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Fare Calculation System Using Face Recognition

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ABSTRACT
In this world of emerging technologies everything turns into artificial intelligence to perform task as human. Computer vision is the area of science which gives a similar, if not a better capability to a machine or a computer. In this paper 'Fare Calculation System Using Face Recognition' is an electronic fare management system for the regular passengers. The main objective is to eliminate the disadvantages like misuse by unauthorized person, renewal of cards, etc. of smart card swipe system. This system will help in saving the man hours required for vending out tokens/ tickets/ smart cards in the metro system. So, it enables the passenger to travel economically as the system becomes paperless. Here we use image processing techniques, the face of the passenger is recognized based on Principal Component Analysis (PCA) and the fare for the journey is calculated using the distance between the entry and exit stations. Users will have a wallet account and fare is debited from the account and intimation is sent to the passenger. This system increases the accuracy and will help in replacing traditional fare calculation methods.

Keywords :- e-fare management, Cascades, Principal Component Analysis (PCA), Eigenfaces, K Nearest Neighbour (KNN).

I. INTRODUCTION

Fare calculation using face recognition captures the face of the passenger and deduces the fare from their account. Computer Vision is one of the most powerful and compelling technology in the field of Artificial Intelligence, which has a wide variety of applications. It is concerned with automatic extraction, analysis and understanding of useful image from a single image or sequences of images.

In 1997 P.Viola proposed Adaboost and Cascade algorithm, which paved path to real-time face detection techniques. Based on PCA, Turk and Pentland introduced Eigenface approach for face recognition. Classification of the recognized faces can be performed by passing the Eigen face values to the K nearest neighbour (KNN) algorithm. It is one algorithm that needs almost no prerequisites. Data encryption and decryption is done by Advanced Encryption Standard (AES). AES is a symmetric-key block cipher algorithm and U.S government standard for secure and classified data encryption and decryption.

II. EXISTING SYSTEM

Current ticket vending systems that are widely in use are traditional ticket vending machines, Open loop smart cards, Radio Frequency Identification Devices (RFID) etc. The traditional method collects money directly by knowing about the destination to where the user has to travel. This system causes considerable delay in travel time due to long queues as it will take time to vend tickets for each user.

The open loop smart cards are issued in partnership with network providers like Visa or Master Card. Disadvantage of using Smart card is the misuse of cards by unauthorized users and validity of the issued cards. As a solution to these bottlenecks, proposed system provides an efficient and hassle-free travel experience to the commuter.

III. OVERVIEW

Proposed system has two modules as depicted in Fig.1, a station and a server. In station module image acquisition and face detection processes are done. And the acquired data is transferred to the server. Face recognition, fare calculations and money transaction processes are done at the server module. The data acquired at the entry side of the station is sent to the server along with the station id using wireless communication protocol. The data processing and the money transaction processes are done at the server. So, it is known as the static module of the system.

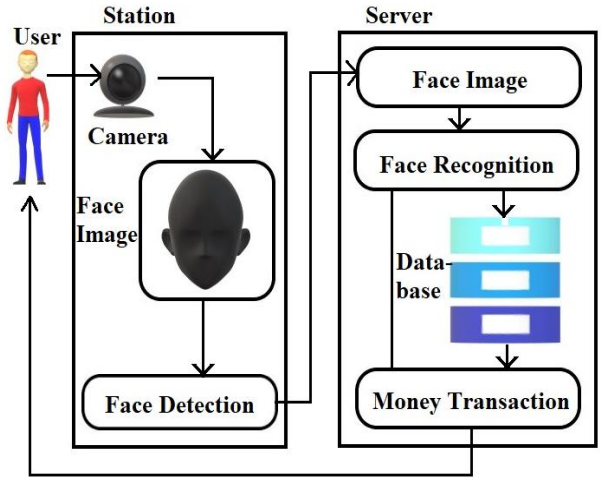

Fig. 1 Framework

The main four steps in this system are explained are: Face Detection, Face Recognition, KNN algorithm and AES algorithm is used for encryption of data.

