Recent Innovations in Mechatronics (RIiM) Vol. 5. (2018). No. 1.
DOI: 10.17667/riim.2018.1/3

Development of Gait Recognition in NI LabVIEW

Dániel SALÁNKI
Department of Mechatronics
University of Debrecen
Debrecen, Hungary
danisalanki@yahoo.com

Kornél SARVAJCZ
Department of Mechatronics
University of Debrecen
Debrecen, Hungary
sarvajcz@eng.unideb.hu

Abstract **— Nowadays, one of the most significantly improving area in security is the world of biometric identifiers. Within the biometric identifiers, the research group is working with the gait recognition speciality. The research group realized a complex gait recognition system in NI LabVIEW, that can detect more reference points simultaneously with a universal camera and is capable of suiting predetermined curves on the detected points. Moreover, the program can compare the functions suited on the reference curve and the actual curve and evaluate if the two gait images are the same or not. In the program there is a saving and a reloading function which contributes to the production of the reference gait image. The foot analysis program before the gait recognition is designed to improve accuracy. The self-developed gait recognition system was tested on more persons and the False Acceptance Rate (FAR) was zero.**

Keywords - biometric; gait; recognition; camera; analysis.

I. INTRODUCTION

In today's world, I find it important to protect our values with the mechanical and electronic tools at our disposal. As a mechatronics engineer student, I sought to find a theme that plays a decisive role in everyday life and is closely related to mechatronics. Numerous biometric identification methods exist today (e.g. face, voice, palm, iris, retina, fingerprint authentication and DNA analysis), but gait recognition is less common.

This is how we came up with the idea of wanting to implement a camera-based gait recognition program using the Vision module of NI LabVIEW software, which is capable of real-time image processing to recognize that the gait image of a person passing by in front of the system is the same as that of the previously stored person's gait image. If this condition is met, the system gives him / her permission. The gait recognition is preceded by a foot examination that examines the leg/foot ratio of the person. If the test is passed, the actual gait recognition begins.

II. GAIT RECOGNITION – REFERENCES

People can often feel that a familiar person is already recognized far from their walk. This common experience is the idea behind the fact that district recognition systems can be used in security technology. You can easily make an image of a person's walk, even in public places, without even getting observed by that person. Walking is also influenced by several factors: footwear, soil, fatigue, current state of mind or any injury [1].

Walking can be defined as a series of cyclic and coordinated movements that result in human displacement [1]. Compared to physiological biometric identification (fingerprint authentication, iris and face identification, earlobe geometry identification), the gait recognition has the advantage of identifying persons with low resolution or hidden camera shots [2]. Physiological biometric methods cannot reliably detect non-cooperating individuals, especially not at distances, under the changing environmental conditions of the real world [3]. However, the accuracy of walking recognition can be greatly influenced by several factors, such as the viewing angle that changes the visual attributes [4].

III. FOOT ANALYSIS PROGRAM

The essence of foot analysis is that we use a program developed in LabVIEW to determine the ration of the leg's and foot's lengths. We first measured the ratio of one of our legs, which ranged between 2.42 and 2.43, so we selected these two numbers as limit values. So, if the ratio of the leg and foot measured in pixels is between these two numbers, the program will give a green signal.

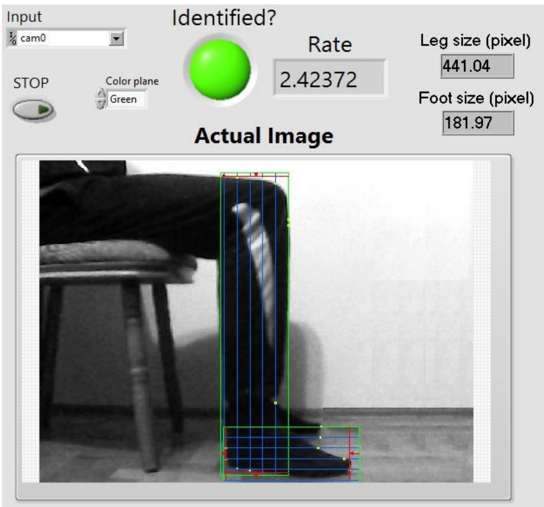

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Fig. 1. Foot analysis program during operation

Fig. 1 shows the program after the run. The proportional value (2.42372) corresponded to the set limits, so the green light flashes. During the experiment, the person was sitting in pants and socks, but similar values were achieved in shorts, without socks, so it can be stated that the clothes have minimal influence on the results and therefore are negligible in terms of analysis.

