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Person Re-Identification Based on Facial Feature using Generative Adversarial Neural Network

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Abstract: Person Re-Identification (Re-ID) has been a problem recently faced in computer vision. Most of the existing methods focus on body features which are captured in the high-end surveillance system. However, it is unhelpful for authentication. Automatic face recognition for still images with high quality can achieve satisfactory performance, but for video-based face recognition it is hard to attain similar levels of performance. Compared to still images face recognition, there are several disadvantages of video sequences. First, images captured by CCTV cameras are generally of poor quality. The noise level is higher, and images may be blurred due to movement or the subject being out of focus. Second, image resolution is normally lower for video sequences. If the subject is very far from the camera, the actual face image resolution can be as low as 64 by 64 pixels. Last, face image variations, such as illumination, expression, pose, occlusion, and motion, are more serious in video sequences. In the face recognition approach for controlled scenario to authenticate a person. Initially, faces are detected by Generative Adversarial Neural Network (GAN) and landmark points are obtained using Supervised descent method (SDM) Finally, face is recognized by Joint Bayesian model and provide the voice, Sms and E-mail alert at the time of unknown face detection in real time environment. The proposed framework overcomes the challenges such as pose variations, low resolution and partial occlusion. The experimental results (accuracy) on benchmark dataset demonstrate the effectiveness of the proposed method.

Keywords: Video surveillance, Person re-identification, Face recognition and SDM.

I. INTRODUCTION

A. IMAGE PROCESSING

Image processing is a method to perform some operations on an image, in order to get an enhanced image or to extract some useful information it. It is a type of signal processing in which input is an image and output may be image or characteristics/features associated with that image. Nowadays, image processing is among rapidly growing technologies. It forms core research area within engineering and computer science disciplines too. The key objective is to develop image recognition techniques that are efficient and less complex. Image Processing is used in the checking for presence, object detection and localization, measurement, identification and verification. It is pre-processed to enhance the image according to the specific task as noise reduction, brightness and contrast enhancement. The measurably devices used must be calibrated to the specified things. Camera calibration includes Geometric calibration and color calibration. Geometric calibration corrects the lens distortion and determines the relationship between pixels and real-world units like milli meter. Color calibration ensures an accurate reproduction of colors.

B. PERSON RE-IDENTIFICATION

Nowadays, a large network of cameras is predominantly used in public places like airports, railway stations, bus stands, and office buildings. These networks of cameras provide enormous video data, which are monitored manually and may be utilized only when the need arises to ascertain the fact. Fascinatingly, an automated analysis of such huge video data can improve the quality of surveillance by processing the video faster. Above all, it is more useful for high-level surveillance tasks like suspicious activity detection or undesirable event prediction for timely alerts. Especially, the person Re-ID task is one of the current attentions in computer vision research. Establishing the correspondence between the image sequences of a person, across multiple camera views or in same camera at different time intervals, is known as person Re-ID. Simply, it implies that a person, seen previously, is identified in his/her next appearance using a unique descriptor of the person. Humans do it all the time without much effort. Our eyes and brains are trained to detect, localize, identify, and later re-identify the objects and people in the real world. Humans are able to extract such a descriptor based on the person's face, height and structure, attire, hair color, hair style, walking pattern, etc. However, a person's face is the most unique and reliable feature that human uses to identify the people. Therefore, facial feature-based Re-ID is used to verify and recognize either the person seen in the camera is the same person spotted earlier in

the same camera at a different time. Especially, it is applicable in controlled environment where the face database is available.

