# Continuous and simultaneous estimation of finger kinematics using inputs from an EMG-to-muscle activation

*File name = Continuous and simultaneous estimation of finger kinematics using inputs from an EMG-to-muscle model.pdf*

Classification approach are not sufficient for natural prosthetic motion as they use a sequential strategy where only one class of movement is active at a time.

* Need simultaneous control of multiple DOF

Difficult to predict the movement of multiple figer simultaneously even if they are recorded simultaneously because the number of involved channel is big

EMD : time delay between muscle motor action (offset in the EMG) and actual movement (tension in the muscle)

* Can be used as a parameter : EMD-to-muscle activation model
* 10 to 150 ms (depending on the task)

This study present a method to control simultaneously 15 DOF on all 5 fingers (3 angle per finger)

* Using a fast forward neural network and a non-parametric gaussian process regression

A motion capture system was used to capture the gesture at the same time than the sEMG to serve as ground truth

Data collection :

* Arms placed on the table
* 3 tasks
  + The subjects is asked to move one finger at a time (flexion extension)
  + Move all finger at the same time (flexion extension)
  + Move any finger freely in any direction (even irregular movement)
* Move in the same speed as they would normally do
* Reach maximum flexion/extension
* The rest of the arm stays fixed (marker on the wrist ensure that it stays fixed)
* Multiple set of each task were made
* After that, additional trials were made to collect MVC
  + Flex arm in all possible plane to induce maximum contraction of all targeted muscles
* Data was then analysed separately for each subject

MVC = maximum volontary contraction

* Gives the maximum EMG

Data processing

* EMG-to-muscle activation model
  + Depends on the current level of EMG and on its recent history
* Low pass filter

ANN

* Useful for its ability to estimate non-linear function
* Multi-layer feed forward neural network
  + Hestimates all 15 DOFs at te same time
* 80% of data for training

Gaussian process of regression

* One dedicated GP for each DOF

ANOVA statitical analysis

Results :

* It works even for all DOF predediction at the same time
* GP gives higher prediction accuracy than ANN
* GP can handle missing data better than ANN
* GP is 10 times slower than ANN
* PCA analysis showed that only the 4 to 6 PCA really have an impact on the hand posture
* Implemantation done offline
  + Need to be able to do it online for real life application
* Don’t know what happens if we change wrist position