National Conference on Innovations in Computing and Networks (NCICN) - 2019
© 2019 IJSRSET | Volume 5 | Issue 9 | Print ISSN : 2395-1990 | Online ISSN : 2394-4099

Automatic Human Identification Via CCTV Using Gait Analysis

Shamna A L[1], Ranjith E[1], Himesh S[2], Jerin Shaji[1], Hariharan B[1]

[1]Department of Computer Science and Engineering, College of Engineering Pathanapuram , Pathanpuram, Kollam, Kerala, India

[2]Department of Computer Science and Engineering, Younus College of Engineering and Technology, Pallimukku, Vadakkevila, Kollam, Kerala, India

ABSTRACT

Human identification using gait has received an increasing attention from the research community due to a rapid deployment of CCTV cameras. Even a small shop to large corporate office have this surveillance system. Human identification can serve many purposes. It can be used for access control, allows prosecution when a crime was committed or can even serve as an early warning system to enable the prevention of crimes. In this project we suggest a cost effective way to make the existing system to automatically identify a person using face and motion detection. However face recognition require both high resolution images and a relatively short distance but gait recognition can be used at long distances and does not require high resolution images and hence could be used in public with CCTV cameras. Here we create a processing module using raspberry pi 3 for this purpose and connect all existing surveillance systems to a single network. This module is connected to cloud server and it processes the CCTV video to detect the person. A single surveillance system requires only one module. If we provide information of a person in the server, whenever the person appear on any of CCTV connected to the network an automatic detection of corresponding person is done.

Keywords: Human Identification, Gait Analysis, Surveillance System, Face Recognition

I. INTRODUCTION

Today CCTV has become the eyes of the world. From a small shop to large enterprise has their own CCTV network and continuously monitoring the activities happening around. This create a huge database of video information. Whenever an exceptional situation occurs, this CCTV backup system is monitored and provide a clear idea of the situation. We have a huge data even in a small location. What if data allover can be connected? Then we get an extremely huge data. And if we could utilize this data we can make a big revolution. We could create a third eye that see all.

In simple words, we make the CCTV to talk to each other. For instance, assume a crime happened in your neighborhood. We talk about the incident to the people in our close network. Then if one of them knew the suspect he tells that to others and all the other knows who the suspect is. Whenever if anyone one among you see the suspect again, then you alert all. This is how actually the system works.

We connect CCTV to a server. All CCTV are connected to a network and communicate to each other. They recognize the person from a scene using their learning capability. We can also upload the image of the suspect to the server. If the suspect happens to come over any CCTV connected to the sever, it identifies the suspect and provides an alert.

II. HUMAN IDENTIFICATION BASED ON GAIT

Gait recognition is a new technique of identification by computer vision. Gait is the "coordinated, cyclic combination of movements that result in human locomotion" as defined by Boyd and Little in [1]. Gait recognition therefore is the recognition of features based on the walking patterns of people. Gait therefore appears to be the most suitable biometric for surveillance use cases. That is because gait recognition can be used at long distances and does not require high resolution images and hence could be used in public with CCTV cameras.

Gait is also a biometric which is very difficult to imitate or to disguise. In contrast, a facial recognition system by CCTV cameras can be circumvented by wearing a mask or even just a cap without looking in the direction of the camera. Gait is a behavioral biometric which contains two kinds of components. There are structural components such as the height, leg length and the crotch height and dynamic components like the joint trajectories. Gait is considered a unique characteristic of a person and it has been shown that humans can identify friends based on gait [2] however only to a degree that does not allow for it to be considered a reliable form of identification.

There are still many challenges to gait recognition such as different levels of background illumination, changes in the subject's appearance, changes in the subject’s footwear, the nature of the ground, the camera angle and even the walking speed and many more. There are many different approaches to gait recognition and they all suffer from different subsets of these covariates.

a) Human Gait as a Biometric

Humans are able to recognize a walking pattern as human gait without any other context given. This has been shown in a study by Johansson using a pattern of moving lights that is called a moving light display.

When looking at an individual image, it is hard to recognize a human silhouette. However, when looking at these images in a rapid succession it is immediately obvious that the illustration shows a walking human. Cutting and Kozlowski [4] further showed that humans are able to identify the gait of a friend even when no other contextual information is given. The humans tested achieved only a recognition rate of 38%, however, that result was significantly better than random which would mean a recognition rate of only 17%. This concludes that gait can be used to recognize and identify a person, albeit it is not yet known whether gait can be used to uniquely identify a person. Gait has the advantage of being able to be measured over a distance requiring no cooperation from the subject. It is also difficult to disguise although not impossible as has been shown by Hadid et al [5]. Even if the recognition rate of technical systems using gait cannot reach the high success rates of recognition techniques based on other biometrics, they can be useful in order to reduce the set of subjects to then allow further identification with other techniques. For example, in the case of a crime captured with a CCTV camera, the gait recognition technique could narrow the suspect from thousands down to 25 subjects. Further identification techniques like DNA testing or fingerprint analysis that require cooperation of the suspect which is not appropriate for mass usage could then be used to identify the offender. Gait is a cyclical motion that can be divided into a typical sequence of stances as is summarized by Boulgouris et al. [6]. The authors explained that a walking cycle is the movement where both feet are used to make a step forward. More precisely, a cycle consists of the double support stance - both feet are on the ground and one foot is in front of the other and the middle stance. This cyclic property and the phases created by it are heavily used in gait recognition approaches.

