

FINAL REVIEW and EVALUATION
of the Doctoral Thesis and Dissertation

**Zixiang Gao: Biomechanical Impact of Running-Induced Fatigue on Lower
Limb Asymmetry in Runner**

Opponent: Prof. Dr. István BÍRÓ

I. Structural aspects

The dissertation was written in the English language. The structure follows the regulations of the Doctoral School of the University of Pannonia. The full length of the work is 110 pages. The dissertation starts with introduction, literature review, and three parts of thesis points, list of publications, abbreviations, tables, and figures. It has 5 main parts and no annex added. The list of bibliography contains 230 items. List of Abbreviations helps the reader.

The structure of chapters and subchapters is excellent, fits the theme well. The references in the text are precise and correct. Author has apparently put a lot of energy into the literature review. The Author has 24 publications, with an impressive 87 independent citations in the Scopus Database.

II. Contextual aspects

The topic of the Dissertation are novel and the outcomes are definitely applicable in the future. It is really is a great challenge regarding to the complexity of the investigated topic. The biomechanical investigation of different sport movements is always difficult. I agree with Author that other research groups did not analyze the correlation between asymmetry and exercise experience until now, for this reason more future research is necessary in this field. As it well known, the asymmetry causes negative performance, but there is no scientific connection between the features of asymmetry and their negative effects.

The formulation of the research objectives and the methodology of the dissertation are correct and these are in line with the elaboration of the topic.

The aims and hypotheses are described in correct way. Author applied deep learning algorithm based on bilateral plantar pressure data for the early identification of fatigue gait. Further important aim is to quantify the gait stability in case of different types of asymmetry. At least as important question the alteration of internal knee loading during long-distance running.

It is an important fact that Author applied up-to-date tools to solve problems undertaken in his research work such as machine learning and finite element modelling technology.

The analysis and evaluation of the experimental results is carried out correctly throughout the dissertation. Scientific results of Author are convincing.

In Fig. 3.1.1 (p. 56) and 3.1.2 (p. 57) Author summarizes important results. In consequence of asymmetry, significant differences can be seen.

Specific comments about the PhD:

I have suggested several modifications to the Author in order to make his dissertation more understandable and clear. After carefully reading the updated version of his PhD, I have noticed that all of my remarks have been taken into consideration and the text, figures and explanations were modified accordingly.

Therefore I would like to conclude that the dissertation is acceptable now, as is.

III. Scientific thesis points

1. I accept the 1st thesis point, and I find it surely a new scientific result. Author created an augmented ConvLSTM model to recognize fatigue on running gait, from the perspective of deep learning, by the use of time-series planter pressure data. This is the most important sentence in this thesis point. By application of the model and based on the high number of runners the obtained results are convinced.
2. I accept the 2nd thesis point with regard to the symmetry function (SF). As it can be seen, the attached diagram contains many useful findings. In the frame of your home defense, please give us some additional information.
3. I accept the 3rd thesis point. The Author demonstrated the effect of long distance running on the significant change of internal loading in the knee joint, and he modified the explanation by emphasizing the method itself as a new scientific result.

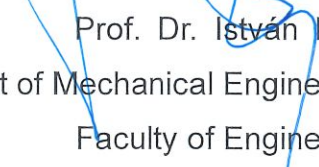
Specific questions

I would like to pose no further questions.

Statement

A significant number of new scientific results are proven in this PhD work. These results are supported by peer-reviewed journal publications. I consider that the work is of high scientific level, current, useful, well documented, with original contributions and competently developed. Based on above-mentioned details I suggest submitting the dissertation to public defense.

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