A SURVEY OF FACE RECOGNITION

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ABSTRACT

Face recognition presents a challenging problem in the field of image analysis and computer vision, and as such has received a great deal of attention over the last few years because of its many applications in various domains. Face recognition techniques can be broadly divided into three categories based on the face data acquisition methodology: methods that operate on intensity images; those that deal with video sequences; and those that require other sensory data such as 3D information or infra-red imagery. In this paper, an overview of some of the well-known methods in each of these categories is provided and some of the benefits and drawbacks of the schemes mentioned therein are examined. Furthermore, a discussion outlining the incentive for using face recognition, the applications of this technology, and some of the difficulties plaguing current systems with regard to this task has also been provided. This paper also mentions some of the most recent algorithms developed for this purpose and attempts to give an idea of the state of the art of face recognition technology.

I. INTRODUCTION

A facial recognition system is a computer application for automatically identifying or verifying a person from a digital image or a video frame from a video source. One of the ways to do this is by comparing selected facial features from the image and a facial database. It is typically used in security systems and can be compared to other biometrics such as fingerprint or eye iris recognition systems. Facial recognition (or face recognition) is a type of biometric software application that can identify a specific individual in a digital image by analyzing and comparing patterns. Facial recognition systems are commonly used for security purposes but are increasingly being used in a variety of other applications. The Kinect motion gaming system, for example, uses facial recognition to differentiate among players. Most current facial recognition systems work with numeric codes called faceprints. Such systems identify 80 nodal points on a human face. In this context, nodal points are end points used to measure variables of a person's face, such as the length or width of the nose, the depth of the eye sockets and the shape of the cheekbones. These systems work by capturing data fornodal points on a digital image of an individual's face and storing the resulting data as a faceprint. The faceprint can then be used as a basis for comparison with data captured from faces in an image or video. Facial recognition systems based on faceprints can quickly and accurately identify target individuals when the conditions are favorable. However, if the subject's face is partially obscured or in profile rather than facing forward, or if the light is insufficient, the software is less reliable. Nevertheless, the technology is evolving quickly and there are several emerging approaches, such as 3D modeling, that may overcome current problems with the systems. According to the National Institute of Standards and Technology (NIST), the incidence of false positives in facial recognition systems has been halved every two years since 1993 and, as of the end of 2011, was just .003% Currently, a lot of facial recognition development is focused on smartphone applications. Smartphone facial recognition capacities include image tagging and other social networkingintegration purposes as well as personalized marketing. A research team at Carnegie Mellon has developed a proof-of-concept iPhone app that can take a picture of an individual and -- within seconds -- return the individual's name, date of birth and social security number. Facebook uses facial recognition software to help automate user tagging in photographs. Here's how facial recognition works in Facebook: Each time an individual is tagged in a photograph, the software application stores information about that person's facial characteristics. When enough data has been collected about a person to identify them, the system uses that information to identify the same face in different photographs, and will subsequently suggest tagging those pictures with that person's name. Facial recognition software also enhances marketing personalization. For example, billboards have been developed with integrated software that identifies the gender, ethnicity and approximate age of passersby to deliver targeted advertising.

Keywords: - Face Recognition, Personal Identification, Biometric

II. PROBLEM DEFINITION

The face recognition problem can be formulated as follows: Given an input face image and a database of face images of known individuals, how can we verify or determine the identity of the person in the input image?

III. WHY USE THE FACE FOR RECOGNITION?

Biometric-based techniques have emerged as the most promising option for recognizing individuals in recent years since, instead of authenticating people and granting them access to physical and virtual domains based on passwords, PINs, smart cards, plastic cards, tokens, keys and so forth, these methods examine an individual's physiological and/or behavioral characteristics in order to determine and/or ascertain his identity. Passwords and PINs are hard to remember and can be stolen or guessed; cards, tokens, keys and the like can be misplaced, forgotten, purloined or duplicated; magnetic cards can become corrupted and unreadable. However, an individual's biological traits cannot be misplaced, forgotten, stolen or forged. Biometric-based technologies include identification based on physiological characteristics (such as face, fingerprints, finger geometry, hand geometry, hand veins, palm, iris, retina, ear and voice) and behavioral traits (such as gait, signature and keystroke dynamics) [1]. Face recognition appears to offer several advantages over other biometric methods, a few of which are outlined here: Almost all these technologies require some voluntary action by the user, i.e., the user needs to place his hand on a hand-rest for fingerprinting or hand geometry detection and has to stand in a fixed position in front of a camera for iris or retina identification. However, face recognition can be done passively without any explicit action or participation on the part of the user since face images can be acquired from a distance by a camera. This is particularly beneficial for security and surveillance purposes. Furthermore, data acquisition in general is fraught with problems for other biometrics: techniques that rely on hands and fingers can be rendered useless if the epidermis tissue is damaged In some way (i.e., bruised or cracked). Iris and retina identification require expensive equipment and are much too sensitive to any body motion. Voice recognition is susceptible to background noises in public places and auditory fluctuations on a phone line or tape recording. Signatures can be modified or forged. However, facial images can be easily obtained with a couple of inexpensive fixed cameras. Good face recognition algorithms and appropriate preprocessing of the images can compensate for noise and slight variations in orientation, scale and illumination. Finally, technologies that require multiple individuals to use the same equipment to capture their biological characteristics potentially expose the user to the transmission of germs and impurities from other users. However, face recognition is totally non-intrusive and does not carry any such health risks.