III. PRE-PROCESSING

Gait recognition is a process that is made up of several consecutive stages:

- First, the video of a walking subject has to be captured and the parts of the video that contain the walking sequences are isolated.
- These sequences then need to be pre-processed to extract the walking subject from the static background.
- Features are extracted from the image of the extracted subject and a gait signature is established. This gait signature can then be recognized using classification techniques to compare the established gait signature with the set of gait signatures from known subjects in the gait database.

a. Walking Sequence Extraction

The first step in gait recognition from image sequences is to identify and track the human(s) in a video. For each subject that contains the walking sequence of a single subject, an appropriate bounding box is calculated. The task of tracking humans in a video and being able to distinguish them from other moving objects like cars, animals or just background noise such as moving tree branches is a challenge on its own. This is further complicated in the case of occlusion where subjects are partially or fully occluded by other moving objects or static objects like street lamps. There are many approaches to this challenge which fall into many different categories that can be distinguished like model-based or featurebased tracking [7]. For some gait recognition approaches, the walking sequence is used as a basis from which the gait features are extracted. However, most approaches (especially the model-free approaches) use the silhouette as a basis which is discussed in the next step.

b) Silhouette Extraction

There are different approaches to extracting a silhouette from walking sequence. In the easiest case, where the subject is walking in front of a static scene, the silhouette can be determined by the simple background subtraction process. This technique creates a model of the background which is then subtracted from each image yielding the silhouette. The model itself can vary in complexity. The simplest way to construct this model is to just calculate the average over all images of the sequence [7]. This process is however very susceptible to errors caused by changes in the illumination of the scene or changing weather conditions. A more sophisticated but still computationally efficient background subtraction model has been proposed by Elgammal et al. [8], which creates a probabilistic model that estimates intensity values. This allows to efficiently deal with small changes in the scene like trees moving in the wind.

Especially in outdoor scene shadows will pose a problem since the shadow will be moving just like the subject and will therefore be extracted as part of the silhouette. Bobick and Johnson propose a way of dealing with this in [9]. Assuming that the camera position relative to the Sun's position is known, the general position of the shadow can be predicted. The shadow can then efficiently be removed by using the fact that the shadow has in general a different intensity and colour distribution than the subject. There are other approaches to silhouette extraction for example using optical flow [8]. Many gait recognition approaches require a binarized silhouette which is created by simply changing the intensity of all foreground pixels to maximum.

c) Contour Extraction

Most approaches use silhouette directly. However, a not insignificant subset uses only the contour of the binarized silhouette. The contour can be calculated by first eroding the silhouette with an appropriate structuring element which effectively removes every foreground pixel that is next to a background pixel. Then the eroded silhouette is subtracted from the original silhouette leaving only the contour as shown in Fig.4.

Fig.4. Silhouette extraction [13].

IV. GAIT FEATURE EXTRACTION APPROACHES

Model-based Approaches

Lee and Grimson presented a model-based approach to gait recognition in [12] by using ellipses which are matched to the silhouette of a subject. The approach is in general not view invariant but they illustrate a way to lift this constraint by using a visual hull which is constructed using multiple cameras [13]. The gait features are extracted by first matching seven ellipses to the silhouette of a person. This is done by drawing a vertical line through the silhouette with exception of the top part yielding a front and back portion of the silhouette. Then a horizontal line is drawn through the centroid and both the upper and lower part are again equally divided by a horizontal line. This yields seven segments as is illustrated in the left part of Fig.5. An ellipse is fitted to each of these segments and from every ellipse four features are extracted:

- Both the x and y coordinates of the centroid.
- The aspect ratio defined by the major and minor axis of the ellipse.
- The orientation of the ellipses major axis.

These four features per ellipse result in a feature vector with 28 features for the whole silhouette which is calculated for every frame. Out of these feature vectors for each frame, two kinds of feature vectors for the whole walking sequence are constructed. The first considers the appearance of the silhouette and is constructed by the mean and standard deviation of each of the 28 features. The second constructs a spectral component feature vector by calculating the Fourier Transform of each feature and the phase to the dominant walking frequency. The authors found that the appearance based feature vector yields better results if a sample of the subject with the same clothing style already exists in the database. However, for drastically different clothing styles the spectral components feature vector performs significantly better.

