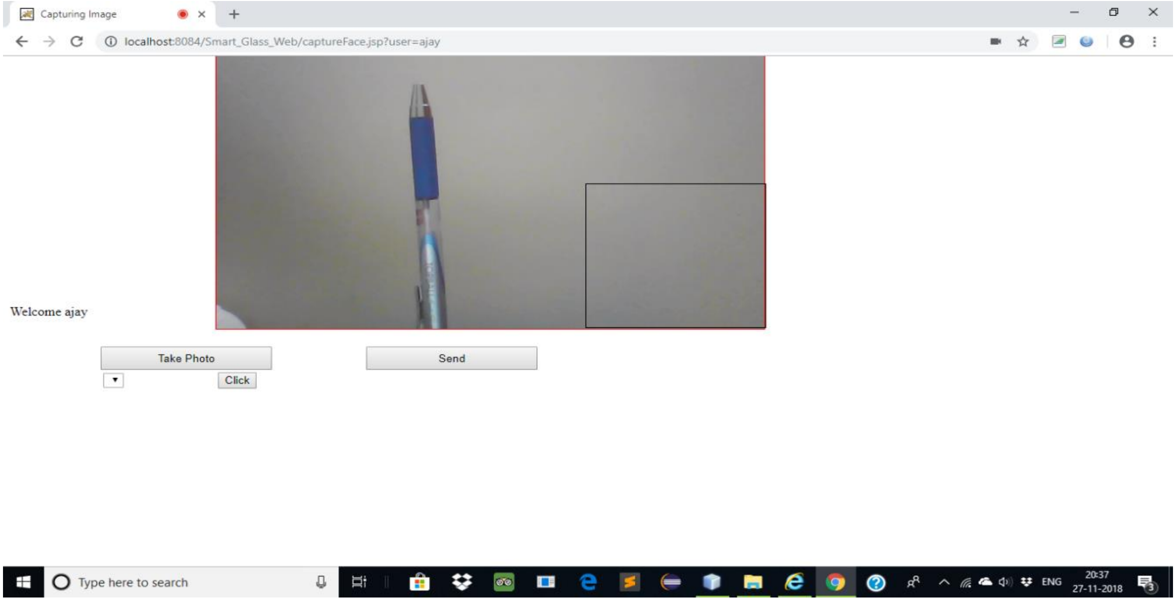


Fig 8. Camera object detection.

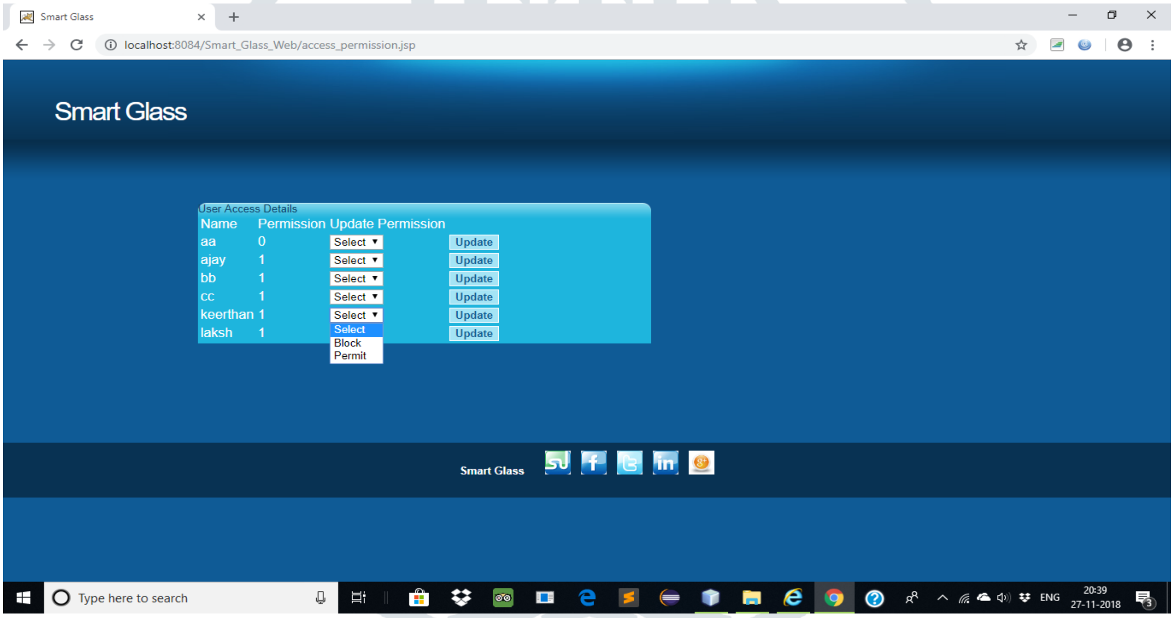


Fig 9.Data management

CONCLUSION

This work proposed the detection of a human face based on a wearable Smart-Glass system. The Eigenfaces method is applied to a large database consisting of large number of images. The challenging details such as background, eye-glasses, beard, mustache is dealt with. pixel results show that sometimes failure occurs. The success rate is calculated as 94.74%. To increase the success rate, the eigenfaces method can be fortified with the use of additional information, such as the face triangle. The future work will focus on increasing success rate for very large databases.

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