

## Biomechanics and Locomotion

### Prediction of kinetic parameters from body mounted IMU data using recurrent neural networks

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Vertical ground reaction force (GRFz) is an excellent parameter for assessing lameness in horses, but cumbersome to obtain. Predicting GRFz using inertial sensors (IMU) information would solve this problem. This study compares GRFz curves and peak-GRFz values with predictions of GRFz from long short-term memory neural networks (LSTM), using IMU data. Twenty-four healthy horses, with IMU on the upper body (UB) and on each limb, were trotted on an instrumented treadmill. Measuring systems were time synchronised. Randomly extracted data from 16, 4, and 4 horses formed training, validation, and test datasets, respectively. LSTM with different input sets (all sensors (ALL), UB, withers, sacrum, or limbs only) were trained to predict GRFz curves and peak-GRFz. Peak-GRFz were also extracted from the predicted curves and calculated using the duty-factor method (DF), based on limb IMU signals. The best GRFz predictions were obtained with the ALL dataset, with mean RMSE of  $0.37 \pm 0.04$  (front limbs) and  $0.29 \pm 0.03$  (hind limbs). For peak-GRFz, the best results were obtained with extracted values from the predicted curves by the ALL dataset, with mean RMSE of  $0.62 \pm 0.14$  (front limbs) and  $0.50 \pm 0.11$  (hind limbs). Predicted peak-GRFz values with the ALL dataset had RMSE of  $0.80 \pm 0.24$  (front limbs) and  $0.61 \pm 0.13$  (hind limbs), while the DF had RMSE of  $1.62 \pm 0.21$  and  $2.21 \pm 0.21$ . These results show the potential of machine learning for equine quantitative locomotion analysis. More data are needed to confirm the usability of LSTM for GRFz prediction, which is highly dependent on individual and environmental factors like speed, gait, and lameness.