Body Tracking Method of Symptoms of Parkinson's Disease Using Projection of Patterns with Kinect Technology

Raquel Torres, Mónica Huerta, Roger Clotet, and Giovanni Sagbay

Abstract

The analysis of the body movement is relevant in different areas, such as therapy, rehabilitation, bioinformatics and medicine. The Parkinson's disease (PD) is a progressive degenerative process of the central nervous system that primarily affects the movement. To measure motor disorders, body sensor networks and portable technologies are the trend for tracking and monitoring symptoms in PD. Through the use of technological tools, such as sensors, whether sensors for movement acquisition (accelerometers, gyroscopes, inclinometers) or environment sensors (sensors that record physiological properties), it is possible to track the symptoms of Parkinsonism in a person. A system has been designed using a Kinect sensor, that uses the projection of patterns technology for monitoring change in body posture, obtaining information for a set of points or joints, and variation that could have during the observed period. The designed Kinect sensor system consists of four modules: the first acquisition of the body movement of the patient with the Kinect sensor V1.0, the second feature extraction module to process captured scene by Kinect V1.0, the third recognition of the skeleton module and finally the acquired data processing module, developed with MatLab. The acquisition of the center of mass with the presented methodology, through projection of patterns used by the Kinect sensor technology, is non-invasive a method and convenient to use in people.

Keywords

Body tracking • Kinect sensor • Motor disorders
Parkinson disease

1 Introduction

The Parkinson's disease (PD) is a degenerative and progressive process of the central nervous system that primarily affects the movement. In presences of symptoms of Parkinsonism there is a need to use some sort of device to capture signals or indicators of the body movement of the patient in non-invasive approach, in order to assist diagnosis, knowledge, and evolution of the disease with impartiality of trial, which brings convenience and low cost, both to the patient as to the physician. To measure motor disorders, body sensor networks and portable technologies set the trend for tracking and monitoring symptoms in PD.

In this research has been studied the movement of the body of a group of healthy people, a through a system that uses a sensor Kinect as a method of data acquisition, for the purpose of establishing a descriptive platform position and displacement of key joints of the human skeleton, so as a basis to compare the position and movement of joints of patients who have neurodegenerative diseases and recognize some symptoms with motor impairment.

R. Torres (✉)
University of the Armed Forces, Caracas, Venezuela
e-mail: rtorres@unefa.edu.ve

R. Torres · R. Clotet
Universidad Simón Bolívar, Caracas, Venezuela
e-mail: clotet@usb.ve

M. Huerta · G. Sagbay
Universidad Politécnica Salesiana, Cuenca, Ecuador
e-mail: mhuerta@ups.edu.ec

G. Sagbay
e-mail: gsagbay@ups.edu.ec

L. Lhotska et al. (eds.), *World Congress on Medical Physics and Biomedical Engineering 2018*,
IFMBE Proceedings 68/3, https://doi.org/10.1007/978-981-10-9023-3_40

2 The Extraction of Information of an Image on a 3D Space

In systems that analyze and follow the body movement are considered the parameters that determine the speed according to the movement of the subject is generated by observing body joints [1].

2.1 Body Tracking

There are different algorithms for body tracking; H.Weiming et al. in [2] studied some of them. Figure 1 show a resume of these algorithms. In a Kinect system the detection of the position is based on dynamic models of the human body, these models are taken as a basis for the movement of the body to the skeleton mapping. In the tracking algorithm based on the model of the skeletal figure, it is considered that the essence of the movement is typically limited to the movements of the head, torso and extremities.

The extraction of information of an image on a 3D space, starting from one or more projections that represent it [3], consists of two large processes, first to acquire an image of the real event and is followed by another stage for the analysis of acquired images to extract information.

The capture stage, considers everything related with the formation process of the image and the mechanism whereby the information of the physical world (scene) is transmitted.

