Facial Authentication Using Viola-Jones

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Abstract - A facial Authentication system is a computer application for automatically recognizing or verifying a human face from a digital image from a source. This paper gives an overview of face and introduction of face recognition and the various methods of the system. To achieve this goal system uses three steps : face identification, feature extraction and comparison. Viola-jones algorithm is used to identify face from digital image. Human face has so many features and face recognition system extract those features of face from the image source or digital image. The person recognized based on these extracted features and then the system generate result in terms of non-identified and identified.

Keywords - Face identification, Feature extraction, comparison, Facial authentication.

1. INTRODUCTION

In our daily life face is our primary focus of attention and it plays an important role in conveying identity and emotions. To distinguish a person the face is the best feature and to naturally identify and verify a face from an image by a source, facial recognition system is used which is very useful application of computer. Humans can remember lots of faces learned throughout our lifespan and identify faces at a glance even after years of separation. Face recognition is an extremely active field of research and there is a wide range of real-world applications. To track criminals and monitor for dangerous persons Facial recognition systems are plays an important role and it also uses in other applications.

Human face has so many features and face recognition system extract those features of face from the image source or digital image. The person recognized based on these extracted features and then the system generate result in terms of non-identified and identified.

Face identification, Feature extraction and comparison are the steps of face Recognition process. In digital image to find out whether the image exist human faces or not face identification methods are used. Face identification, as a significant feature of automatic face recognition system. With advancement of technologies there are various hardware and software are available that leads to high image qualities in almost every mobile devices. People do a lot of photography or snap and then upload them to social networks to share with their dear ones, friends and family members. Hence face identification plays an important role to examine or arrest the criminals and suspects. Regardless of color, size, position, and features face identification is based on locating and identifying a human face in a digital images. For Face identification there are so many Approaches. Viola and Jones proposed face detection which is most popular technique which is based on statistical methods.

Figure 1.1Example of Haar features.

To test the performance of our Face Recognition system on color image, we have used database containing 20 still images. GUI detects the face and features in face. Here we use feature like left eye, right eye, nose, mouth. After feature detection these entire feature window extract individually and calculate their histogram. The histogram consists of the gray levels of images, that is, a graph indicating the number of times each gray level occurs in the image. Here we detect the face and extract them in a separated window. A user will be able to judge the whole tonal arrangement at a glance by looking at the histogram for a definite picture. Now days in many digital cameras are coming with picture histogram. We can recognise the face from database with the help of histogram of these entire features. For face detection in images there are so many approaches have been proposed, we discuss here some of them.

1.1 Knowledge-based methods:

Knowledge-based methods are basically rule-based methods. Knowledge-based methods try to gain our face knowledge, and convert them into a set of rules. It's simple to guess some easy rules[3]. It extrapolates the human understanding of the face structural characteristics. From morphological facts rules are formalized [12].

1.2 Feature invariant approaches:

Feature invariant algorithms try to find invariant face features despite its position or angle. The perception is to defeat the limits of our natural face knowledge. In feature invariant approach locating facial features firstly and then collecting their relevant enclosing entities such as blobs, graphs, streaks and edges as a detected face in bottom-up manner[13]. To identify particular shapes such as eyes, eyebrows and noses etc. edge detectors are used and between these shapes statistical models estimate distance.

1.3 Template matching:

These methods attempt to define a face as a objective. From all the faces we try to find a standard template. To express the face as a whole or the features of face individually several standard patterns are stored. For quick face detection scassellati [14] uses ratio templates. The method is the human face is virtually divided into 16 regions of interest using a 14 × 16 pixels grayscale window. Using a grayscale window each region is averaged.

1.4 Appearance-based methods:

These methods rely on methods from arithmetical analysis and machine learning to find the significant characteristics of face images. Some appearance-based approaches work in a probabilistic network. A picture or feature vector is a random variable with some expectation of belonging to a face or not. To capture the representative variability of faces from a set of training images the models are learned [15].

To extracts features from the information feature extraction algorithm is used. On the bases of combinations of the original data it builds those features. It involves simplifying the amount of resources needs to describe a bulky set of information perfectly. Feature extraction is a method of creating combinations of the variables to get around these complications while still characterizing the data with sufficient accuracy. A big amount of memory and calculation power or a sorting algorithm which over fits the training sample and generalizes weakly to new samples are needed to analysis with a large number of variables.

Facial recognition is a technique to identify the face from a database. Facial recognition is a developing area, varying and getting better constantly. Many research areas affect face identification - computer vision, optics, neural networks, pattern recognition, machine learning. It has so many dissimilar approaches in which we examine here some of them.

