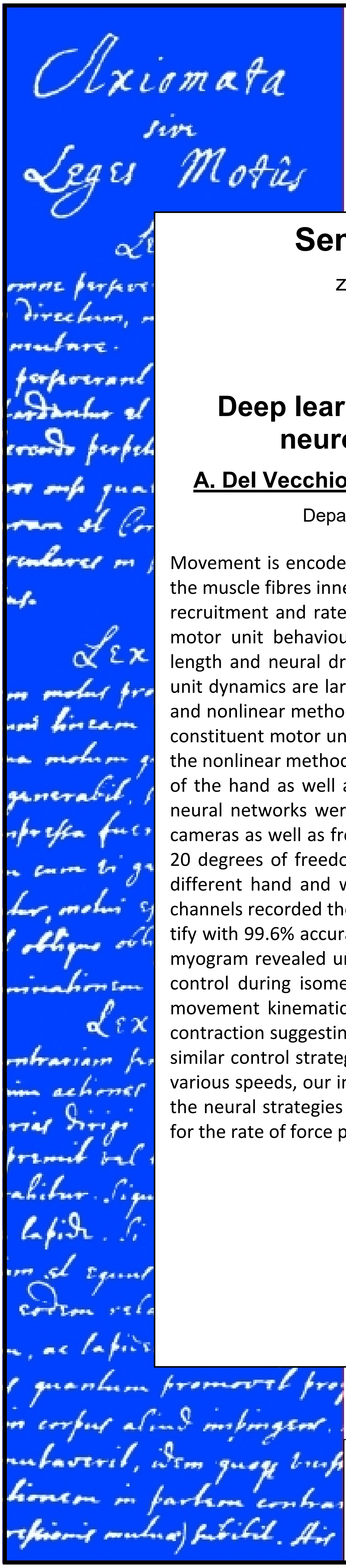

FRIEDRICH-ALEXANDER UNIVERSITÄT ERLANGEN-NÜRNBERG
TECHNISCHE FAKULTÄT

Seminar über Fragen der Mechanik

zu folgendem Vortrag wird herzlich eingeladen

Mittwoch, 19.01.2022, 09:30 Uhr

https://fau.zoom.us/j/97303812645

Deep learning human movement: an example of the neuromuscular control of the human hand

A. Del Vecchio, M. Oßwald, R. Simpetru, M. Cakici, D. Braun, D. O. Souza

Department Artificial Intelligence in Biomedical Engineering, FAU

Movement is encoded by spinal motor units. The motor unit is formed by a motoneuron, and the muscle fibres innervated by its axon. All motor action is generated by the interplay between recruitment and rate coding of motor units. There is very little knowledge on the changes in motor unit behaviour during natural dynamic movements consisting of changes in muscle length and neural drive. Moreover, the associations between kinematics, kinetics and motor unit dynamics are largely unknown. Here we aimed to explore these associations with a linear and nonlinear method. With the linear method, we decomposed high-density EMG signals into constituent motor unit action potentials during dynamic and isometric hand movements. With the nonlinear method, we built a framework with digital cameras that recorded the movements of the hand as well as recording isometric forces with an instrumented circular object. Deep neural networks were trained to understand the exact position of the hand from the digital cameras as well as from the high-density EMG signals. The movements consisted of more than 20 degrees of freedom, ranging from individual and combined finger flexion/extensions, and different hand and wrist gestures at different speeds (0.5 and 1.5 Hz). Four hundred EMG channels recorded the activity of the forearm muscles. The non-linear method was able to identify with 99.6% accuracy the exact movement of the fingers. The decomposition of the electromyogram revealed unique motor unit firing patterns that were significantly different than the control during isometric contractions. The delays between the onset of neural activity and movement kinematics were similar across all fingers and decreased with the speed of force contraction suggesting that the central nervous system compensates the muscle dynamics with similar control strategies for each finger. Because the hand digits were flexed and extended at various speeds, our interface shows that the dynamical output of the hand is fully explained by the neural strategies and that the musculotendinous unit has only a passive amplification role for the rate of force production.

Prof. Dr.-Ing. P. Steinmann
Prof. Dr.-Ing. K. Willner

Lehrstuhl für Technische Mechanik
Egerlandstraße 5, 91058 Erlangen

Prof. Dr.-Ing. S. Leyendecker

Lehrstuhl für Technische Dynamik
Immerwahrstraße 1, 91058 Erlangen