The results of a series of 20 measurements are shown in Fig. 2. Without footwear, the program was working with 90% accuracy, and in the case of two negative results only 0.5% was missing for compliance. Wearing footwear (slippers), the program never recognized the person. The simple explanation is that the footwear has larger dimensions than the foot. So, the measurement is necessary to be done without footwear to achieve the correct result. With another person, the leg/foot ratio was around 2.5, so the green light didn't flash.

Measurement nr.	Leg/Foot ratio	Passed?	Measurement nr.	Leg/Foot ratio	Passed?
1	2.42384	yes	14	2.41906	no
2	2.42735	yes	15	2.42288	yes
3	2.42863	yes	16	2.42511	yes
4	2.42407	yes	17	2.42091	yes
5	2.42514	yes	18	2.4181	no
6	2.42643	yes	19	2.42372	yes
7	2.42227	yes	20	2.42337	yes
8	2.42124	yes	21	2.26314	no
9	2.42441	yes	22	2.2617	no
10	2.42424	yes	23	2.26053	no
11	2.42138	yes	24	2.46508	no
12	2.42316	yes	25	2.46502	no
13	2.42396	yes			

Fig. 2. 20 measurements without footwear (grey fields), 5 measurements in footwear (blue fields).

IV. The Presentation of the Gait Recognition Software

We attach a point to the knee and one to the leg of the person, in the tibia region. The background of the points is white, the point itself is black. It is important to have a light or white background to avoid false point detection, and to have your foot closer to the camera where the reference points are located. Measurements were made with artificial light, with normal room lighting, with a darkened shade, creating approximately the same lighting conditions for each measurement.

Fig. 3 shows the front panel after running. On the right side of the figure, the coordinates of the detected points are stored in blocks. On the second and third tabs, the gait image is processed. On the second tab, the actual gait image is processed, while on the third tab the saved and reloaded gait image is processed. The program suits a function on the curves drawn by the two reference points (see Fig. 4). You can choose between four function models (Linear, Polynomial, Exponential, Power – see Fig. 4) and you can choose the order of the function too. On Fig. 4 the blue points represent the detected points and the red curves are the functions suited on them. According to the tests, the most accurate fit is the fourth-degree (quartic) polynomial function. However, for quarter-degree polynomials, the third and fourth coefficients take very small values (up to 10^{-10}), and the second-order (quadratic) function also follows well the curve drawn by the points, so the use of the fourth-degree polynomials becomes unnecessary.

Fig. 3. The front panel of the gait recognition software

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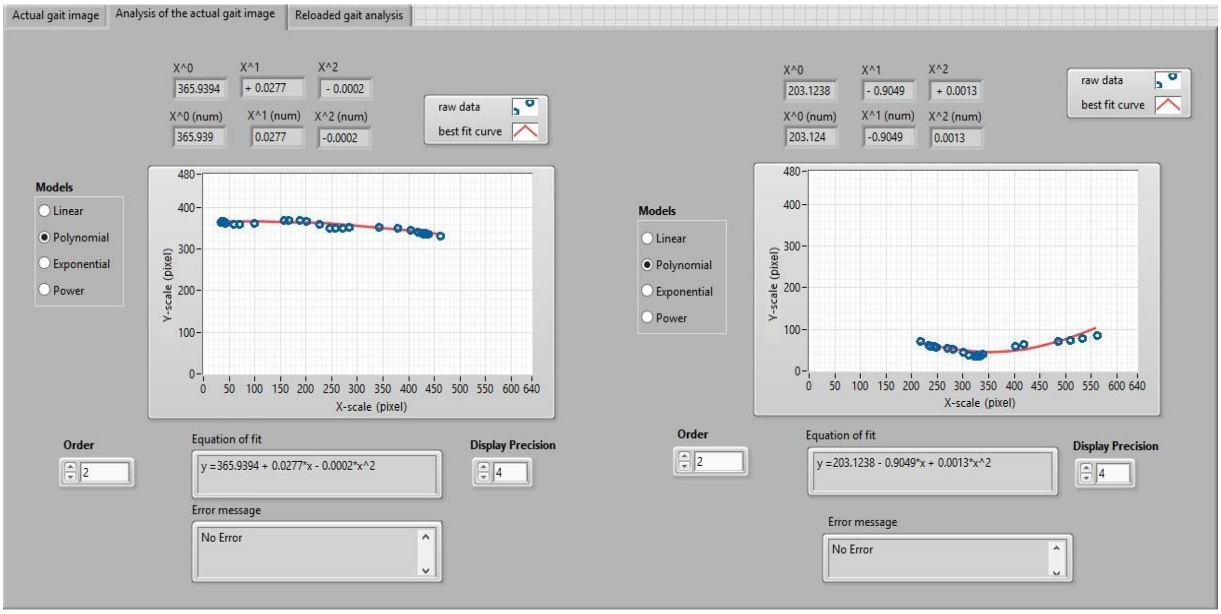

