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Human Gait Cycle Recognition Using MTI Principles and PCA

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***Abstract*- Security today depend on biometrics principles rather than classical password e.g. fingerprint, person signature, iris recognition, face recognition, voice recognition and gait cycle recognition. Gait cycle recognition concept became important in the last years, it depend on extraction moving objects (human) from the background, in our propose method we used Moving Target Indicator (MTI) principle to extract human from the background, this technology depend on the previous capture because it work by subtract next capture from previous capture to find moving human. In addition, we used Principle Component Analysis (PCA) to compression and decompression the capture after finding Signal Eigen vectors and Noise Eigen vectors. Finally, we will use these vectors to separate noise from the capture.**

***Keywords*- Gait Recognition, Moving Target Indicator, Principle Component Analysis, Object Extraction, Signal Eigen Vector, Noise Eigen Vector.**

I. Introduction

Biometrics approaches are technologies used for measuring and analyzing a person's unique characteristics. There are two types of biometrics: behavioral and physical. Behavioral biometrics systems are generally use for verification while physical biometrics can be used for either identification or verification. A biometric is an aspect that something can be using to verify the identity of an individual. The most common biometric that comes to mind is a fingerprint. Recent events have brought national interest in quick identification of suspicious individuals. Areas such as airports, parking lots, banks, and bus/subway stations, all have a need for quick detection of threats. However, current biometrics such as fingerprints, and face recognition, iris recognition are limited and time consuming. Trying to fingerprint everyone that walks through an airport is not possible. It is probably not even legal. A major advantage of gait recognition is that is it unobtrusive. It can be measured at a distance, without the knowledge or cooperation of the subject. [1,2]

Gait recognition have some advantages that make it better than other recognition methods also these advantages are not in other biometric mentation: [3,4]

- It is uncontracting, and a user does not forced special operation for identification.
- A user is not conscious of being recognized, since identification is performed at the time of the usual walking operation.
- Identification can he performed from a long distance.
- It is easy to acquire the data since man usually needs to walk at the time of movement.

In addition, the Gait recognition system has some disadvantages e.g. Physical changes, Psychological, Clothing, Stimulants. [5]

II. Gait Recognition Technique

Biometric systems are becoming increasingly important, since they provide more reliable and efficient means of identity verification. Biometric gait recognition (i.e. recognizing people from the way they walk) is one of the recent attractive topics in biometric research. [11]

Human gait recognition system has many advantages as biometric option, such as being an unobtrusive technology, can be captured at a distance, it does not require the consent of the observed individual and it is very difficult to steal, fake or hide. [12]

Most gait recognition systems work in the same general way as shown in Fig. 1. Firstly, data must be collected from the individual in question. In this step it helps to have the background be as simple as possible to provide the highest level of recognition. Additionally selection of an appropriate viewpoint, one in which the gait is observed from the side, is also important. From here, through a process called background subtraction, the object or gait is separated from the background noise. Next the specific markers of the identification scheme are extracted from the gait data. These are compared with the database in hopes of a positive recognition. [1]

MTI and PCA techniques are used for background subtraction and feature extraction in our system and we used Sobel method after applying PCA to find edges of the object (human).

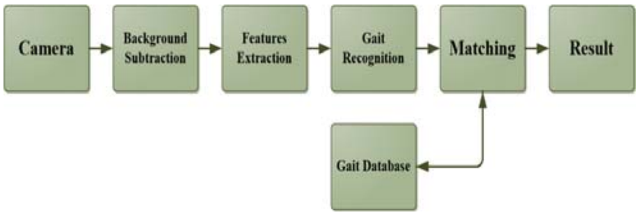


Fig. 1 normal Gait recognition system

The Gait recognition system in our propose paper based on several steps as show in Fig. 2:

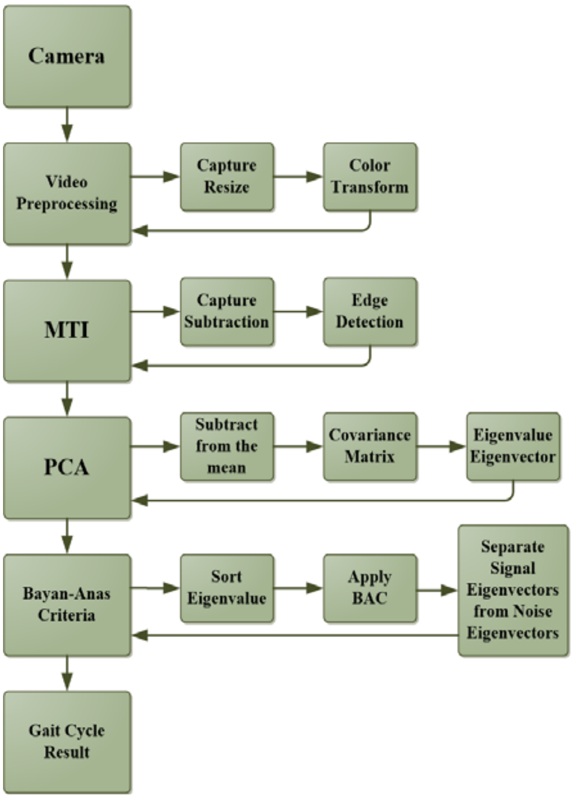


Fig. 2 propose Gait recognition system

Finally, there are many challenges in Gait recognition system and the most one is object (human) extraction from background, so we propose MTI method to extract human from the background.

III. MOVING TARGET INDICATOR (MTI)

It is a mode of operation of a radar to discriminate a target against clutter [6], this mode take its advantage from moving target depending on stationary clutter, in Gait recognition system we used MTI to subtract captures from each other to separate object (human) from the background as show in Fig. 3:

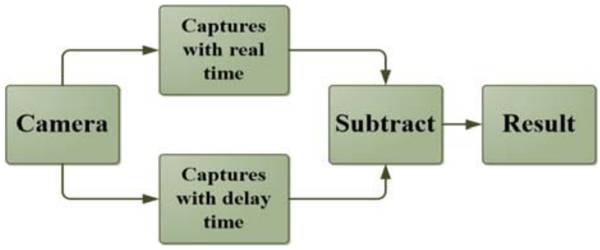


Fig. 3 MTI system operation

The result of MTI system is the output of subtraction capture number two from capture number one and capture number three from capturer number two and so on, so we can conclude that we will have black captures with only edges of the moving objects, Equation (1) show the MTI operation.

Result = captures with real time - captures with delay time (1)

IV. PRINCIPLE COMPONENT ANALYSIS (PCA)

It is a mathematical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components. [7]
There are many application of using PCA for example: [8]

- Exploratory data analysis.
- Data preprocessing, dimensionality reduction.
- Data compression, data reconstruction.

In our Gait recognition system, we used AMC to separate Noise vector from Signal vector after compression and decompression the capture by PCA, then finding Eigen vectors, Fig. 4 show the operation of PCA and AMC calculation in our system.

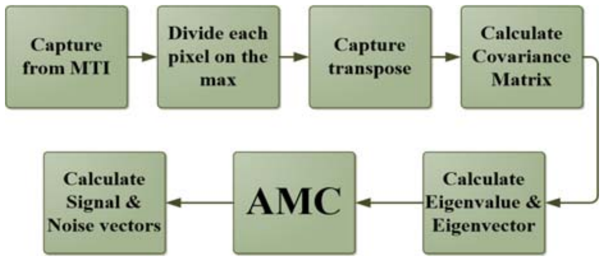


Fig. 4 PCA system with AMC calculation

As show in Fig. 4 the start point of PCA system with the result of MTI system, at the first we will divide each pixel in the capture on the maximum pixel value in the capture after that we will take the transpose of the capture and multiply it with the capture after divided on the maximum value to have covariance matrix as show in Equation (2).

Covariance Matrix = capture divided on max * transpose capture (2)

After we calculate covariance matrix we could now calculate Eigenvalue and Eigenvector of our capture, then we will apply

Akaike Modified Criterion (AMC), which will separate Signal Eigen vector from Noise Eigen vector in several steps as show: [9]

- The Eigen values are sorting from maximum to minimum value.
- Scaling the Eigen values by the maximum eigenvalue.
- Calculate Maximum Likelihood (ML) as show in Equation (3):

$$\mathbf{ML} = \sum_{j=m+1}^{N} \lambda_j / \lambda_{max} \quad \textbf{(3)}$$

- Calculate number of free adjusted parameters = (m+1) (1+1/N).