1.4 Piecemeal/Wholistic approaches:

From little information faces can often be identified. Processing facial features independently, some algorithms follow this scheme. The relation of a feature with the entire face or the relation between the features is not taken into description. Lots of early researchers followed this approach, trying to figure out the most related features. A number of approaches tried to use a combination of features [20], the eye [23] and so on.

1.5 Appearance-based approaches:

These methods represent a face in terms of some unprocessed intensity images. As a high-dimensional vector an image is measured. To obtain a feature space from the image division statistical techniques are generally used and with the training set, trial image is compared. A linear dimension reduction is performed by linear appearance-based methods [24].

2. SYSTEM MODEL

Face authentication is a very popular topic in research application of pattern recognition and computer vision. The purposes of the study were to give valuable knowledge for those who are interested in computer vision, and to implement a facial authentication application using the viola-jones. Face authentication system can help in many ways; face authentication can be used for both verification and identification. Authentication technology is applied to a wide variety of problems like passport fraud, human computer interaction and support for law enforcement and so many applications. Face authentication is also applied in identity authentication, human-machine interaction, artificial intelligence, video surveillance and various applications. This has motivated researchers to develop computational models to identify faces, which are relatively simple and easy to implement. Users of camera can use them as an aid to explain the allotment of tones captured, and whether image feature has been lost to blown-out highlights or blacked-out shadows. Because the data contained in the graph is a demonstration of pixel distribution as a function of tonal variation, image histograms can be analyzed for peaks and/or valleys which can then be used to determine a threshold value.

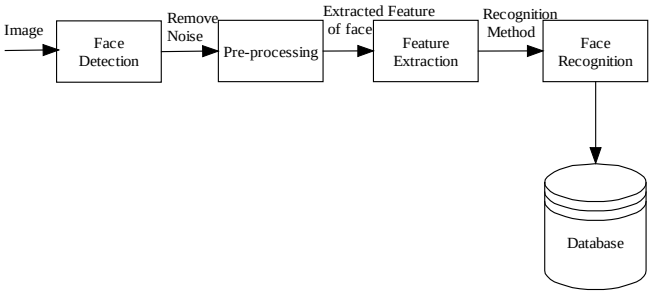

Figure2.1 The four basic steps in Face Authentication

The model to detect face used here is the Viola-Jones algorithm with computer vision toolbox and histogram matching is used for recognition for faces from database. We have developed a technique of face authentication that is quick, practically simple and correct with a comparatively easy and simple to understand algorithms and techniques. In recent years face authentication has received generous attention from both the market and research communities, but still remained very difficult in real applications. Face identification is the first step of face

authentication as it automatically detects a face from a complex background to which the face authentication algorithm can be applied.

3. PROPOSED METHODOLOGY

In proposed method system consists of various steps: face identification, feature extraction and comparison. There is a database of features of face images which is using for authentication. An input image is use for the identification of face from that database of image and displayed in a separated window with histogram. Then local feature like eye, nose and mouth is extracted during feature extraction, all the features and histogram is stored in a feature database. Matching processing check all feature in a sequence in one by one manner, if first feature is matched then it check the next feature, otherwise it go to check the another input images. Matching of the entire feature is the main focus of work. After the entire feature matching from data base, it moves to the authentication process.

3.1 Face identification:

In digital images Face detection is the procedure that determines the sizes and locations of human faces. Here we use viola jones face detection algorithm. Paul Viola and Michael Jones presented a quick and robust method for face detection which is 15 times faster than any method at the time of release with 98% accuracy. The method relies on the use of simple Haar-like features that are evaluated quickly through the use of a new image representation. On the bases of “Integral Image” it generates a huge set of features and to decrease the over-complete set the boosting algorithm AdaBoost is used and to provides for strong and quick interferences the introduction of a degenerative tree of the boosted classifiers is used. The detector is applied in a scanning manner and used on gray-scale images, the scanned window that is applied can also be scaled, as well as the features evaluated. Paul Viola and Michael Jones in 2001 proposed a first object detection framework to present real time competitive object detection[57].

Figure3.1.1 Different Haar classifiers used in Viola-jones [57].

Even though it can be skilled to detect a variety of object classes, it was motivated mainly by the difficulty of face detection. The Viola-Jones algorithm is implemented in OpenCV as cvHaarDetectObjects(). On the bases of Haar wavelets Viola and Jones features are used. These classifiers are single square waves (one low interval and one high interval). A square wave is a couple of adjacent rectangles - one dark and one light, In two dimensions.