Fig. 4. Second tab – The detected points and the functions suited on curves

How can two gait patterns be compared? Before testing, the coefficients of a previously saved gait pattern are reloaded, and we measure the current gait pattern. For zero-degree coefficients, if the deviation is within 5% (first point) or 25% (second point), the program fragment provides one logic 1. For the first-degree and second-degree coefficients, we have set boundaries because of the high percentage deviations, shown in Table I. If within that narrow bounds falls the given coefficient, it also gives a logical 1 to the program. If all six of the logic 1s are given, the green light will flash, so the system recognized the person.

TABLE I.

First point				**Second point**			
X^2		*X^1*		*X^2*		*X^1*	
Max.	*Min.*	*Max.*	*Min.*	*Max.*	*Min.*	*Max.*	*Min.*
0.0002	-0.0003	0.05	-0.14	0.002	0.001	-0.5	-1.2

X^0	X^1	X^2	X^0	X^1	X^2	X^0	X^1	X^2	X^0	X^1	X^2
373.6298	-0.2329	0.0002	325.4167	-1.3881	0.0025	353.6152	-0.1192	8.26E-05	139.1351	-0.5073	0.0009
373.3425	-0.1974	0.0001	196.1278	-0.6277	0.0011	353.7429	-0.0867	-3.49E-05	170.9622	-0.7358	0.0012
379.34	-0.2399	0.0002	249.1721	-0.9672	0.0016	355.5487	-0.0672	-9.52E-05	196.8606	-0.858	0.0013
372.077	-0.1939	8.97E-05	219.6966	-0.8317	0.0015	361.3664	-0.1049	-4.14E-05	174.3736	-0.6982	0.0011
378.0727	-0.264	0.0002	236.9901	-0.9307	0.0016	357.2629	-0.1118	4.16E-05	162.301	-0.6797	0.0012
380.2123	-0.2756	0.0003	147.7936	-0.2505	0.0004	362.4711	-0.1184	2.62E-05	185.2648	-0.7772	0.0013
376.068	-0.2785	0.0003	222.5547	-0.839	0.0015	357.1883	-0.1124	6.12E-05	170.0862	-0.7681	0.0014
370.8115	-0.2147	0.0002	152.7052	-0.2911	0.0005	344.6318	0.0053	-0.0002	181.6022	-0.7892	0.0013
384.1069	-0.2987	0.0003	172.5713	-0.3834	0.0006	357.0924	-0.0731	-7.50E-05	196.4917	-0.892	0.0015
369.9979	-0.2017	0.0001	214.1039	-0.7529	0.0013	379.9573	-0.2489	0.0003	234.2505	-1.1582	0.0019

Fig. 5. The coefficients of the suited functions on the detected points

On Fig. 5, the green columns refer to the first point, while the blue columns refer to the second point. The six columns on the left are the values of one person, while the right-hand six columns refer to another person with similar height. Based on the results, in 8 of 10 cases the tested person was detected by the system correctly, while the False Acceptance Rate was zero, so the gait recognition system never accepted an access attempt by an unauthorized user.

V. Conclusion

In conclusion, the accuracy of the district recognition system is adequate and, in combination with the previous foot analysis program, its accuracy can be improved further by implementing a two-stage biometric system. Plans in the future include more cameras to get a better image of a person's gait. The cameras could be positioned at a certain angle and coordinated with the images formed by them to obtain a camera system that can be examined with spatial geometric equations. In addition, we would like to introduce additional reference points, thereby reducing the defect potential during detection.

Acknowledgment

The publication / presentation / poster was supported by the EFOP-3.6.1-16-2016-00022 project. The project was funded by the European Union, co-financed by the European Social Fund.

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