  Where:

  N = number of elements.

  m = 0, 1, 2, 3… N-1.

- Calculate AMC as show in Equation (4):

AMC (m) = ln (ML) + (m+1) (1+1/N) (4)

AMC was modifying method from Akaike Information Criterion (AIC) which founded by Wax and Kailath, the Equation (5) and Equation (6) show AIC calculation equation. [10]

AIC (m) = -2log (ML) + 2m (2N-m) + 1 (5)

Where (ML) in AIC is calculate as show:

$$\mathbf{ML} = \left(\prod_{i=m+1}^{N} \lambda_i \Big/ \left(\frac{1}{N-m} \sum_{i=m+1}^{N} \lambda_i \right)^{N-m} \right)^{P} \quad \textbf{(6)}$$

Where (P) is number of snapshots.
But after we applied AMC on our system, we found it does not give the result that supposed to be so we made some changes on AMC and we found AMC2, which give what we supposed to have as show in Equation (7):

AMC2 (m) = ln (ML) + ($m^{1.576758}$+1/N) (7)

The power of (m) that appear in Equation (7) was conclude after trying many numbers until we found the optimum result for our system.

V. PROCESSING ALGORITHM

The final steps in our propose system is Gait cycle result as show in Fig. 2, several steps will be done to have gait frequency as show below:

- Calculate Distance Matrix which is the distance between the farthest points from the left side and from the right side in each capture.
- Find all peaks that will appear in Distance Matrix after draw it.
- Calculate Threshold of all peaks values which equal mean value of all peaks.
- Calculate new peaks and their locations depend on the Threshold of all peaks.
- Calculate Threshold of all peaks locations then divide it on the length of them.
- Find the final peaks.
- Calculate steps time.
- Find Gait time.
- Find Gait frequency.

After these steps, we will find the frequency and the time of the moving object (human).

VI. RESULTS

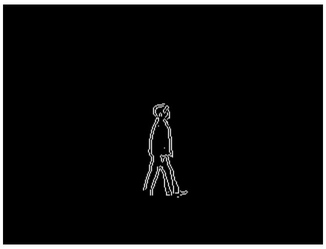
In this section we will take examples of different videos that we applied our propose system on it and the result as show.

