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AUTOMATED FARE CALCULATION IN METRO TRAIN USING FACE DETECTION AND RECOGNITION

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Abstract- There has been tremendous advancement in the field of computing in the last two decades. Human face is the most dominant characteristic which is used to verify/authenticate a person amongst group of people. Face detection technology is developed for detecting facial features and ignores background images or cluttered images. Computer-based face recognition system has revolutionized the way the world works around these days, as government agencies (law and justice enforcement) are readily accepting this technology as a standard method for recognizing the uniqueness in a human beings. The proposed system is based on facial recognition that can be used by Metro train System for easing up the process of fare calculation deduction system by means of automating the system using cameras placed at the entry gate, inside the metro rail and at the exit gate. This system will help in saving the man hours required for vending out tokens/ tickets/ smart cards in the metro system. This system will also increase the accuracy and will help in replacing traditional fare calculation activity which is perform daily.
Keywords –Voila Jones, Ada Boost, local binary Pattern, Support vector machine, eigenfaces, fisherfaces.

1. INTRODUCTION

Since the dawn of scientific era and computer advancements especially in the field of internet, E- commerce and E-banking through safe portals the lives of people using these services have become tremendously easier. With the introduction of biometrics based system such as finger print detection, iris matching and facial recognition have provided strength to the security feature that is required while doing this financial transactions using online services such as buying tickets, reserving seats for a movie, buying software online, funds transfers. This proposed system based on the facial detection and recognition algorithms which will automatically detect the face of the passenger of a metro and recognize it by matching with the existing database and calculate/deduct fare accordingly. This will be processed based on the distance travelled by the passenger and amount would be deducted from his or her bank account at the end of the journey.

A biometric is a unique, measurable characteristic of a human being that can be used to automatically recognize an individual or verify an individual's identity. Biometrics can measure both physiological and behavioral characteristics.

Types of Biometrics are:

1. Physiological biometrics: This biometrics is based on measurements and data derived from direct measurement of a part of the human body like Finger-scan, Facial Recognition, Iris-scan, Retina-scan, and Hand-scan.
2. Behavioral biometrics:This biometrics is based on measurements and data derived from an actions like Voice-scan and Signature-scan.

There are two predominant approaches to the face recognition: Geometric (feature based) and photometric (view based).

Geometric: Is based on geometrical relationship between facial landmarks, or inother words the spatial configuration of facial features. That means that the main geometrical features of the face such as the eyes, nose and mouth are first located and then faces are classified on the basis of various geometrical distances and angles between the features

Photometric stereo: Used to recover the shape of an object from a number ofimages taken under different lighting conditions. The shape of the recovered object is defined by a gradient map, which is made up of an array of surface normal.

In the existing system, limitations are bound to occur in the systems designed by humans. As humans can strive to achieve perfection but possibility of error occurrence is always present. There are various systems besides facial recognition system which prone to inaccuracy due to the following errors:

Table 1: Different existing systems

System	Drawbacks
RFID-based	Unethical usage of the passengers.
Fingerprint-based	It is time consuming as somebody has to clean the fingerprint device after a certain number of inputs. It's a contact basedsystem therefore prone to errors and contact diseases.
Iris-based	Invasion of privacy of the user.
Wireless-based	Poor performance due to topographical situation

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Face detection and recognition technology is gaining popularity day by day and the techniques that are being applied have witnessed a growing interest from the biometric community present around the globe. The Face Detection and recognition process is as shown in Figure 1.

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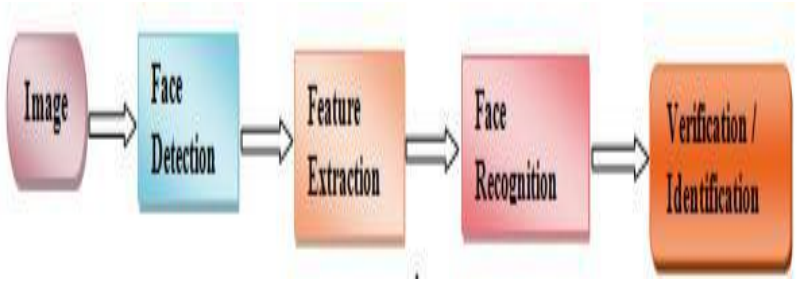

Fig. 1: Face Detection and recognition process

The rest of the paper is organized as, proposed system is explained in section II. Experimental results are presented in section III. Concluding remarks are given in section IV.