C. FACIAL FEATURE-BASED PERSON REIDENTIFICATION

In earlier days, it was stated that "re-identification cannot be done by face due to immature camera capturing technology" . Nowadays due to remarkable growth of VLSI-based fabrication techniques, a person's face-capturing ability of camera has increased even in low illumination condition. Therefore, facial feature Re-ID booms, and it is a well-authenticated one. Facial feature-based re-identification is a process of identifying a person using his/her face under consistent labeling across multiple cameras or even with the same camera to reestablish different tracks. Since the face is a biometric feature that cannot be replicated easily, it is used for human re-identification. Also the face is the most natural and unique hallmark widely used as a person's identifier. In reality, re-identification cannot be applied to find similarity among people after several days due to likely alterations in their visual appearance like attire, gait, etc. The face is also helpful in person re-identification and deserves attention. The feature extracted from neck and above is an important clue for person re-identification. Biometric recognition features like the face, iris, and fingerprint can overcome these constraints by working on highly discriminative and stable features. Unlike the iris and fingerprint, to identify and recognize a person's "face" are successfully captured in the scene with improved camera technology. Beyond face recognition techniques, face re-identification techniques improve the system's metric learning and provide the best assurance to person's presence in the captured environment . This proposed framework focuses on facial feature-based Re-ID for indoor surveillance such as IT sectors, government agencies, and ATM centers. The emergence of the facial feature-based person Re-ID task can be attributed to the increasing demand of public safety and the widespread huge camera networks in theme parks, university campuses, streets, IT sectors, etc. However, it is extremely expensive to rely solely on brute-force human labor to accurately and efficiently spot a person-of-interest or to track a person across cameras. Automation of the facial feature-based person Re-ID is quite difficult to be accomplished without human intervention. It is still a challenging topic, due to the fact that the appearance of the same face looks dramatically different in controlled or uncontrolled environments with pose variations, different expressions, illumination conditions, low resolutions, and partial occlusions specifically.

II. RELATED WORK

"on pairwise costs for network flow multi-object tracking" by v. chari, s. lacoste-julien, the paper contributes The task of visual multi-object tracking is to recover spatio-temporal trajectories for a number of objects in a video sequence. Tracking multiple objects, like people or vehicles, has a wide range of applications from Robotics to video surveillance. Multi-object tracking has been recently approached with the min-cost network flow optimization techniques. Such methods simultaneously resolve multiple object tracks in a video and enable modeling of dependencies among tracks. Min-cost network flow methods also fit well within the "tracking-by-detection" paradigm where object trajectories are obtained by connecting per-frame outputs of an object detector. Object detectors, however, often fail due to occlusions and clutter in the video. To cope with such situations, we propose to add pair wise costs to the min-cost network flow framework. While integer solutions to such a problem become NP-hard, we design a convex relaxation solution with an efficient rounding heuristic which empirically gives certificates of small sub optimality. We evaluate two particular types of pair wise costs and demonstrate improvements over recent tracking methods in real-world video sequences.

"**Multi target tracking in non overlapping cameras using a reference set"** by x. chen, l. an, and b. Bhanu, the paper contributes a unified three-layer hierarchical approach for solving tracking problems in multiple non-overlapping cameras . Given a video and a set of detections (obtained by any person detector), first solve within-camera tracking employing the first two layers of our framework and, then, in the third layer, solve across-camera tracking by merging tracks of the same person in all cameras in a simultaneous fashion. To best serve our purpose, a constrained dominant sets clustering (CDSC) technique, a parameterized version of standard quadratic optimization, is employed to solve both tracking tasks. The tracking problem is caste as finding constrained dominant sets from a graph. That is, given a constraint set and a graph, CDSC generates cluster (or clique), which forms a compact and coherent set that contains a subset of the constraint set. The approach is based on a parameterized family of quadratic programs that generalizes the standard quadratic optimization problem. In addition to having a unified framework that simultaneously solves within- and across-camera tracking, the third layer helps link broken tracks of the same person occurring during within-camera tracking. A standard algorithm to extract constrained dominant set from a graph is given by the so-called replicator dynamics whose computational complexity is quadratic per step which makes it handicapped for large-scale applications. In this work, we propose a fast algorithm, based on dynamics from evolutionary game theory, which is efficient to large-scale real-world applications. This approach on a very large and challenging dataset (namely, MOT challenge Duke MTMC) and show that the proposed framework outperforms the current state of the art. Even though

the main focus of this paper is on multi-target tracking in non-overlapping cameras, proposed approach can also be applied to solve re-identification problem.

"**person re-identification by deep learning multi-scale representations"** by y. chen, x. zhu, and s. Gong, the paper contributes person re-identification (re-id) methods depend mostly on single-scale appearance information. This not only ignores the potentially useful explicit information of other different scales, but also loses the chance of mining the implicit correlated complementary advantages across scales. It demonstrate the benefits of learning multi-scale person appearance features using Convolutional Neural Networks (CNN) by aiming to jointly learn discriminative scale-specific features and maximize multi scale feature fusion selections in image pyramid inputs. Specifically, we formulate a novel Deep Pyramid Feature Learning (DPFL) CNN architecture for multi-scale appearance feature fusion optimized simultaneously by concurrent per-scale re-id losses and interactive cross-scale consensus regularization in a closed-loop design. Deep Pyramidal Feature Learning (DPFL) CNN architecture for learning explicitly multi-scale deep feature representation. Specifically, the DPFL consists of m scale specific branches each for learning one input image scale in the pyramid, and an additional scale-fusion branch for learning complementary combination of multi-scale features. Extensive comparative evaluations demonstrate the re-id advantages of the proposed DPFL model over a wide range of state-of the-art re-id methods on three benchmarks Market-1501, CUHK03, and Duke MTMC-re-ID.

