DIFFICULTIES OF FEEDBACK CONTROLLED FES

- The outcome of a stimulation pattern is difficult to predict.
- Complex models require long lasting identification experiments. Parameters are difficult to identify.

MODEL & PROBLEM ANALYSIS

- A static non-linear function describes the amount \( \lambda \) of recruited motor units in dependence of the stimulation intensity \( v \).
- Usually there are hysteresis effects along with a time variant behaviour.

PROPOSED SOLUTION: FEEDBACK OF EVOKED EMG

- Measurement and signal processing of EMG gives \( \hat{\lambda} \), the controlled variable.
- The function \( rc \) is linearised by the feedback loop.
- At an outer loop e.g. the joint-angle \( \vartheta \) is controlled by using the reference \( \hat{r}_\lambda \).
- Sampling rate: 25Hz

RESULTS

- For a constant reference \( \hat{r}_\lambda \), the stimulation intensity increases, while the angle stays constant.

CONCLUSION

- The recruitment function can be linearised by feedback of evoked EMG.
- Reduced effort for identification (hysteresis, threshold and non-linearity of \( rc(v) \) can be neglected)

Future

- Adaptive control: Closed-loop online identification.