The diagram represents above are not true Haar wavelets in Figure 5.2. For visual object detection these feature rectangle combinations are for visual recognition tasks they are much better suited.

Figure3.1.2Rectangular features over a face[57].

By subtracting the pixel value of average dark-region from the pixel value of average light-region we can determined the presence of a Haar feature . The Haar feature is said to be present if the difference is above a threshold (set during learning).

3.2 Feature extraction :

Feature extraction is the task of reducing the high dimensional training data to a set of features to investigate characteristics of the data [10][11]. Although there are many features on human face, most of them are very useful for facial expression representation. Here features of input image are extracted such as eye, nose and mouth and calculate their histogram for recognition phase. These all extracted features of input image are matched with the feature database one by one, in a nested loop and have to decide if the person is belongs to the database or not.

3.3 Comparison :

Face comparison is the process to verify or identify faces from a digital image from a database source. Recognizing is done through histogram based methods. Here apply histogram calculation for face recognition, for every extracted feature, histogram of that feature is calculated and match their histogram with feature database. First we match eye, if eye will match it will check the nose histogram matching otherwise it will check the next image and leave that image and so on. After matching of the entire feature then it match the face from database. The

recognition of a face person is represented in the figure 3. The algorithm given below worked for face recognition with success rate of 98%. In lighting conditions most face recognition algorithms are very sensible. In recognizing process there are some other issues that can affect such as makeup, emotion, hair style, size and rotation angle(54).

4. CONCLUSION

After wide studies of topic-related areas the prototype of an image processing application was designed and implemented. During the first stage of the development the Graphical User Interface was created. It required careful consideration of the purpose of the program, in order to place elements correctly. The actual programming part introduced me to some challenges concerning mostly connecting functionality with the GUI objects. The most difficult part was to realize that not all of the functions can be implemented for any type of the graphic file. Just to call out an example – operations responsible for flipping the picture vertically and horizontally work only for grayscale images. Learning about the constraints and possibilities of errors helped me to understand how important it is to plan and think through all the details of the new software in the beginning of the work. To sum up, the outcome of this thesis is a simple program that presents possibilities of Matlab and the GUIDE tool. In addition to the practical part of the thesis, the other goal was to learn new information from various areas related to the computer graphics and Matlab in general. Theory presented in this thesis covers quite precisely the most important topics within the computer graphics, such as colormaps, file formats, vector and raster graphics together with color systems. Great amount of time was given into getting to know the Image Processing Toolbox – one of the libraries of Matlab suite. Finding out what is the range of possible image transformations that can be done with this toolbox helped me to realize that Matlab is a great piece of software and may be widely used in many purposes. Overall idea behind my thesis was to show that Matlab is not only good for complicated and complex mathematical drawings but also provides a broad collection of regular image processing functions. Of course it is great for medical image transformations and recognition but that is not all. Many programmers do not realize the full potential of Matlab and the Graphical User Interface tool that it provides. Despite the outcome of my thesis, including the image processing application, the topic stays open to the future modifications and development.

5. FUTURE SCOPES

We plan to further improve our method.The face recognition and detection algorithms were thoroughly studied taking a number of test images and varying the conditions and variables. All the work mentioned above involved real time data. The Viola-jones and computer vision success rates were given while for face detection, the success rate was different for different images depending on the external factors. The overall success rate was 98%.Even though the aim of the study was completed, there are still a lot of possibilities for future development. Wide selection of the libraries, filled with multiple choice of available functions gives the programmer almost unlimited chance of growth. A simple image processing application can become a complex piece of new software. Image Processing Toolbox implements many functions that were not used in my application. Among them there is a group of morphological operations such as dilation, erosion, morphological opening and closing, filling certain areas and more. IPT also provides couple of methods of a thresholding. A big collection of functions implement different types of filters. Some of them are needed in the process of image adjustments and others are responsible for object recognition.Next generation person recognition systems will need to recognize people in real-time and in much less constrained situations.

REFERENCES

[1]. [1] McKenna, S.J.[Stephen J.], Jabri, S.[Sumer], Duric, Z.[Zoran], Rosenfeld, A. [Azriel], Wechsler, H.[Harry], Tracking Groups of People,CVIU(80), No. 1, October 2000, pp. 42-56.

[2]. M. Yang, D. Kriegman, and N. Ahuja, “Detecting Faces in Images: A Survey,” IEEE Transaction Pattern Analysis and Machine Intelligence, vol. 24, no. 1, pp. 34-58, 2002

[3]. E. Hjelmas, and B.K. Low, “Face Detection: A Survey,” Computer Vision and Image Understanding, vol. 83, pp. 236-274, 2001.

