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A Novel Algorithm to Find Number of Steps and Time of Human Gait Cycle

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***Abstract*— Human gait cycle is one of newest biometrics that depend on the way of walking of person. Gait cycle could be measure by many methods for example putting flag or pointer that have value equal one when legs cross and zero in otherwise. In this paper, new algorithm proposed to measure number of steps and time of gait cycle. This algorithm work on binary images, which contents black and white pixels only (without gradual). Also, the work in this paper was built based on Sobel edge detection results that come after apply Moving Target Indicator (MTI) principles on the original image.**

***Keywords*— Gait Cycle, Moving Target Indicator, Gait Time, number of Steps, Peaks Filter Algorithm and Peaks Filter Modify Algorithm.**

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. PREPROCESSING

A. *RGB to Gray level*

In this work, the first step is convert video captures from natural colors to gray level, which will help us to speed up the processing time by working with one layer rather than three layer (RGB layers). Equation (1) will use to convert RGB image to gray level one.

$$Gray\ Level = \frac{R_{Layer} + G_{Layer} + B_{Layer}}{3} \qquad (1)$$

B. *Extract Human from Captures*

In this section, MTI, PCA and Sobel edge detection used to extract moving human from video captures. The results will be a binary image, which contents two value (black and white) only. Figure (1) show the result of MTI and Figure (2) show the result of Sobel edge detection that will be the input of the new algorithm.

Fig. 1 MTI Result

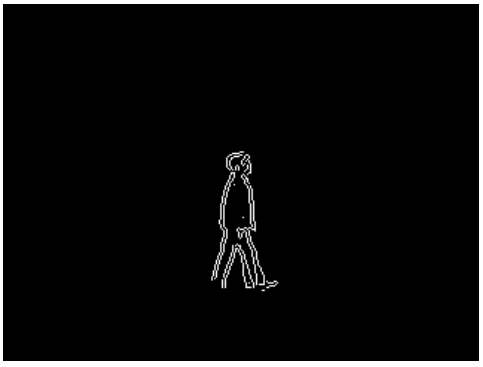

Fig. 2 Sobel edge detection result

III. GAIT PERIODICITY

The distance between human legs (step) will appear as peaks when draw values of distance of each frame (capture). Figure (3) will be the input of our new algorithm that will separate real peaks from the fake one.

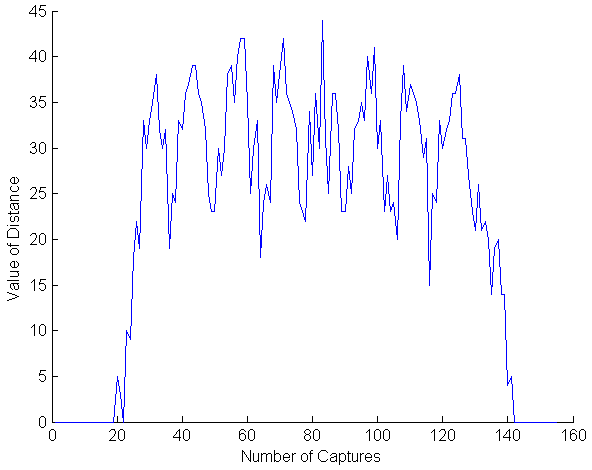

Fig. 3 Shape of human steps

IV. ALGORITHM RESULT

The new algorithm has two phases, first one called Peaks Filter Algorithm (PFA). The second one called Peaks Filter Modify Algorithm (PFMA) that based on first phase.

A. PFA PHASE

This phase was built to filter peaks that appear in Figure (3), some missing in peaks recognition was appear after apply PFA on the results of Sobel operator. Figure (4) show the result of PFA.

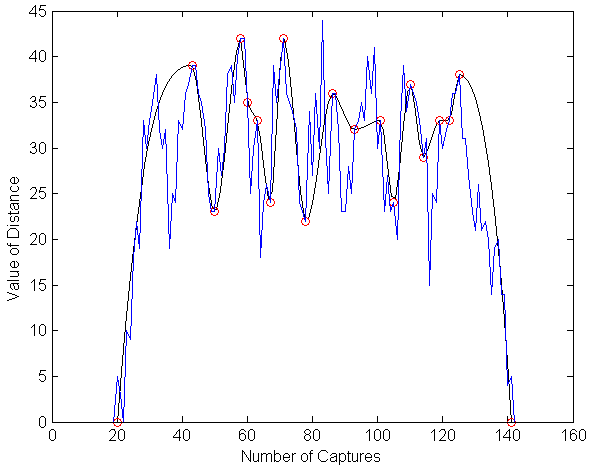

Fig. 4 Result of PFA

As shown in the figure above, red circles not appeared on all peaks, which mean PFA does not found all peaks (missing peaks). In addition, circles not in the right place there is some shifting of the location.