Model-Free State-Space Approaches

This section discusses the state-space approaches which are model-free. Kale et al. investigated the discriminative capabilities of the width of the contour of binarized silhouettes in [17]. They found that it contains both structural and dynamic information that could be used for gait recognition. Due to a high degree in redundancy caused by the fact that certain body parts are almost not moving during a walking cycle they found encouraging results even after smoothing the width vector using eigen decomposition. Based on these insights Kale et al developed a model-free state space approach which they presented in [18]. They use two different approaches to generate the gait signature. In the first approach, they use the width of the contour of the silhouette. The second approach uses the whole silhouette instead of just the contour. This is more computationally expansive however in low quality images the contour might suffer from information loss since it is very susceptible to noise. For both approaches a hidden Markov model is trained using stances of the individual with high discriminative capability. This process yields the gait signature which they find to be robust.

Model-Free Spatiotemporal Approaches

Harris and Nixon. They first extract spatial templates by performing background subtraction on the walking sequence of a subject and then normalizing the silhouette image in size. These spatial templates are then used to calculate temporal templates using optical flow between consecutive frames. This means each walking sequence is turned into a set of temporal templates. Motion Energy Images (MEI) are the basis for the Gait Energy Image that was developed by Han and Bhanu and serves as the basic feature of the recognition technique presented in [23]. The MEI only illustrates where motion occurred while the GEI also contains the information how much motion occurred at each position. These GEIs are however high in dimension and are therefore projected into eigenspace. A similar approach uses optical flow between consecutive frames to construct their so called Gait Flow Image (GFI) [24] which can then project into canonical space for classification. GEIs are calculated for a whole walking sequence but GFIs are calculated for each gait cycle therefore an exemplar GFI is created for each walking sequence by averaging the GFIs of this sequence.

V. CONCLUSION

The gait recognition approaches reviewed in this paper all employed very different feature extraction methods, constructed different feature vectors and used yet again different methods to create a compact gait signature. Individual approaches to gait recognition do sometimes lend ideas and concepts from other existing approaches to no small degree. This leads to the problem that the comparison of gait recognition algorithms is very difficult. It is envisioned that the amount of data that would need to be sent from a large amount of CCTV cameras directly to a server would be huge. It would therefore be useful to have a local machine close to the cameras which does the pre-processing, gait feature extraction and gait signature creation step. This way the server would only receive data once actual walking sequences were captured that could be used for identification.

VI. REFERENCES

[1]. J. E. Boyd and J. J. Little, Advanced Studies in Biometrics, Springer Berlin Heidelberg, pp. 19–42, 2005.

[2]. J. E. Cutting and L. T. Kozlowski, Recognizing friends by their walk: Gait perception without familiarity cues, Bulletin of the Psychonomic Society, Vol. 9, pp. 353- 356, 1977.

[3]. G. Johansson, Visual motion perception, Scientific America, pp. 76-88, 1975.

[4]. J. E. Cutting and L. T. Kozlowski, Recognizing friends by their walk: Gait perception without familiarity cues, Bulletin of the Psychonomic Society, Vol. 9, pp. 353- 356, 1977.

[5]. A. Hadid et al., Can gait biometrics be Spoofed?, Proceesings of the 21st International Conference on Pattern Recognition (ICPR), pp.3280-3283, 2012.

[6]. N. V. Boulgouris, D. Hatzinakos and K. N. Plataniotis, Gait recognition: a challenging signal processing technology for biometric identification, in IEEE Signal Processing Magazine, vol. 22, no. 6, pp. 78-90, 2005.

[7]. L. Wang, W. Hu and T. Tan, Recent developments in human motion analysis, Pattern Recognition, vol. 36, no. 3, pp. 585–601, 2003.

[8]. A. Elgammal, D. Harwood, L. Davis, Non-parametric Model for Background Subtraction, Proceedings of ECCV 2000, Volume 1843 of the series Lecture Notes in Computer Science, pp 751-767, 2000.

[9]. A. E. Bobick and A.Y. Johnson, Gait recognition using static, activity-specific parameters, Computer Vision and Pattern Recognition, Proceedings of the IEEE Computer Society Conference on, vol.1, pp 423-430, 2001.

[10]. Hu Ng et. al., Human Identification Based on Extracted Gait Features, International Journal of New Computer Architectures and their Applications (IJNCAA), vol .1 no. 2, pp. 358–370, 2011.

[11]. C. BenAbdelkader, R. Cutler, H. Nanda and L. Davis, EigenGait: Motion-Based Recognition of People Using Image Self-Similarity, Proceedings of the International Conference on Audio- and Video-Based Biometric Person Authentication, pp 284-294, 2001.
[12]. L. Lee, W. E. L. Grimson, Gait analysis for recognition and classification, Automatic Face and Gesture Recognition, Proceedings of the 5th IEEE International Conference on, pp. 148 – 155, 2002.
[13]. G. Shakhnarovich, L. Lee and T. Darrell, Integrated face and gait recognition from multiple views, Proceedings of the IEEE