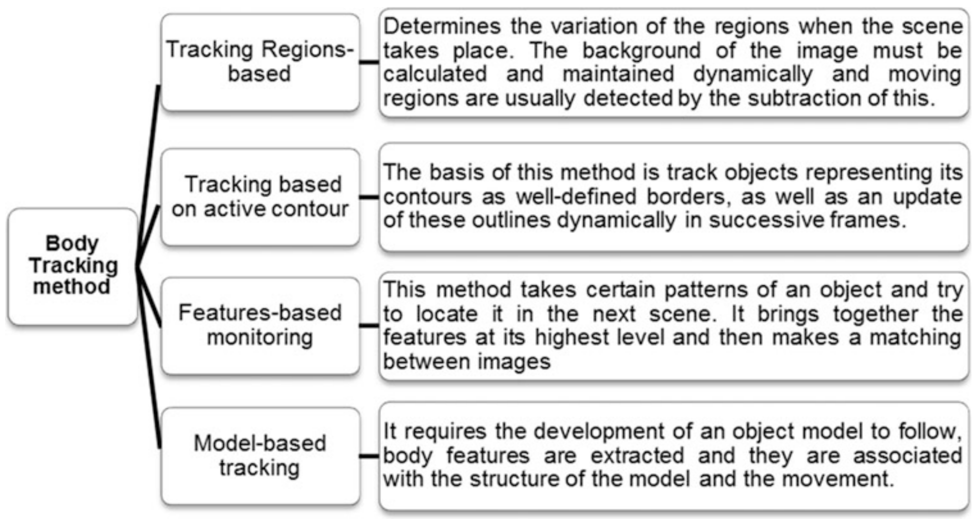

Fig. 1 Methods for monitoring according to [2]

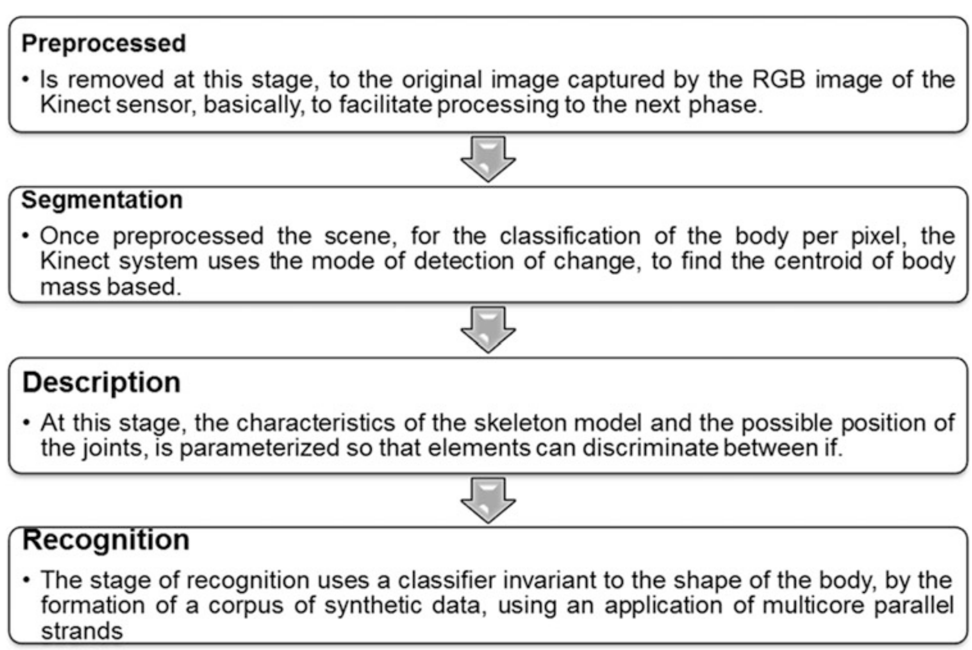

Fig. 2 The process of analysis or imaging components

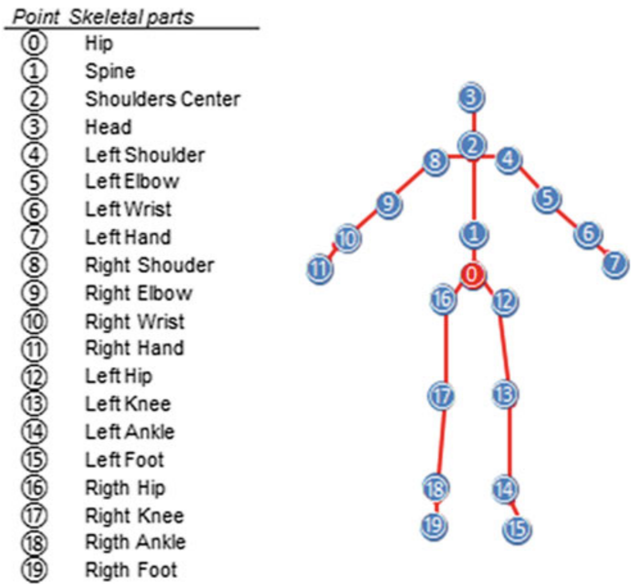

Fig. 3 Dot structure of Skeletal Tracking for the Kinect (Color figure online)

To extract information, once it is captured or acquires the image of the scene in study, proceeds in four essential steps: preprocessed, segmentation, description and recognition [4], presented in Fig. 2.