B. PFMA PHASE

This phase is based on PFA phase with some modify. Also, it solve the problems that appeared in PFA phase (missing peaks and peaks with wrong location). The steps of applying PFMA shows below:

- Find all peaks that will appear in Figure (3).
- Calculate Threshold of all peaks, which equal mean value of all peaks.
- Calculate new peaks and their locations depend on the mean of peaks values.
- Calculate threshold from first and last new peaks locations.
- Calculate so near threshold.
- Find the final peaks.
- Calculate steps time.
- Calculate number of steps.
- Find Gait time.

In addition, Figure (5) show the result of PFMA

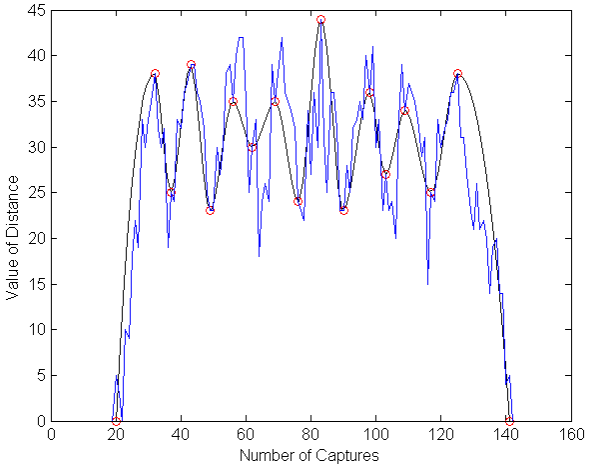

Fig. 5 Result of PFMA

C. PFA and PFMA VALUES RESULTS

In this section, results of all steps of PFA and PFMA will shows. Table (1) show the results of common information between PFA and PFMA.

TABLE 1
COMMON INFORMATION BETWEEN PFA AND PFMA

All Peaks Values with their Locations									
PV	**PL**	**PV**	**PL**	**PV**	**PL**	**PV**	**PL**	**PV**	**PL**
5	20	39	43	34	79	33	101	38	125
10	23	30	51	36	81	27	103	26	131
22	26	39	55	44	83	24	105	22	133
33	28	42	58	36	86	39	108	20	137
38	32	33	63	28	91	37	110	5	141
32	35	26	66	35	95	31	115	-	-
25	37	39	68	40	97	25	117	-	-
33	39	42	71	41	99	33	119	-	-
Peaks after filter by peaks values threshold which equal (30.8649)									
PV	**PL**	**PV**	**PL**	**PV**	**PL**	**PV**	**PL**	**PV**	**PL**
33	28	39	55	34	79	40	97	31	115
38	32	42	58	36	81	41	99	33	119
32	35	33	63	44	83	33	101	38	125
33	39	39	68	36	86	39	108	-	-
39	43	42	71	35	95	37	110	-	-
Note: PV is Peak Value and PL is Peak Location									

TABLE 2
RESULT OF PFA

Peaks after filter by first last threshold which equal (4.2174)									
PL 1	**PL 2**	**PL 3**	**PL 4**	**PL 5**	**PL 6**	**PL 7**	**PL 8**	**PL 9**	**PL10**
43	58	63	71	86	101	110	119	125	-
Note: PL is Peak Location									

TABLE 3
RESULT OF PFMA

Peaks after filter by first last threshold which equal (4.2174)									
PL 1	**PL 2**	**PL 3**	**PL 4**	**PL 5**	**PL 6**	**PL 7**	**PL 8**	**PL 9**	**PL 10**
32	43	55	58	68	71	83	97	99	108
PL 11	**PL 12**	**PL 13**	**PL 14**	**PL 15**	**PL 16**	**PL 17**	**PL 18**	**PL 19**	**PL 20**
110	125	-	-	-	-	-	-	-	-
Peaks after filter by so near threshold equal (7.7500)									
PL 1	**PL 2**	**PL 3**	**PL 4**	**PL 5**	**PL 6**	**PL 7**	**PL 8**	**PL 9**	**PL 10**
32	43	56.5	69.5	83	98	109	125	-	-
Note: PL is Peak Location									

Table (4) will show results of PFA and PFMA on some videos with step time, number of steps, gait time and correct number of peaks.

TABLE 4
GAIT CYCLE RESULTS USING PFA AND PFMA

Video	Algorithm	Steps Time (sec)	Number of Steps	Gait Time (sec)	Correct number of steps
Video1	PFA	20.42	9	1.0214	8
	PFMA	26.50	8	1.3250	
Video2	PFA	23.71	9	1.1857	6
	PFMA	26.00	6	1.3000	
Video3	PFA	32.14	9	1.6071	7
	PFMA	44.80	7	2.2400	
Video4	PFA	36.71	9	1.8357	7
	PFMA	38.33	7	1.9167	
Video5	PFA	21.20	12	1.0660	6
	PFMA	38.83	6	1.9417	

V. CONCLUSIONS

The conclusion of this work could be summarizing as below:

- Using of MTI principles and Sobel edge detection algorithm give a clear view result (edges not blur) of binary capture.
- PFMA phase can find the right positions and no missing of peaks rather than PFA phase.

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