III. PROBLEM FORMULATION

Existing works, related to the person Re-ID, deal only with the gait-based Re-ID for a short period, and very few works focus on long period re-identification of an individual. Research has been in progress toward long-term Re-ID (i.e., video is recorded for a month using a single camera), but at the same time, it is the need of the hour problem for authentication as well as for public safety. Here, facial feature based Re-ID is the authenticated one, and other feature-based Re-ID is the suspicious one. Hence, there is a need to develop facial feature-based Re-ID using deep learning algorithm which handles low resolution, illumination variation, pose variation, and partial occlusion.

A. Objective

The main objective of the proposed framework is to develop facial feature-based person re-identification algorithm, using deep learning technology that works well for long-term Re-ID even in low illumination, pose variation, partial occlusion condition (Goggles, Mask, etc.) for a controlled environment.

IV. PERSON RE-ID BASED ON FACIAL FEATURE

Face detection is the first stage of a face recognition system. A lot of research has been done in this area, most of which is efficient and effective for still images only & could not be applied to video sequences directly. Face recognition in videos is an active topic in the field of image processing, computer vision and biometrics over many years. Compared with still face recognition videos contain more abundant information than a single image so video contain spatio-temporal information. To improve the accuracy of face recognition in videos to get more robust and stable recognition can be achieved by fusing information of multi frames and temporal information and multi poses of faces in videos make it possible to explore shape information of face and combined into the framework of face recognition. The video-based recognition has more advantages over the image-based recognition. First, the temporal information of faces can be utilized to facilitate the recognition task. Secondly, more effective representations, such as face model or super-resolution images, can be obtained from the video sequence and used to improve recognition results. Finally, video-based recognition allows learning or updating the subject model over time to improve recognition results for future frames. So video based face recognition is also a very challenging problem, which suffers from following nuisance factors such as low quality facial images, scale variations, illumination changes, pose variations, Motion blur, and occlusions and so on. In the video scenes, human faces can have unlimited orientations and positions, so its detection is of a variety of challenges to researchers. In recent years, multi-camera networks have become increasingly common for biometric and surveillance systems. Multi view face recognition has become an active research area in recent years, and the approach for video-based face recognition in camera networks is proposed. Traditional approaches estimate the pose of the face explicitly. A robust feature for multi-view recognition that is insensitive to pose variations is proposed in this project. The proposed feature is developed using the spherical harmonic representation of the face, texture mapped onto a sphere. The texture map for the whole face is constructed by back-projecting the image intensity values from each of the views onto the surface of the spherical model. A particle filter is used to track the 3D location of the head using multi-view information. Videos provide an automatic and efficient way for feature extraction. In particular, self-occlusion of facial features, as the pose varies, raises fundamental challenges to designing robust face recognition algorithms. A promising approach to handle pose variations and its inherent challenges is the use of multi-view data. In video based face recognition, great success has been made by representing videos as linear subspaces, which typically lie in a special type of the deep learning approach of generative adversial neural network(GAN).Generative adversial

neural network is considered a powerful generative model. Compared to traditional generative model such as deep boltmann machines and VAE, GAN is more time efficient and have fewer restrictions on the network, but produces better samples. GAN can be used to identify different objects and their boundaries in the image. Generative adversial neural network based on Cycle GAN to translate images from source domain to target domain. The translated images are utilized to train re-ID models in a supervised manner. These methods attempt to reduce the divergence between source domain and target domain on either the image space or feature face. In the proposed method of face tracking framework that is capable of face detection using generative adversial neural network and landmark points are obtained using supervised descent method (SDM) algorithm, SDM learns in a supervised manner generic descent directions and is able to overcome many drawbacks of second-order optimization schemes, such as non differentiability and expensive computation of the Jacobians and Hessians. Moreover, it is extremely fast and accurate. This method improves the minimization of analytic functions that overcomes the problem of facial feature detection and tracking. Finally the face is recognized by joint Bayesian model. The joint probability of two faces of the same or different persons is calculated, by using joint Bayesian model with improved accuracy in door control system. Finally provide Voice, SMS and E-mail alert system with real time implementation.