2. PROPOSED SYSTEM

This system is based on face recognition. The users Face will be recognized, if it is stored in the database and if the user has sufficient balance in his E-Wallet, user will be allowed to board the train. In case if the traveler is not a registered user the traveler will have to register before boarding. The bill will be generated in the end of the users travel according to the distance travelled. In the proposed system the Viola-Jones[1] Algorithm is used for detecting various facial features on the human face image that have captured.

Face Detection: AdaBoost [2] classifier is used with Haar [3] and Local Binary Pattern (LBP) [4] features whereas Support Vector Machine (SVM) [5] classifier is used with Histogram of Oriented Gradients (HOG) [6] features for face detection evaluation. Haar-like [3] features are evaluated through the use of a new image representation that generates a large set of features and uses the boosting algorithm AdaBoost [2] to reduce degenerative tree of the boosted classifiers for robust and fast interferences only simple rectangular Haarlike [3] features are used that provides a number of benefits like sort of ad-hoc domain knowledge is implied as well as a speed increase over pixel based systems, suggestive to Haar [3] basis functions equivalent to intensity difference readings are quite easy to compute. Implementation of a system that used such features would provide a feature set that was far too large, hence the feature set must be only restricted to a small number of critical features which is achieved by boosting algorithm, Adaboost [2]. The original LBP [4] operator labels the pixels of an image by thresholding the 3-by-3 neighborhood of each pixel with the center pixel value and considering the result as a binary number. Each face image can be considered as a composition of micro-patterns which can be effectively detected by the LBP [4] operator. To consider the shape information of faces, they divided face images into N small non-overlapping regions T0, T1, ..., TN. The LBP [4] histograms extracted from each sub-region are then concatenated into a single, spatially enhanced feature histogram defined as:

$H_{i,j} = \Sigma_x, _y I(f_l(x,y)=i) I((x,y) \in T_j)$ where i = 0, ... , L-1; j = 0, ..., N-1.

The extracted feature histogram describes the local texture and global shape of face images.

SVM [5] classifier is been used with HOG [6] features for face detection. HOG [6] greatly outperforms wavelets and degree of smoothing before calculating gradients damages, results emphasizes much of the available information is from sudden edges at fine scales that blurring this for reducing the sensitivity to spatial position is a mistake. Gradients should be calculated at the finest available scale in the current pyramid layer and strong local contrast normalization is essential for good results. Whereas SVM [5] are formulated to solve a classical two class problem

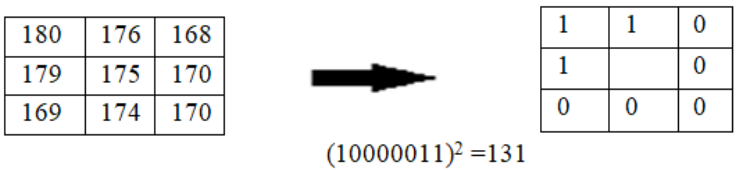

Fig. 2: LBP calculation

which returns a binary value, the class of the object. To train our SVM [5] algorithm, the problem is formulated in a difference space that explicitly captures the dissimilarity between two facial images. The summary of above methods is stated below as in table 1.

Table 1: Face detection results summary

Dataset	Dataset(%)		
	Adaboost		SVM
	Haar	LPB	HOG
1	98	95	93
2	99	99	95
3	97	72	88
4	96.9	95	92
5	91	88	90
Mean	96.38%	89.8%	91.6%

The system is been tested on different datasets and based on above demonstrated system, result is demonstrated below as in Fig 3.

Fig. 3: Face detection

To reduce pose variation and illumination in extracted faces two extra actions performed in pre-processing stage to improve recognition results.

