First analysis of gymnastics landing load prediction using LSTM neural network based on acceleration data

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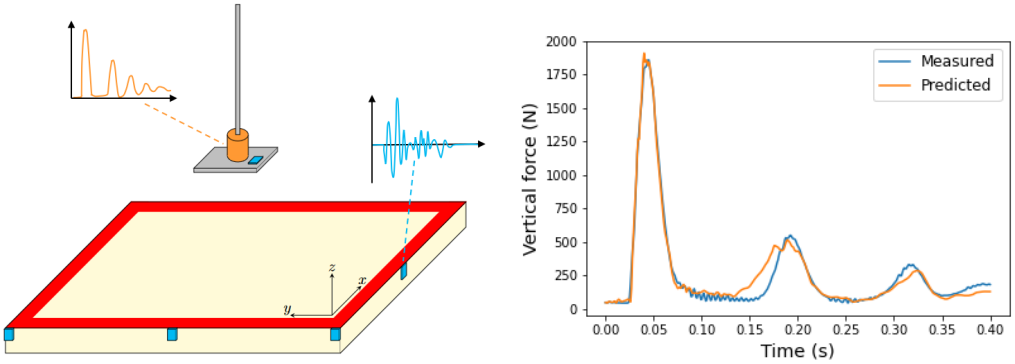
Most injuries in gymnastics are repetitive stress syndrome injuries on the lower limbs [1] and happen because of the repetition of high landing loads [2]. Assessing the loads undergone by gymnasts when landing could be a good way to prevent those injuries. Since mats are highly deformable, this task is complicated using classical biomechanical tools and methods.
The goal of this work is to use a Long Short-Term Memory (LSTM) cells neural network to reconstruct this load based on the acceleration propagated onto the sides of the mat when a landing is performed [3].
To train this network, we collected impacts of three different types (repeated, dropped and cushioned) with an instrumented impactor. With this setup, presented on *the figure*, the load applied on the mat and the acceleration of the sides of the mat were measured. We also collected data from drop landings performed by two gymnasts from different heights to predict the load undergone by the gymnasts.
The LSTM network showed good results on reconstructing impacts from the testing set. As can be seen on *the figure*, the first peak was better predicted than the rest of the signal in the case of cushioned impacts since those impacts were less numerous in the training set, and their force signals present several peaks compared to the dropped and repeated impacts. Indeed, for the first peak only, the peak error (7.8%) is close to the one of Zhou et al. [3] got with their LSTM model (6.7%).
Regarding the prediction for drop landings, the first peak of the prediction might be underestimated by the network, and the predicted load doesn't converge towards the weight of the gymnast, which can be explained by the differences between impact and drop landing signals. Future work will include numerical prediction methods to reconstruct landing loads in gymnastics.



Exprimental setup (left). Measure and prediction by the LSTM for a cushioned impact (right).

References

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