Kinematic model of Savannah Monitor Locomotion

Adam Kłodowski[1], Míriam Febrer-Nafría[2], Albert Martinez-Silvestre[3], Josep M. Font-Llagunes[2] and Josep Fortuny Terricabras[4]

[1] *Laboratory of machine design, Lappeenranta University of Technology, adam.klodowski@lut.fi*
[2] *Biomechanical Engineering Lab, Department of Mechanical Engineering and Research Centre for Biomedical Engineering, Universitat Politècnica de Catalunya, miriam.febrer@upc.edu, josep.m.font@upc.edu*
[3] *Centre de Recuperació d'Amfibis i Rèptils de Catalunya, crarc@amasquefa.com*
[4] *Josep Fortuny Terricabras, Institut Català de Paleontologia Miquel Crusafont, josep.fortuny@icp.cat*

Locomotion is one of the basic needs of all animals. Nature has created a variety of locomotion mechanisms to adapt to different environments, to increase chances of survival in competition with other animals living in the same area, and to allow exploring other area in search for food and shelter [1, 2]. This paper focuses on savannah monitor (*Varanus exanthematicus*, see Fig. 1.) walking [3]. Monitors are vertebrates with dorsally depressed anatomy and both the pectoral and scapular girdle confer them the characteristic reptilian ambulation system. This work presents the first step before the inverse dynamic analysis of walking using natural motion data acquired through motion capture and force plate recordings. The kinematic model is used together with the motion data recorded during an experiment conducted at the Universitat Politècnica de Catalunya, Biomechanical Engineering Lab in 2017. The data was used for determining range of motion for individual body segments, center of mass position during locomotion and, finally, contact points with the ground in global reference frame.

The presented model is based on body measurements and is developed in Matlab [4]. All joints were assumed to be spherical joints as it is often done in human body models [5, 6]. Body segment masses were calculated based on volume approximated by simplified body geometry and were used only for center of mass calculation from static equilibrium.

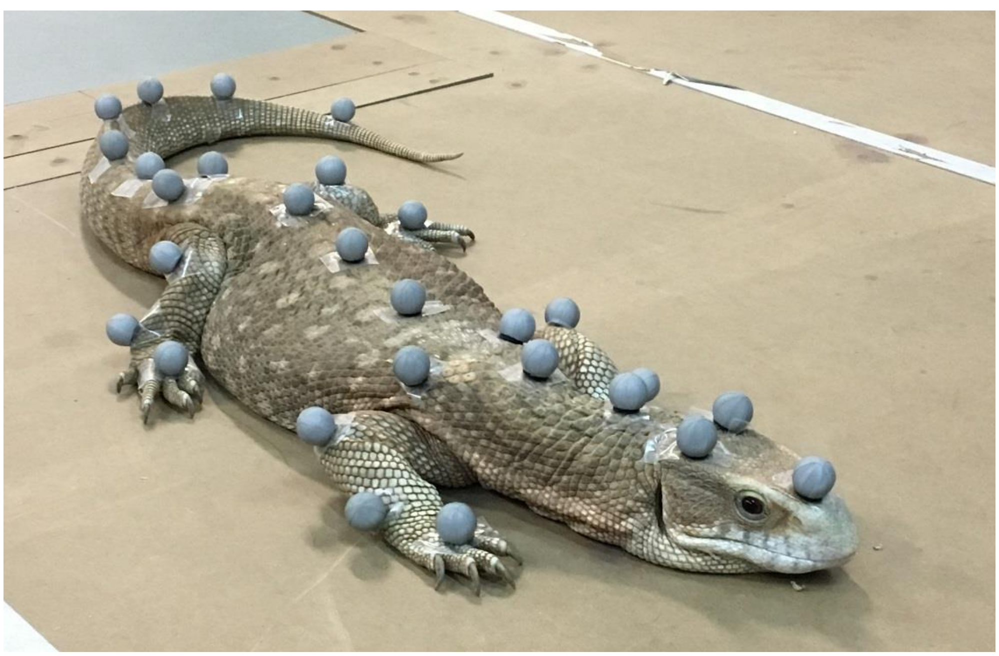

Fig. 1: Test subject with reflective markers during motion capture (Savannah Monitor)

References

[1] A. R. McNeill. *Principles of animal locomotion*. Princeton University Press, 2003.

[2] C. T. Farley, T. C. Ko, *Mechanics of locomotion in lizards*, The Journal of Experimental Biology 200 (1997): 2177–2188.

[3] Savannah Monitor, The IUCN Red List of Threatened Species,

[4] http://dx.doi.org/10.2305/IUCN.UK.2010-4.RLTS.T178346A7527972.en

[5] MathWorks, Inc. MATLAB: the language of technical computing. Desktop tools and development environment, version 7. Vol. 9. MathWorks, 2005.

[6] A. Kłodowski, T. Rantalainen, A. Mikkola, A. Heinonen, H. Sievänen "*Flexible multibody approach in forward dynamic simulation of locomotive strains in human skeleton with flexible lower body bones.*" Multibody System Dynamics 25.4 (2011): 395-409.

[7] A. Kłodowski, M. E. Mononen, J. P. Kulmala, A. Valkeapää, R. K. Korhonen, J. Avela, I. Kiviranta, J. S. Jurvelin, A. Mikkola. "*Merge of motion analysis, multibody dynamics and finite element method for the subject-specific analysis of cartilage loading patterns during gait: differences between rotation and moment-driven models of human knee joint.*" Multibody System Dynamics 37.3 (2016): 271-290.