[4]. G. Yang and T. S. Huang. Human face detection in complex background.Pattern Recognition, 27(1):53–63, 1994.

[5]. R. Kjeldsen and J. Kender. Finding skin in color images. Proc. Second International Conf. Automatic Face and Gesture Recognition, pages 312–317, 1996.

[6]. T. K. Leung, M. C. Burl, and P. Perona. Finding faces in cluttered scenes using random labeled graph matching. Proc. Fifth IEEE International Conf. Computer Vision, pages 637–644, 1995.

[7]. I. Craw, D. Tock, and A. Bennett. Finding face features. Proc. Second European Conf. Computer Vision, pages 92–96, 1992.

[8]. A. Lanitis, C. J. Taylor, and T. F. Cootes. An automatic face identification system using flexible appearance models. Image and Vision Computing, 13(5):393–401, 1995.

[9]. T. F. Cootes and C. J. Taylor. Statistical models of appearance for computer vision. Technical report, Imaging Science and Biomedical Engineering. University of Manchester, March 2004.

[10]. M. Turk and A. Pentland. Eigenfaces for recognition. J. Cognitive Neuroscience, 3(1):71–86, 1991.

[11]. Z. Li, Lijie Xue and Fei Tan, “Face Detection in Complex Background Based on Skin Color Features and Improved

AdaBoost Algorithms", 978-1-4244-6789-1110/$26.00 ©2010 IEEE.

[12]. Yao-Jiunn Chen, Yen-Chun Lin, "Simple Face-detection Algorithm Based on Minimum Facial Features", 1-4244-0783-4/07/$20.00 ©2007 IEEE.

[13]. Proyecto Fin de Carrera, "Face Recognition Algorithms", Ion Marqu´es June 16, 2010.

[14]. W. Zhao, R. Chellappa, A. Rosenfeld, and P. Phillips. Face recognition:A literature survey. ACM Computing Surveys, pages 399–458, 2003.

[15]. W. W. Bledsoe. The model method in facial recognition. Technicalreport pri 15, Panoramic Research, Inc., Palo Alto, California, 1964.

[16]. W.W. Bledsoe and H. Chan. A man-machine facial recognition systemsome preliminary result. Technical report pri 19a, Panoramic Research, Inc., Palo Alto, California, 1965.

[17]. W. W. Bledsoe. Man-machine facial recognition: Report on a largescale experiment. Technical report pri 22, Panoramic Research, Inc., Palo Alto, California, 1966.

[18]. W. W. Bledsoe. Some results on multicategory patten recognition. Journal of the Association for Computing Machinery, 13(2):304–316, 1966.

[19]. W. W. Bledsoe. Semiautomatic facial recognition. Technical report sri project 6693, Stanford Research Institute, Menlo Park, California, 1968.

[20]. T. Kenade. Picture Processing System by Computer Complex and Recognition of Human Faces. PhD thesis, Kyoto University, November 1973.

[21]. M. Pham and T. Cham, "Fast training and selection of haar features using statistics in boosting-based face detection," IEEE 11th International Conference on ComputerVision, pp. 1–7, 2007.

[22]. P. Viola and M. Jones, "Rapid object detection using a boosted cascade of simplefeatures," in CVPR01, pp. 511–518, 2001.

[23]. C. Kotropoulos and I. Pitas, "Rule based face detection in frontal views," Proc. ofIEEE Int. Conf. on Acoustics, Speech and Signal Processing, April 1997.

[24]. G. Yang and T. Huang, "Human face detection in complex background," PatternRecognition, vol. 27, no. 1, pp. 53–63, 1994.

[25]. M.-H. Yang, D. J. Kriegman, and N. Ahuja, "Detecting faces in images: A survey,"IEEE Trans. Pattern Anal. Mach. Intell., vol. 24, no. 1, pp. 34–58, 2002.

[26]. S. A. Sirohey, "Human face segmentation and identification," Master's thesis, University of Maryland, 1993.

[27]. J. Canny, "A computational approach to edge detection," IEEE Trans. Pattern Anal. Mach. Intell., vol. 8, pp. 679–698, November 1986. Available from: http://portal.acm.org/citation.cfm?id=11275.

[28]. D. Saxe and R. Foulds, "Toward robust skin identification in video images," in FG '96: Proceedings of the 2nd International Conference on Automatic Face and Gesture Recognition (FG '96), (Washington, DC, USA), p. 379, IEEE Computer Society,1996.