IV. TECHNIQUE: TRADITIONAL

Some facial recognition algorithms identify facial features by extracting landmarks, or features, from an image of the subject's face. For example, an algorithm may analyze the relative position, size----, and/or shape of the eyes, nose, cheekbones, and jaw.[2] These features are then used to search for other images with matching features.[3] Other algorithms normalize a gallery of face images and then compress the face data, only saving the data in the image that is useful for face recognition. A probe image is then compared with the face data.[4] One of the earliest successful systems[5] is based on template matching techniques[6] applied to a set of salient facial features, providing a sort of compressed face representation. Recognition algorithms can be divided into two main approaches, geometric, which looks at distinguishing features, or photometric, which is a statistical approach that distills an image into values and compares the values with templates to eliminate variances. Popular recognition algorithms include Principal Component Analysis using eigenfaces, Linear Discriminate Analysis, Elastic Bunch Graph Matching using the Fisherface algorithm, the Hidden Markov model, the Multilinear Subspace Learning using tensor representation, and the neuronal motivated dynamic link matching.

V. 3-DIMENSIONAL RECOGNITION

A newly emerging trend, claimed to achieve improved accuracies, is three-dimensional face recognition. This technique uses 3D sensors to capture information about the shape of a face. This information is then used to identify distinctive features on the surface of a face, such as the contour of the eye sockets, nose, and chin.[7] One advantage of 3D facial recognition is that it is not affected by changes in lighting like other techniques. It can also identify a face from a range of viewing angles, including a profile view.[3][7] Three-dimensional data points from a face vastly improve the precision of facial recognition. 3D research is enhanced by the development of sophisticated sensors that do a better job of capturing 3D face imagery. The sensors work by projecting structured light onto the face. Up to a dozen or more of these image sensors can be placed on the same CMOS chip—each sensor captures a different part of the spectrum.[8] Even a perfect 3D matching technique could be sensitive to expressions. For that goal a group at the Technion applied tools from metric geometry to treat expressions asisometries[9] A company called Vision Access created a firm solution for 3D facial recognition. The company was later acquired by the biometric access company BioscryptInc.which developed a version known as 3D FastPass.

VI. SKIN TEXTURE ANALYSIS

Another emerging trend uses the visual details of the skin, as captured in standard digital or scanned images. This technique, called skin texture analysis, turns the unique lines, patterns, and spots apparent in a person's skin into a mathematical space.[3] Tests have shown that with the addition of skin texture analysis, performance in recognizing faces can increase 20 to 25 percent.[3][7]

Software

Notable software with face recognition ability include:

- digiKam (KDE)
- iPhoto (Apple)
- OpenCV (Open Source)
- Photoshop Elements (Adobe Systems)
- Picasa (Google)
- Picture Motion Browser (Sony)
- Windows Live Photo Gallery (Microsoft)

VII. HUMAN FACE RECOGNITION

face recognition is a subarea of object recognition which aims to identify a face given a scene or still images. It is very complex problem with high dimensionality due to the nature of digital images. Face recognition benefits many fields such as computer security and video compression. Two approaches are commonly used in face recognition are video-based and still images. Since the 80's, image-based recognition is more dominant in face recognition in comparison with the video-based approach. Few recent studies took advantages of the features of video scenes as it provides more dynamic characteristic of the human face that help the recognition process. Also, farm sequences sequence.provide more features of 3D representation and high resolution images. Besides, in video-based recognition the prediction accuracy can be improved using the farm

VIII. FACE RECOGNITION FROM OTHER SENSORY INPUTS

Though the bulk of the research on face recognition has been focused on identifying individuals from 2D intensity images, in recent years some attention has nevertheless been directed towards exploiting other sensing modalities, such as 3D or range data and infra-red imagery, for this purpose.