2.2 Technology of Projection of Patterns with Kinect Sensor

The Kinect system uses the technology of projection of patterns, where a known pattern of points of infrared light hits on the surface whose distances you want to calculate, determining its geometry through the analysis of differences in the image obtained with the original pattern is projected [5–7]. Dot structure of Skeletal Tracking for the Kinect, it is shown in Fig. 3. The red point (0) represents center hip.

3 Case Study

In this project, a system composed of a Kinect sensor, was used to follow the change of body stance, finally obtaining information about the location a set of point or systems of joints on the Kinect sensor and variation that they might have had during the observed period [12, 13].

For the body tracking method for different age groups, it followed the process shown in Fig. 4. The designed system using Kinect sensors consists of four modules: first one is an acquisition of the body movement of the patient with the Kinect sensor V1.0, the second one features the extraction module to process the scene captured by Kinect V1.0, third

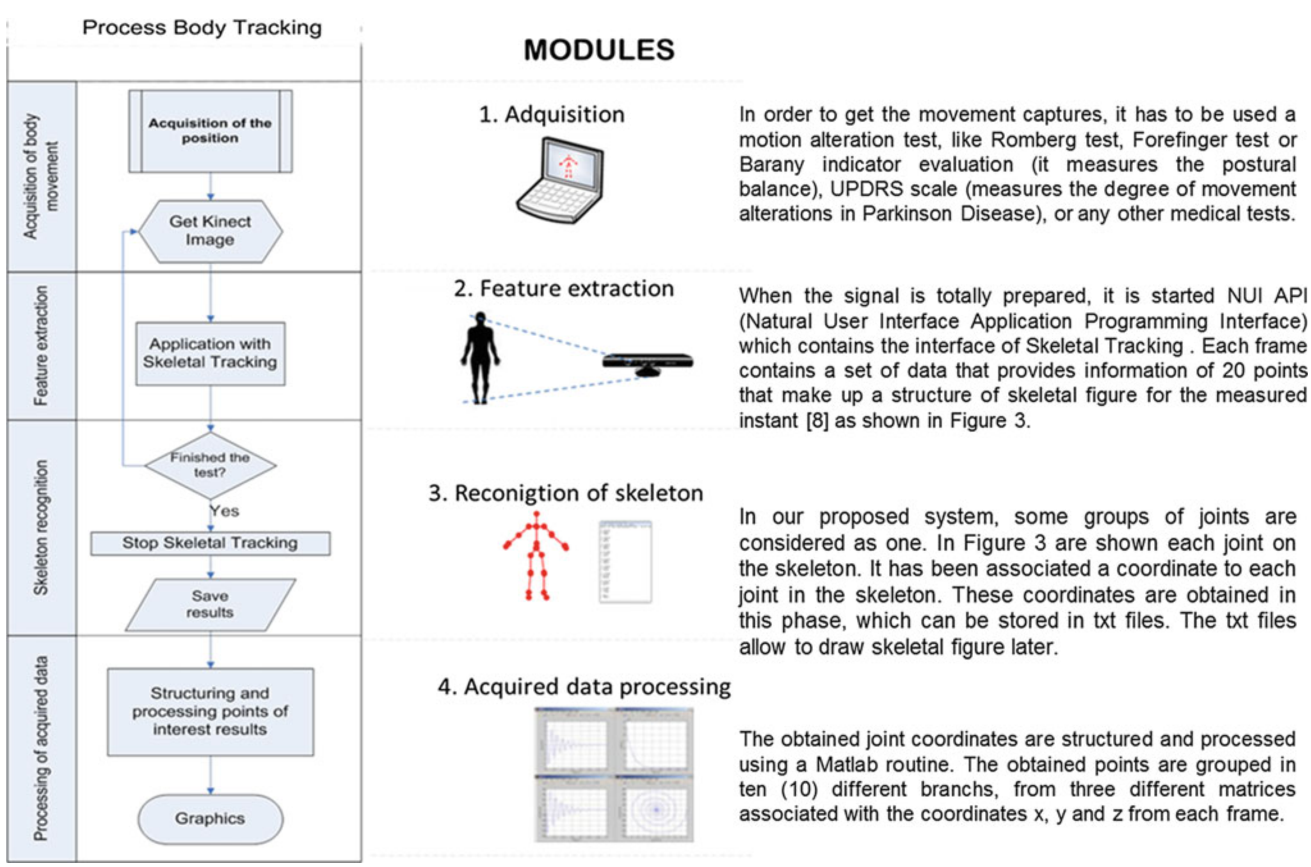

Fig. 4 Process for the body tracking method for different age groups and modules of designed system