A. Face Image Acquisition

A face recognition system is a computer application capable of 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 face database. Recognition algorithms can be divided into two main approaches, geometric, which look 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. Face recognition from image or video is a popular topic in biometrics research. Face recognition is an interesting and successful application of Pattern recognition and Image analysis. Facial images are essential for intelligent vision-based human computer interaction. Face processing is based on the fact that the information about a user's identity can be extracted from the images and the computers can act accordingly. Many public places usually have surveillance cameras for video capture and these cameras have their significant value for security purpose. It is widely acknowledged that the face recognition have played an important role in surveillance system as it doesn't need the object's cooperation. The actual advantages of face based identification over other biometrics are uniqueness and acceptance. As human face is a dynamic object having high degree of variability in its appearance, that makes face detection a difficult problem in computer vision. In this field, accuracy and speed of identification is a main issue. In this module, admin can train multiple faces. Face may be captured through web cameras or uploaded as still pictures. In this image, user faces without occlusion, straight pose and normal light conditions.

B. Features Extraction

Applying human visual property in the recognition of faces, people can identify face from very far distance, even the details are vague. That means the symmetry characteristic is enough to be recognized. Human face is made up of eyes, nose, mouth and chin etc. There are differences in shape, size and structure of those organs, so the faces are differ in thousands ways, and we can describe them with the shape and structure of the organs so as to recognize them. One common method is to extract the shape of the eyes, nose, mouth and chin, and then distinguish the faces by distance and scale of those organs. The other method is to use deformable model to describe the shape of the organs on face subtly. This module, facial features are extracted. And constructed as feature vectors. Facial features include nose part, eye parts and lip part. These values are stored is in the form of matrix.\

C. Register the Face

Face registration is the process of transforming different sets of data into one coordinate system. Facial features are stored with labels. Image registration or image alignment algorithms can be classified into intensity-based and feature based. Face recognition systems identify people by their face images. Face recognition systems establish the presence of an authorized person rather than just checking whether a valid identification (ID) or key is being used or whether the user knows the secret personal identification numbers (Pins) or passwords. The following are example. To eliminate duplicates in a nationwide voter registration system because there are cases where the same person was assigned more than one identification number. The face recognition system directly compares the face mages of the voters and does not use ID numbers to differentiate one from the others. When the top two matched faces are highly similar to the query face image, manual review is required to make sure they are indeed different persons so as to eliminate duplicates. One of the images is referred to as the reference or source and the others are respectively referred to as the target, sensed or subject images. Image registration involves spatially registering the target image(s) to align with the reference image. Intensity-based methods compare intensity patterns in images via correlation metrics, while feature-based methods find correspondence between image features such as points, lines, and contours. Intensity-based methods register entire images or sub-images. If sub-images are registered, centers of corresponding sub images are treated as corresponding

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feature points. Feature-based methods establish a correspondence between a numbers of especially distinct points in images.

D. Face Classification

Face recognition have gained a great deal of popularity because of the wide range of applications such as in entertainment, smart cards, information security, law enforcement, and surveillance. It is a relevant subject in pattern recognition, computer vision, and image processing. Face identification is a one-to-many matching process that compares a query face image against all the template images in a face database to determine the identity of the query face. The identification of the test image is done by locating the image in the database that has the highest similarity with the test image. The identification process is a "closed" test, which means the sensor takes an observation of an individual that is known to be in the database. This module is known as login phase or testing phase. Input is in the form of real time video capturing. Video images are splited into still images. Face detection is done in the process. Matching the features using Joint Bayesian algorithm. The temporal information in video sequences enables the analysis of facial dynamic changes and its application as a biometric identifier for person recognition. It utilize the human nature that human will have at least small amount of movements such as eyes blinking and/or mouth and face boundary movements.

E. Alert System

In many of the access control applications, such as door open, the size of the group of people that need to be recognized is relatively small. If the feature vectors are not matched means, considered as unknown faces. Create alert for unknown labeling. Finally provide voice alert and SMS alert, Email Alert to authorized person

V. METHODOLOGY

A. Overview of deep learning algorithm for face detection

Deep learning applies multiple processing layers to learn representations of data with multiple levels of feature extraction. The technique has reshaped the research landscape of face recognition since 2014, launched by the breakthroughs of deep face method.

B. Face detection using generative adversarial network

The fundamental aspect of GAN is the min-max two-person zero-sum game. In this game, one player takes the advantages at the equivalent loss of the other player. A generative adversarial network has two types of networks called discriminator and generator denoted as D and G respectively.