[29]. H. Graf, E. Cosatto, D. Gibbon, M. Kocheisen, and E. Petajan, "Multimodal system for locating heads and faces," in FG '96: Proceedings of the 2nd International Conference on Automatic Face and Gesture Recognition, (Washington, DC, USA),p. 88, IEEE Computer Society, 1996.

[30]. B. Scassellati, "Eye finding via face detection for a foveated, active vision system," in AAAI '98/IAAI '98: Proceedings of the fifteenth national/tenth conference on Artificial intelligence/Innovative applications of artificial intelligence, (Menlo Park, CA, USA),pp. 969–976, American Association for Artificial Intelligence, 1998.

[31]. A. S. Yuille, D. S. Cohen, and P.W. Hallinan, "Feature extraction from faces usingdeformable templates," Int. J. Comput. Vision, vol. 8, no. 2, pp. 99–111, 1992.

[32]. M. Turk and A. Pentland, "Eigenfaces for recognition," Journal of Cognitive Neuroscience,vol. 3, no. 1, pp. 71–86, 1991.

[33]. P. Belhumeur, J. Hespanha, and D. Kriegman, "Eigenfaces vs. fisherfaces: Recognition using class specific linear projection," IEEE Transactions on Pattern Analysisand Machine Intelligence, vol. 19, no. 7, pp. 711–720, 1997.

[34]. M. Turk, "A random walk through eigenspace(special issue on machine vision applications)," IEICE transactions on information and systems, vol. 84, no. 12, pp. 1586–1595, 2001.

[35]. M. Turk and A. Pentland, "Eigenfaces for recognition," Journal of Cognitive Neuroscience,vol. 3, no. 1, pp. 71–86, 1991.

[36]. K. K. Sung and T. Poggio, "Example-based learning for view-based face recognition," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 20, no. 1,pp. 39–51, 1994.

[37]. H. Rowley, S. Baluja, and T. Kanade, "Human face detection in visual scenes," in Advances in Neural Information Processing Systems (D. S. Touretzky, M. C. Mozer,and M. E. Hasselmo, eds.), vol. 8, pp. 875–881, 1996.

[38]. H. Rowley, S. Baluja, and T. Kanade, "Rotation invariant neural network-based face detection," in Proceedings of Computer Vision and Pattern Recognition, 1998,(Washington, DC, USA), p. 963, IEEE Computer Society, 1998.

[39]. E. Nowak, F. Jurie, and B. Triggs, "Sampling strategies for bag-of-features image classification," in European Conference on Computer Vision (4), vol. 3954 of LectureNotes in Computer Science, pp. 490–503, Springer, 2006.

[40]. J.Winn, A. Criminisi, and T. Minka, "Object categorization by learned universalvisual dictionary.," in ICCV, pp. 1800–1807, 2005.

[41]. D. Lowe, "Distinctive image features from scale-invariant keypoints," in International Journal of Computer Vision, vol. 20, (Hingham, MA, USA), pp. 91–110,Kluwer Academic Publishers, 2004.

[42]. M. Pham and T. Cham, "Fast training and selection of haar features using statistics in boosting-based face detection," IEEE 11th International Conference on ComputerVision, pp. 1–7, 2007.

[43]. P. Viola and M. Jones, "Rapid object detection using a boosted cascade of simplefeatures," in CVPR01, pp. 511–518, 2001.

[44]. P. Yang, S. Shan, W. Gao, S. Li, and D. Zhang, "Face recognition using adaboostedgabor features," in AFGR04, pp. 356–361, 2004.

[45]. M.A. Grudin, "A compact multi-level model for the recognition offacial images," Ph.D. thesis, Liverpool John Moores Univ., 1997.
[46]. A. Pentland, B. Moghaddam, and T. Starner, "View-Based and modular eigenspaces for face recognition," Proc. IEEE CS Conf.Computer Vision and Pattern Recognition, pp. 84-91, 1994.
[47]. T.J. Stonham, "Practical face recognition and verification withWISARD," Aspects of Face Processing, pp. 426-441, 1984.
[48]. S. Lawrence, C.L. Giles, A.C. Tsoi, and A.D. Back, "Face recognition: A convolutional neural-network approach," IEEE Trans. NeuralNetworks, vol. 8, pp. 98-113, 1997.
[49]. M. Lades, J.C. Vorbruggen, J. Buhmann, J. Lange, C. Von Der Malsburg, R.P. Wurtz, and M. Konen, "Distortion Invariant object recognition in the dynamic link architecture," IEEE Trans. Computers,vol. 42, pp. 300-311, 1993.

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