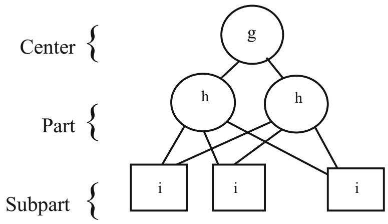

Fig. 5 Hierarchy model [11]

one works on the recognition of the skeleton module, and finally, the acquired data processing module, which is based on a routine in MatLab.

4 Results

It was realized a series of measurements to a group of people with the purpose of establishing a model with a group of patients from different groups of ages [8], in order to establish a comparative basis of motor signs for the evaluation of the position with the use of sensors, as it has been reported in [9]. In this case study, has been considered the track to body mass center, located in the middle of the hip, it is taken as premise computer vision algorithms presented in [10] and the hierarchical model for visual objects categorization presented in [11], see Fig. 5.

Table 1 Data acquired of center of mass on the x axis (Volunteers, age)

Age (years)	Gender	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}
22	M	0.0355	0.03555	0.0356	0.03565	0.03571	0.03577	0.03583	0.03588	0.03594	0.036
22	F	0.10656	0.10664	0.10671	0.10678	0.10684	0.10689	0.10694	0.10699	0.10704	0.10709
26	M	0.07521	0.07522	0.07522	0.07523	0.07523	0.07524	0.07524	0.07524	0.07524	0.07524
29	M	0.11948	0.11933	0.11919	0.11906	0.11892	0.11879	0.11868	0.11857	0.11846	0.11835
29	M	−0.12748	−0.12744	−0.12741	−0.12739	−0.12737	−0.12735	−0.12734	−0.12733	−0.12733	−0.12732
31	F	0.0901	0.0901	0.09011	0.09012	0.09015	0.09017	0.0902	0.09021	0.09023	0.09024
46	M	0.06309	0.06337	0.06364	0.06388	0.0641	0.06431	0.0645	0.06468	0.06484	0.06499
49	M	0.09574	0.09617	0.09666	0.09715	0.0977	0.09823	0.09874	0.09923	0.09967	0.10009
50	F	0.18671	0.18342	0.17875	0.17316	0.16616	0.15662	0.14781	0.1406	0.13301	0.12542
57	F	0.01341	0.01351	0.0136	0.01368	0.01376	0.01382	0.01388	0.01393	0.01397	0.01401
64	F	0.15188	0.15588	0.15912	0.16182	0.16382	0.16458	0.1642	0.16303	0.16205	0.16039
70	F	0.22714	0.23424	0.23832	0.23855	0.23621	0.22942	0.22403	0.22056	0.21651	0.21357
79	M	−0.04057	−0.04078	−0.04098	−0.04117	−0.04135	−0.04153	−0.0417	−0.04187	−0.04205	−0.04226
75	F	0.25321	0.08545	0.0602	−0.07075	−0.07991	−0.13775	−0.13499	−0.14351	−0.16498	−0.16256

Table 2 Data acquired of center of mass on the y axis (Volunteers, age)