Face Recognition: Eigenfaces [7] considered as 2-D face recognition problem, faces will be mostly upright and frontal. That's why 3-D information about the face is not required that reduces complexity by a significant bit. It convert the face images into a set of basic functions which essentially are the principal components of the face images seeks directions in which it is more efficient to represent the data. This is mainly useful for decrease the computational effort. Linear discriminant analysis is primarily used here to reduce the number of features to a more manageable number before recognition because face is represented by a large number of pixel values. Each of the new dimensions is a linear combination of pixel values, which form a template. The linear combinations obtained using Fisher's linear discriminant are called Fisherfaces [9]. LBP [4] is an order set of binary comparisons of pixel intensities between the center pixel and its eight surrounding pixels.

LBP (xa,ya) = Σn=07s(im - ia) 2n

Where ia corresponds to the value of the center pixel (xa,ya) im to the value of eight surrounding pixels, function f(x) is defined as:

f(x) = 1 if x>=0

0 if x<0

3. EXPERIMENT AND RESULT

For implementing the proposed system, MATLAB has been used. The database to detect and recognize the metro train passengers consisting of nearly 1500 passengers. Following are the results obtained from the proposed system.

In home page (Fig 4) the user has to register (Fig 5) by entering the name, contact number, and wallet balance. If he/she is already a user he/she can press the start journey button and once the traveler reaches the destination he/she has to press the end journey. The start time and the end time will be noted. The fare is calculated according to the duration.

Table 2: Face recognition results summary

Dataset	Recognition(%)			
	PCA	LDA	LBP	Gabor
1	74	78	86.03	94.07
2	68	75.61	81.3	88.76
3	71	79.34	86.09	90.99
4	75	80.95	87	97.91
5	68.04	73.21	76.69	88.93
Mean	71.208	77.422	83.422	92.132

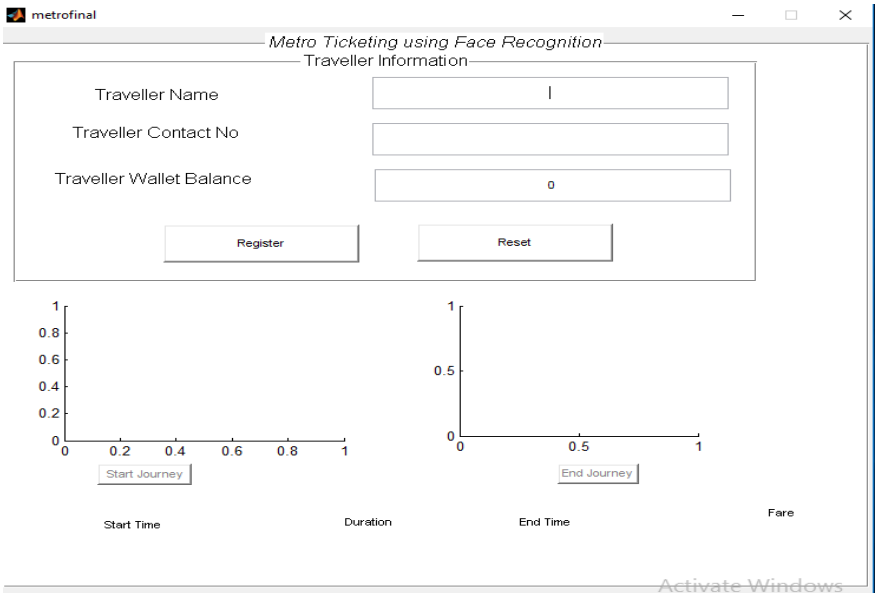

Fig 4: Home Page

After giving the details as in the figure 5 the user has to press the regiter button to complete the registration process (Fig 6). Camera will be opened for capturing the face and stored in database.