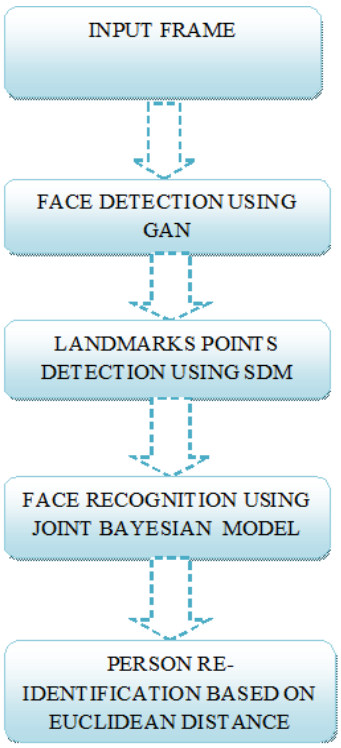

Figure 1: facial feature-based person Re-ID framework

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C. GENERATIVE ADVERSIAL NEURAL NETWORK(GAN)

GAN can be used to identify different objects and their boundaries in the image. First, GAN creates bounding boxes, or region proposals, using a process called selective search. The selective search process identifies the object selecting the image area through the windows of different sizes, and for each size, it tries to group together the adjacent pixels by texture, color, or intensity. Once the proposals are created, GAN warps the region to a standard square size (e.g., 227 **X** 227). The final step of GAN is to tighten the bounding box to fit the true dimension of the object. This is done, by using a simple linear regress on the region proposal.

Soft max loss function given by Eq. (1) is used for training the face detection task:

$$\text{Loss} = -(1-L).\log(1-p) - L.\log(p) \qquad -(1)$$

D. FACE RECOGNITION USING SDM AND JOINT BAYESIAN APPROACH

After detecting the face and extracting the facial feature, the next task is recognition of face, i.e., the given face is verified with the class of faces (face verification) and certified with face identity (face identification). Face verification means verifying whether the given two faces belong to the same person or not. Face identification means an identity number is assigned to the probe person face with respect to the gallery. The conventional face recognition pipeline uses the facial features for face alignment and face verification. To detect facial landmark points SDM is used. SDM learns in a supervised manner generic descent directions and is able to overcome many drawbacks of second-order optimization schemes, such as non differentiability and expensive computation of the Jacobians and Hessians. Moreover, it is extremely fast and accurate. This method improves the minimization of analytic functions that overcomes the problem of facial feature detection and tracking. SDM solves nonlinear least squares (NLS) and accurate in facial feature detection and tracking in challenging databases. SDM algorithm detects facial landmarks as shown in Figure 3b. By detecting the landmarks, face images are globally aligned by similarity transformation. Further based on the extracted features, the face is recognized by joint Bayesian model. The joint probability of two faces of the same or different persons is calculated, by using joint Bayesian model. The feature representation of a face is given as a combination of inter- and intrapersonal variations, or f = P (μ, ε), where both μ and ε are estimated from the training data and represented in terms of Gaussian distributions. Face recognition is achieved through log-likelihood ratio test, as given in Eq. (2):

$$log\,\frac{p(f1,f2|H\ inter)}{p(f1,f2|H\ outer)} \qquad -(2)$$

Here, the numerator and denominator are the joint probabilities of two faces (f1 and f2), when given the inter- or intrapersonal variation hypothesis (), respectively.

Finally, Joint Bayesian model classify faces with improved accuracy in alert system. It provide voice, SMS and Email based alert system with real time implementation.

VI. CONCLUSION

Face recognition technique for still images and video sequences. Most of these existing approaches need well-aligned face images and only perform either still image face recognition or video-to video match. They are not suitable for face recognition under surveillance scenarios because of the following reasons: limitation in the number (around ten) of face images extracted from each video due to the large variation in pose and lighting change; no guarantee of the face image alignment resulted from the poor video quality, constraints in the resource for calculation influenced by the real time processing. So it can propose a local facial feature-based framework for still image and video-based face recognition under surveillance conditions. This framework is generic to be capable of vide to face matching in real-time. While the training process uses static images, the recognition task is performed over video sequences. The results show that higher recognition rates are obtained when we use video sequences rather than statics based on Generative adversarial neural network and Joint Bayesian model algorithm. Evaluation of this approach is done for still image and video based face recognition on real time image datasets with SMS alert system.

VII. FUTURE WORK

Till now, the scope of the algorithm is limited for frontal and profile face verifications, handling partial occlusions in a sparse crowd. Future work focuses on person Re-ID in a high-dense crowd under severe occlusions.

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