Age (years)	Gender	y_1	y_2	y_3	y_4	y_5	y_6	y_7	y_8	y_9	y_{10}
22	M	−0.2833	−0.283	−0.283	−0.283	−0.283	−0.283	−0.284	−0.284	−0.28356	−0.28358
22	F	−0.22107	−0.22099	−0.22092	−0.22085	−0.22078	−0.22071	−0.22064	−0.22057	−0.22049	−0.22041
26	M	−0.16732	−0.1672	−0.16709	−0.16699	−0.1669	−0.16682	−0.16674	−0.16667	−0.16661	−0.16655
29	M	0.23773	0.23767	0.23762	0.23758	0.23745	0.23734	0.23719	0.23693	0.23669	0.23639
29	M	−0.02209	−0.02207	−0.02204	−0.02202	−0.02201	−0.02199	−0.02198	−0.02197	−0.02197	−0.02196
31	F	−0.42804	−0.42776	−0.42751	−0.42716	−0.42673	−0.42633	−0.42598	−0.42559	−0.42514	−0.42473
46	M	−0.13417	−0.1342	−0.13423	−0.13427	−0.13431	−0.13435	−0.13439	−0.13444	−0.13448	−0.13452
49	M	−0.03881	−0.03858	−0.03832	−0.03803	−0.0377	−0.03738	−0.03705	−0.03674	−0.03644	−0.03615
50	F	0.15829	0.15575	0.15332	0.14966	0.14595	0.13978	0.13308	0.12988	0.12689	0.12474
57	F	0.07208	0.0721	0.07212	0.07213	0.07215	0.07217	0.07219	0.0722	0.07222	0.07224
64	F	−0.16	−0.16172	−0.1625	−0.16205	−0.16061	−0.15847	−0.15473	−0.15022	−0.14399	−0.13665
70	F	0.22714	0.23424	0.23832	0.23855	0.23621	0.22942	0.22403	0.22056	0.21651	0.21357
79	M	0.13999	0.11304	0.10631	0.06886	0.05767	−0.04716	0.01002	−0.0112	−0.02394	−0.02526
75	F	0.13999	0.11304	0.10631	0.06886	0.05767	−0.04716	0.01002	−0.0112	−0.02394	−0.02526