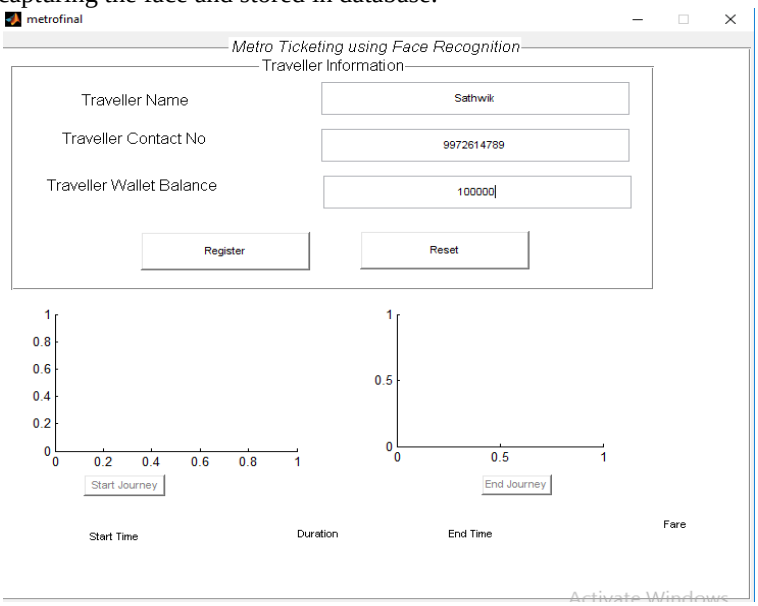

Fig. 5: Register

Once the Start Journey option is selected (Fig 7) again camera will be opened for capturing the traveller's image and the equivalent match will be recognised from the database as shown in the figure 7.. The start time will be noted.

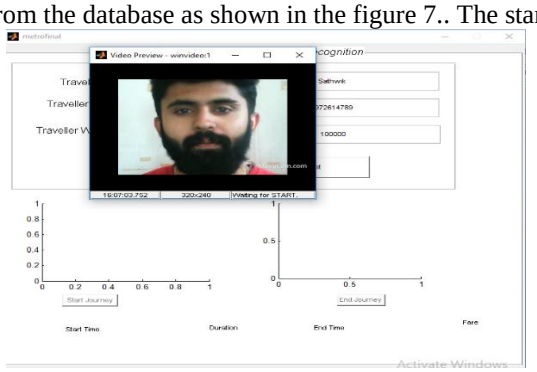

Fig 6: Register camera

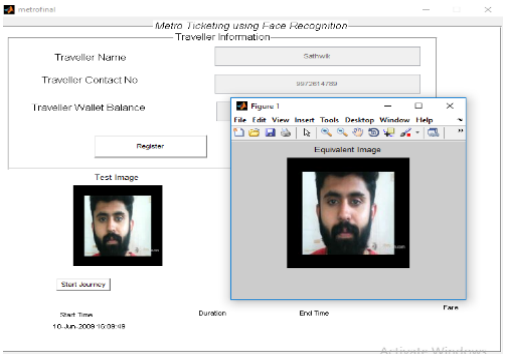

Fig 7: Start Journey

Once the traveler reaches the destination he/she has to press the end journey button the camera will be opened again (fig 8) for recognition and the fare will be calculated according to the duration of the travel. The fare is calculated (Fig 9) on the basis of time frame. The E-wallet amount will be automatically deducted from the travelling fare.

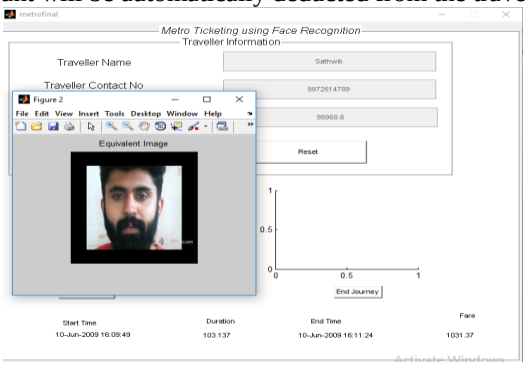

Fig. 8: End Journey

Start Time	Duration	End Time	Fare
10-Jun-2009 16:09:49	103.137	10-Jun-2009 16:11:24	1031.37

Fig. 9: Fare Calculation

4. CONCLUSION

The automated fare calculation in metro using face recognition is an efficient way for calculating the travel fare based on faces and travel time. The face detection technology is developed for detecting facial features and ignores background images or cluttered images. This system avoids fraudulent use of metro smart cards and also is time efficient. This system is also efficient and reduces the use of human resource. This system can also be used in various fields for calculating fare on the basis of time constraints and face value.

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