XVII International Symposium on Computer Simulation in Biomechanics
July 28th – 30th 2019, Alberta, Canada

APPLICATION OF MOTION CAPTURE SYSTEM TO ASSESS A HUMAN STABILITY LOSS

Agata Matuszewska[1], Jakub Liszkowski, Tomasz Walczak[1] and Jacek Buśkiewicz[1]

[1]Institute of Applied Mechanics, Poznan University of Technology, Poland
Email: agata.matuszewska@put.poznan.pl, tomasz.walczak@put.poznan.pl, jacek.buskiewicz@put.poznan.pl

INTRODUCTION

Human stability is a very important problem in many disciplines as medicine and physiotherapy [1]. Authors indicate that correct and precise human stability assessment plays a significant role during kinesiotherapy. Determination of the sensitivity of human organism to equilibrium disturbance is a complex and difficult issue because it depends on many factors.

The main research problem of this work is assessing of human stability loss in the case of falls from a static position. The examined patients were asked to take a starting position: standing on two legs with hands along the thorax. Next, patients had been leaning back until they had fallen down. In order to determine the instant of human stability loss the new measures and parameters were proposed.

METHODS

Tests have been carried out at Poznan University of Technology in Laboratory of Biomechanics. Motion was recorded by BTS Motion Capture System. This system allows to determine the positions of the markers, placed on the patient's body. Nineteen markers were used in this study and they were arranged at the points defined in the Clauser model [2]. In this method the location of center of mass of the particular body segment is given, that is expressed as percent of particular segment length. The masses of segments were expressed as a percent of the total body weight. According to this model the mass center of human body was calculated, which was relevant point of this work, because it is a main factor to express proposed stability criteria.

Analysis of human body motion was performed by using model with fourteen segments, that are: head, thorax, two arms, two forearms, two hands, two thighs, two calves and two feet. Fourteen-segments model is widely used in biomechanics [3].

In this study the AMTI Force Platforms were also used. There are many scientific articles in which signals from platforms are basic data source in stability studies and motion analysis [4, 5, 6, 7]. In this survey the values of ground reaction force and locations of CoP (Center of Pressure) point were measured. CoP is the point on the foot/ground surface where ground reaction force actually acts [8].

RESULTS AND DISCUSSION

In order to assess human stability three parameters were determined: ground reaction force, the distance between the CoP point and GCoM (Ground Projection of the Center of Mass [8]) point and the distance between GCoM point and convex hull of the foot support area (called also support polygon).

The relevant computations and visualization of survey results were carried out in Matlab software. Performed simulation shows marker positions in three dimensional space for the chosen instant of the movement. Calculations results include parameters values in time domain.

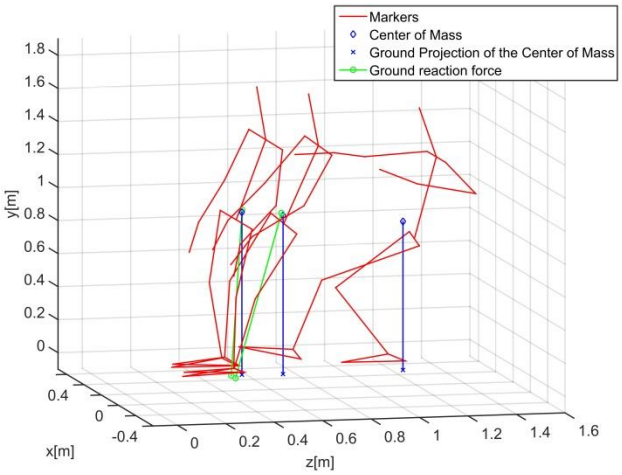

Fig 1: Scene view during fall.

CONCLUSIONS

Obtained results are characterized by high agreement. The stability loss occurs when the value of ground reaction force starts moving away from a static baseline. Assessment of human stability loss was performed just for one special type of movement. In order to determine the instant of human stability loss accurately the additional studies are being planned. There are two groups of the parameters being developed for assessment of the human stability: geometrical parameters (connected with the position of GCoM point and support polygon) and also kinematic parameters (connected with velocity and acceleration of the selected points). The intended effect is to apply the introduced parameters for another types of the human movement.

REFERENCES

1. Kostiukow A., Rostkowska E., Samborski W.: Assessment of Postural Balance Function (Badanie zdolności zachowania równowagi ciała), Annales Academiae Medicae Stetinensis (Roczniki Pomorskiej Akademii Medycznej w Szczecinie), 55, 3, 2009, s.102-109.
2. Tejszerska D., Świtoński E. (ed), Biomechanical engineering. Selected Issues. Laboratory (Biomechanika inżynierska. Zagadnienia wybrane. Laboratorium), Wydawnictwo Politechniki Śląskiej, Gliwice 2004.
3. Bober T., Zawadzki J.: Biomechanics of human movement system (Biomechanika układu ruchu człowieka), Wydawnictwo BK, Wrocław 2006.
4. Sung P.S., The Sensitivity of Thresholds by Ground Reaction Force and Postural Stability in Subjects With and Without Navicular Drop, The Journal of Foot & Ankle Surgery, Vol. 57, Issue 4, p. 742-746, 2018
5. Hong C-Y., Guo L-Y., Song R., Nagurka M.L., Sung J-L. and Yen C-W., Assessing postural stability via the correlation patterns of vertical ground reaction force components, Hong et al. BioMed Eng OnLine, 2016.
6. Winiarski S., Rutkowska-Kucharska A., Estimated ground reaction force in normal and pathological gait, Acta of Bioengineering and Biomechanics, Vol. 11, No. 1, 2009.
7. Clark K.P., Ryan L.J. and Weyand P.G., A general relationship links gait mechanics and running ground reaction forces, Journal of Experimental Biology, 2017.
8. Goswami A., Foot rotation indicator (FRI) point: A new gait planning tool to evaluate postural stability of biped robots, International Conference on Robotics & Automation, Detroit, Michigan 1999.

ACKNOWLEDGEMENTS

This work was supported by grants of the Ministry of Science and Higher Education in Poland: 02/21/DSMK/3528. The simulations have been made at the Institute of Applied Mechanics, Poznan University of Technology.