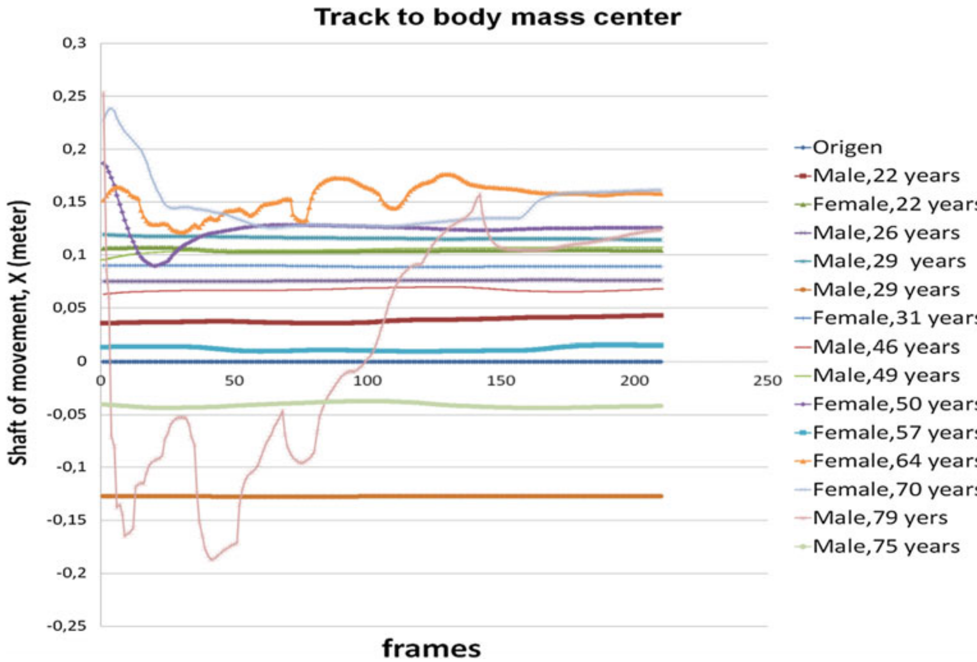

Fig. 6 Shaft displacement in axes x of center of mass

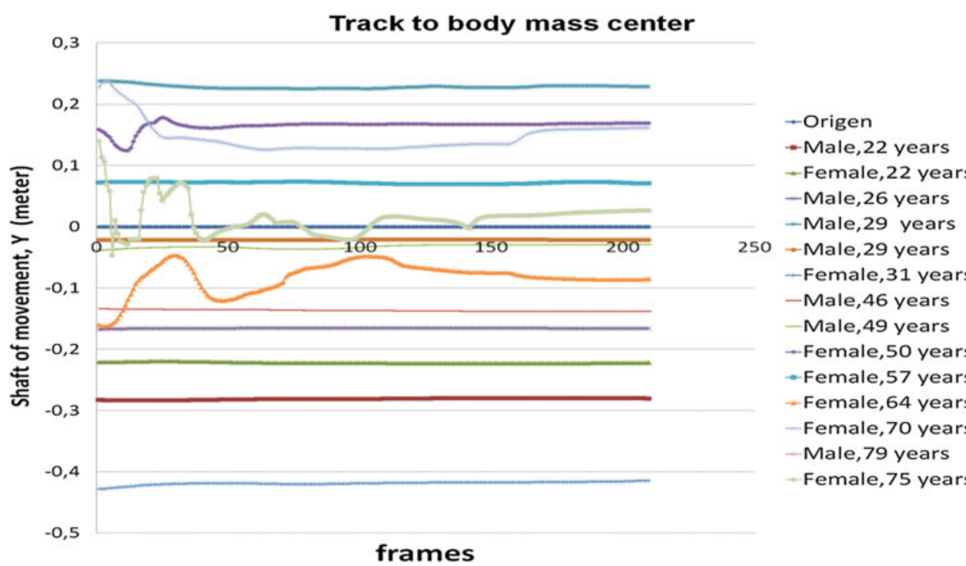

Fig. 7 Shaft displacement in axes y of center of mass

With a series of measurements to a group of people of different ages, we can establishing a model of reference, to classify them in different age groups as [8] suggest. Data acquired center of mass on the X axis is show in Table 1 and data acquired center of mass on the Y axis is show in Table 2.

The displacement in axes X of center of mass is show in Fig. 6 and displacement in axes Y of center of mass is show in Fig. 7.

5 Discussion

The results obtained with the methodology used in this proposal, for the monitoring of body center of mass of a group of volunteers from different age groups, shown in Fig. 6, exposed that the group of volunteers with greater variation from body center of mass with regard to the origin, is represented by people with different ages both for the axis

X as in the shaft Y. To obtain information about the center of mass of a body, will allow analyzing the positions of equilibrium, as well as also could work in the appropriate increase of stability with the support and caring by a specialist. The acquisition of the center of mass with the presented methodology, through projection of patterns used by the Kinect sensor technology, a method is non-invasive and convenient to use in people. Although, is important to consider the constraints of the sensor (maximum distance from the camera to the human body in observation).

Acknowledgements The authors gratefully acknowledge the support of the NEURO-SISMO project, Universidad Politécnica Salesiana from Ecuador.

Conflict of Interest statement The authors have no conflict of interest.

References

1. Cappozzo A., Cappello A.; Croce U.D., Pensalfini F., "Surface-marker cluster design criteria for 3-D bone movement reconstruction"; Biomedical Engineering, IEEE Transactions on, vol.44, pp. 1165– 1174, 1996.
2. Weiming H., Tieniu T.; Liang W.; Maybank S., "A survey on visual surveillance of object motion and behaviors," Systems, Man, and Cybernetics, Part C: Applications and Reviews, IEEE Transactions on, vol. 34, no. 3, pp. 334, 352, Aug. 2004.
3. Watt A., Policarpo F., "The image computer", England, 1998.
4. González A., "Técnicas y algoritmos básicos de visión artificial", Universidad de la Rioja, 2006.
5. Shotton J., Fitzgibbon A., Cook M., Sharp T., Finocchio M., Moore R., Kipman A., Blake A., "Real-time human pose recognition in parts from single depth images," Computer Vision and Pattern Recognition (CVPR) 2011, IEEE Conference on, pp. 1297, 1304, June 2011.
6. Zhang Z., "Microsoft Kinect Sensor and its effect", IEEE Computer Society, 2012.
7. Skeletal Tracking, available in http://msdn.microsoft.com/en-us/library/hh973074.aspx. Fecha de consulta: March 2018.
8. Los factores definitorios de los grandes grupos de edad de la población: tipos, subgrupos y umbrales, available in http://www.ub.edu/geocrit/sn/sn-190.htm. March 2018.
9. Torres R., Huerta M., González R., Clotet R., Bermeo J., Vayas G., "Sensors for Parkinson's disease evaluation", Devices, Circuits and Systems (ICCDCS), 2017 International Caribbean Conference on, 2017.
10. Szeliski R., "Computer Vision,Algorithms and Applications", Springer-Verlag London Limited 2011.
11. Bouchard G. and Triggs B., "Hierarchical part-based visual objects categorization", CVPR, Springer,Volumen 1, 2005.
12. Torres R., Huerta M., Clotet R., González R., Sánchez L., Erazzo M,, y otros. (2014). A Kinect based approach to asist in the Diagnosis and Quantificaction of Parkinson's Disease. VI Congreso Latinoamericano de Ingeniería Biomédica CLAIB2014. Paraná-Argentina.
13. Torres R. et al., "Diagnosis of the corporal movement in Parkinson's disease using kinect sensors," in IFMBE Proceedings, 2015, vol. 51, pp. 1445–1448.