A. *Face detection*

Face Detection is the technology in which the computer identifies the human faces from digital images. Face detection can be regarded as a classification process in which the computer classifies an image that is captured by the camera. For this we need many positive and negative examples to train the computer. The real time face detection has three modules, they are (1) detection of face (2) face verification and (3) face tracking. Real time face detection is more beneficial for detecting faces in a crowded open space. Face Detection is the most important step in the area of image processing. There are various algorithms that are used to implement face detection. Working of these algorithms is based on the accuracy of the face detection and feature extraction. In this system, OpenCV is used as a method for image processing [1]. OpenCV comes with a trainer as well as a detector. It can be used to create classifier for any object like car, plane, etc. It already contains many pre-trained classifiers for face, eyes, smiles, etc. Those XML files are stored in the opencv/data/haarcascades/folder.
In this system of e-fare management a camera is fixed at every station at the entry gate. As the user enters the station, face of the user is captured and if the person is a registered user then they are allowed travel. At the exit side also the face of the user is captured in order to find the travel distance of the user. Here face detection consist of mainly three major steps

1. Feature Extraction
2. Classification
3. Detection

Digital images captured by the cameras are normally pixel oriented or can be considered as a collection of pixel values. Classifying the images based on pixel value is a tremendous process, so it is better to use features rather than the pixel values for extraction of features in the detected image. Feature based system is more advantageous to use than a pixel based system. Three types of features are used for face detection, two-rectangle feature, three-rectangle feature and four-rectangle feature. The difference between the sums of pixel values within the two rectangular region is the two-rectangle feature or the edge features (Fig.2(a) and 2(b)). The rectangular region will be of same size and shape and are either horizontally or vertically adjacent. Three-rectangular feature or the line feature (Fig.2(c) and 2(d)) is that which calculates the sum within two outside rectangle subtracted from the sum of pixel values at the centre rectangle. Features of the four rectangle computes the difference between diagonal pairs of rectangle (Fig.2(e)).Features of an image is extracted by these feature based system.

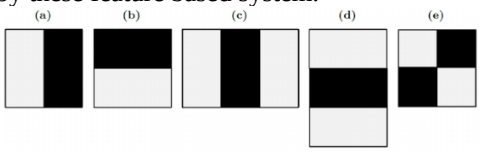

Fig.2 Feature Based Systems

Haar cascade is used to detect the face from an image that is captured. In this, the cascades of different images of the same person are taken and are stored in the database. Subtraction is performed on every image in the cascade but may not produce a good result. Many of the images may have lot of errors and the image with least error is selected. That is, the images are classified into strong class. The initial class is the weak class.
The images that produce more erroneous results are discarded. Rectangle features can be computed easily using the integral image [2]. The formula for calculating integral image at location x, y contains the sum of the pixels above to the left of x, y.

$$jj(x,y) = \sum_{x'<=x,y'<=y} j(x',y') \quad (1)$$

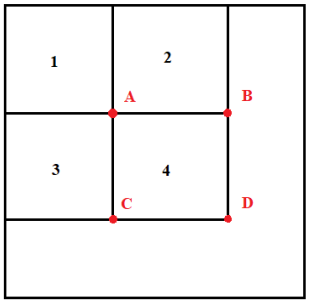

Fig.3 Integral image

From the Fig.3, intregral image at the location A is the sum of pixels in the region 1; at the location B sum of pixels in the region 1 + sum of pixels at the region 2; at location C it will be sum of pixels at region 1 + sum of pixels at region 3; similarly for location D sum of pixels at region 1+ region 2 + region 3 + region 4.

After feature extraction and classification process, all the cascaded structures are combined to detect the face from the image captured.

B. *Face Recognition*

Face recognition technology is used for identifying or verifying a person from a digital image. Facial recognition basically consist of four interrelated steps,

1. Face detection
2. Normalization
3. Feature extraction
4. Face recognition.

Face detection is done by cameras and the detected images are stored in database, these images are used to train the system. In the normalization of face, basic feature points are selected and reduce the effect of unused or redundant information, so as to enhance the face recognition process. In feature extraction, meaningful data are extracted from the original dataset on the basis on certain conditions.

The face images of users are represented in grayscale. Grayscale simplifies the algorithm and reduces computational requirements than operating on color images directly. The conversion of a color image into a grayscale image is

converting the RGB value of 24 bit into grayscale value of 8 bit. Image processing techniques or software applications can used to convert color image to grayscale image. Indeed, color may be of limited benefit in many applications and the unnecessary information could increase the amount of training data required to achieve good performance.

Principal Component Analysis (PCA): There are many algorithms that can be used for face recognition. Here, we centered on Principle Component Analysis (PCA) for face recognition. PCA is simple and efficient algorithm that is easy to implement and having fast computational time. PCA reduces the large dimensionality of datasets. The original image is in vector space and its dimensionality is high, it is reduced by using PCA [3].