3D Model-based The main argument in favor of using 3D information for face recognition appears to be that it allows us to exploit features based on the shape and the curvature of the face (such as the shape of the forehead, jaw line, and cheeks) without being plagued by the variances caused by lighting, orientation and background clutter that affect 2D systems [37, 226, 227]. Another argument for the use of depth data is that "at our current state of technology, it is the most straightforward way to input or record complex shape information for machine analysis" [228]. The obvious drawbacks of such approaches are their complexity and computational cost [202].

The following techniques are currently being used to obtain 3D information [226]:

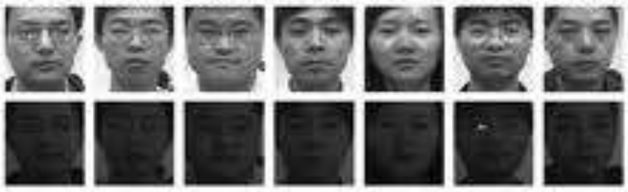
•Scanning systems: Laser face scanners produced by companies like Cyberware Inc. [229] and 3D Scanners Ltd. [230] seem to be producing highly accurate results; however, the cost of these commercial scanning services is obviously substantial.

•Structured light systems: These systems make use of the principles of stereo vision to obtain the range data. Their main advantage is that the only equipment they require is cameras and some kind of projection system.

IX. INFRARED BASED

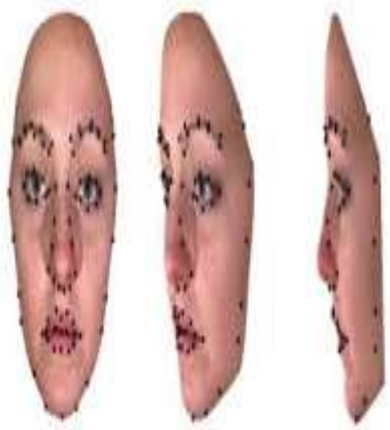
Infra-red imagery of faces is relatively insensitive to variations in lighting [253], such images can hence be used as an option for detecting and recognizing faces. Furthermore, [254] argues that since infra-red facial images reveal the vein and tissue structure of the face which is unique to each individual (like a fingerprint), some of the face recognition techniques for the visible spectrum should therefore yield favorable results when applied to these images. However, there exist a multitude of factors that discourage the exploitation of such images for the face recognition task, among which figure the substantial cost of thermal sensors, the low resolution and high level of noise in the images, the lack of widely available data sets of infra-red images, the fact of infra-red radiation being opaque to glass (making it possible to occlude part of the face by wearing eyeglasses) [255] and, last but not least, the fact that infra-red images are sensitive to changes in ambient temperature, wind and metabolic processes in the subject [256] (Note that in [257], the use of blood perfusion data is suggested to alleviate the effect of ambient temperature).

Visible Light Face Images under Controlled and Weak Light Condition



LBP+AdaBoost Matching Scores for intra- and extra-class pairs

	Ctrl 1	Ctrl 2	Ctrl 3	Ctrl 4	Ctrl 5	Ctrl 6	Ctrl 7
Weak 1	**0.4888**	0.4831	0.4751	0.4689	0.4764	0.4745	0.4658
Weak 2	0.4831	**0.5131**	0.4578	0.5202	0.4926	0.5014	0.4709
Weak 3	0.4808	0.4588	**0.4804**	0.4724	0.4814	0.4653	0.4619
Weak 4	0.4531	0.4563	0.4415	**0.4688**	0.4570	0.4582	0.4570
Weak 5	0.4892	0.4904	0.4757	0.4893	**0.5275**	0.4780	0.4824
Weak 6	0.4648	0.4835	0.4768	0.5085	0.4864	**0.4935**	0.4691
Weak 7	0.4686	0.4683	0.4636	0.4708	0.4887	0.4687	**0.5068**



X. CONCLUSIONS

Face recognition is a challenging problem in the field of image analysis and computer vision that has received a great deal of attention over the last few years because of its many applications in various domains. Research has been conducted vigorously in this area for the past four decades or so, and though huge progress has been made, encouraging results have been obtained and current face recognition systems have reached a certain degree of maturity when operating under constrained conditions; however, they are far from achieving the ideal of being able to perform adequately in all the various situations that are commonly encountered by applications utilizing these techniques in practical life. The ultimate goal of researchers in this area is to enable computers to emulate the human vision system "Strong and coordinated effort between the computer vision, signal processing, and psychophysics and neurosciences communities is needed" to attain this objective