Figure (5.a) normal video capture

Figure (5.b) gray scale video capture

Figure (5.c) MTI result

Figure (5.d) edge detection result



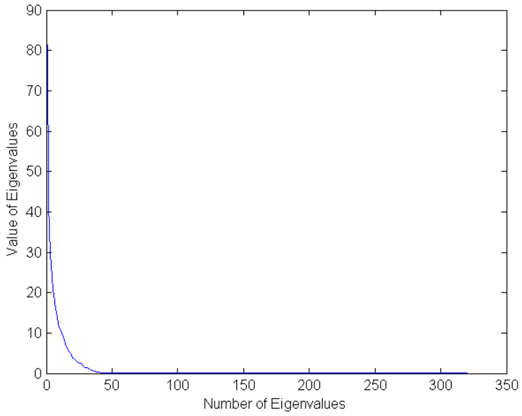


Figure (6) Eigenvalue of capture 90

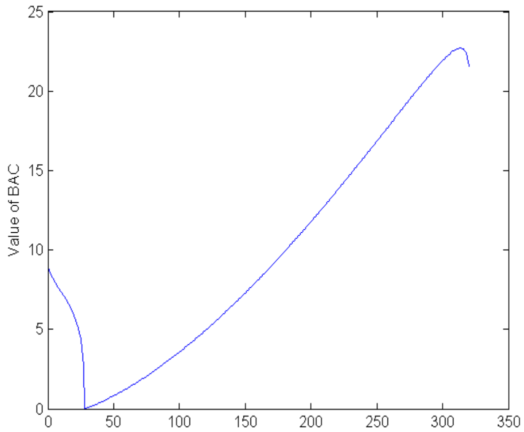


Figure (7) BAC of capture 90

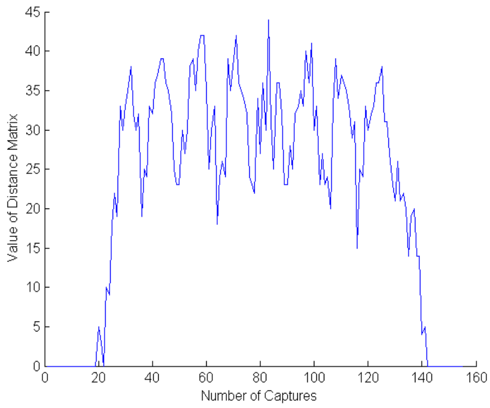


Figure (8) Distance Matrix

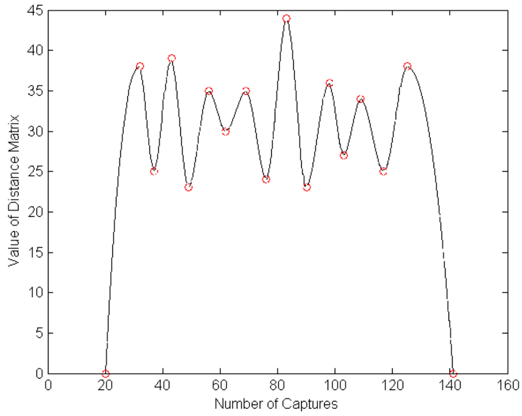


Figure (9) Filtered peaks

TABLE 1
FILTERED PEAKS RESULTS

Table 1 filtered peaks results									
Peaks after filter by peaks location threshold which equal (4.2174)									
PL1	**PL2**	**PL3**	**PL4**	**PL5**	**PL6**	**PL7**	**PL8**	**PL9**	**PL10**
32	43	55	58	68	71	83	97	99	108
PL11	**PL12**	**PL13**	**PL14**	**PL15**	**PL16**	**PL17**	**PL18**	**PL19**	**PL20**
110	125	-	-	-	-	-	-	-	-
Peaks after filter by threshold equal (7.7500)									
PL1	**PL2**	**PL3**	**PL4**	**PL5**	**PL6**	**PL7**	**PL8**	**PL9**	**PL10**
32	43	56.50	69.50	83	98	109	125	-	-
Note: PL is Peak Location									

TABLE 2
GAIT CYCLE FREQUENCY OF SOME EXAMPLES

Table 2 Gait cycle frequency of some examples				
Video	**Steps Time (second)**	**Number of Peaks**	**Gait Time (second)**	**Gait Frequency**
Video 1	26.50	8	1.3250	0.7547 Hz
Video 2	26.00	6	1.3000	0.7692 Hz
Video 3	44.80	7	2.2400	0.4464 Hz
Video 4	38.33	7	1.9167	0.5217 Hz
Video 5	38.83	6	1.9417	0.5150 Hz

VII. CONCLUSIONS

From our propose system we conclude:

- Gait recognition is verification and identification method which is very useful rather than other biometric methods e.g. face recognition because it does not need any attention from the walking human, also the system observing and identifying human without any observe from human.
- There is unique Gait frequency of each person like other biometric e.g. fingerprint.
- MTI principles, PCA with using AIC after modify it (BAC) and edge detection was good methods to extract human from the background which is the challenge problem in Gait recognition system.

REFERENCES

[1] David C Post,"Gait Analysis Review", 2006 http://www.nd.edu/~dpost/IntSyst/report1.pdf

[2] JeffreyE.Boyd,JamesJ.Little,"BiometricGaitRecognition",SpringerVerlagBerlinHeidelberg, 2005

[3] Kota Iwamoto, Kazuyuki Sonobe, and Naohisa Komatsu,"A Gait Recognition Method using HMM",SICE, 2003

[4] Yanmei Chai, Qing Wang, JingpingJia, and Rongchun Zhao,"A Novel Human Gait Recognition Method by Segmenting and Extracting the Region Variance Feature",IEEE Computer Society Washington, DC, USA,2006.

[5] Mark Ruane Dawson, M. Sc. Thesis, "Gait Recognition", Department of Computing Imperial Coll of Science, Technology & Medicine,2002

[6] http://www.wikipedia.com

[7] Jackson, J.E. (1991). A User's Guide to Principal Components (Wiley).

[8] Rezarta Islamaj Dogan http://www.cs.umd.edu/~samir/498/PCA.pdf

[9] High Resolution Array Signal Processing by Bayan Mahdi Sabbar 1987

[10] Wax M. and Kailath T. "Determination the number of signals by information theoretic criteria" Proc. PP. 192_196. 1983