Input images are discriminated into different classes, which mean different users. The task of a face recognition system is to show that the picture in which testing is performed belongs to a user in the database. A face contains certain set of features and these characteristic features are called Principal components or Eigen faces. It is possible to transform each original picture into corresponding Eigenfaces and can reconstructing original image by combining the Eigen faces. Eigen faces are characteristic features of the original image, which may or may not be present in the original image [4].

These features can be extracted from the original image with the help of Principal Component Analysis. The reconstructed picture is an approximation of the original image from which the face image user is recognized. After the face recognition process is successfully completed, the user can enter the station.

C. KNN Algorithm

KNN is one of the simplest classification algorithms available for supervised learning. The idea is to search for the closest match of the test data in the feature space. The model for KNN is an entire training data set. When a prediction is required for an unseen data instance, the KNN algorithm will search through the training data set for the k- most similar instances. The prediction attribute of the most similar instances is summarized and returned as the prediction for the unseen instance. The KNN algorithm belongs to the family of instance-based, competitive learning and lazy learning algorithms.

The Fig.4 is a spread of red circles (RC) and green squares (GS) and a blue star (BS). The closest points to BS are three RC, so BS should belong to the class RC. Here the choice was very obvious as all the votes from the closest neighbor went to RC.

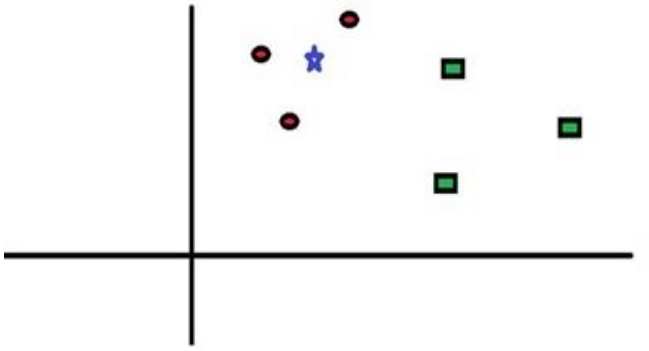

Fig. 4 Example of Classification

Here KNN classifier is used to classify different face images. The Euclidean distance between the testing image feature and the training image feature is determined by finding the distance between the testing and training feature and a distance matrix is created. In the distance matrix first K values are considered and the majority label of the K value is considered as the correct label of the given testing image [6].

The performance of the system is measured in terms of accuracy. The accuracy is given by,

Accuracy = (correctly detected face images) / (total number of face images) (2)

D. AES Algorithm

There is a rising concern about the security and privacy of biometric data itself. Face recognition systems like most biometric systems, need a template database [5]. AES algorithm is used for encryption and decryption. A different encryption/decryption key is used for each user and that key is not stored in the database. It is extracted by expanding the submitted user identification (ID).

Rijndael is a block cipher. The algorithm is flexible in supporting any combination of data and key size of 128, 192 and 256 bits. It allows a 128 bit data length that can be divided into four basic blocks which works on an array of 4x4 matrixes called state. The data is passed through Nr (the number of rounds) rounds, it is a function of the key and block lengths. The four transformations in each round are :

1. Add round Key transformation
2. Subtype transformation
3. Shift rows transformation
4. Mix columns transformation

After the initial Add round key, the above functions are performed iteratively. The number of iteration depends on the key length.

Each user in the system has their own Id which consists of eight characters. It is then expanded to a 16 byte encryption/decryption key. The two steps performed in key expansion are a string scrambling technique and a string expansion technique using simple pseudo random generator [5].

IV. FARE CALCULATION AND MONEY TRANSACTION

The proposed system calculates the fare using the distance between the user's entry point and exit point. The face images at both these points are compared with the face images which are already stored in the DB. A fare is set for the minimum distance traveled. Each registered user will have wallet to which they can add money. Once the face image comparison is performed successfully, the system initiates money transfer from the wallet. Once the money is debited, the user will get intimation about the transaction details. A user can travel only if the user's wallet has at least minimum balance.

V. CONCLUSION

This paper presents an effective method for fare calculation using secure face recognition technique. It eliminates the drawbacks of systems that is currently in use. It allows the passenger to have a trouble free journey. OpenCV is used here for image processing. Algorithms such as PCA and KNN are applied for face detection and classification. Further data security is provided by implementing AES security algorithm. The only assumption in the system is that each user must have a wallet account from where the fare for travel is being debited and the face of the passenger must be stored in the database. The accuracy of the system depends on the camera used at the stations to capture images. It can be considered as more economical as the system is paperless.

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