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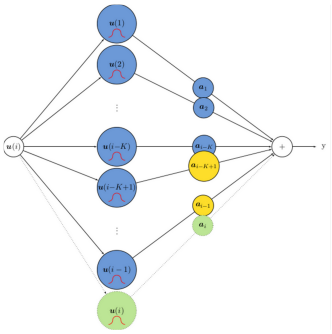
Subject Area	Sensor, Actuator and Communication Systems

Kernel Adaptive Filtering for External Disturbances Suppression

Term Thesis

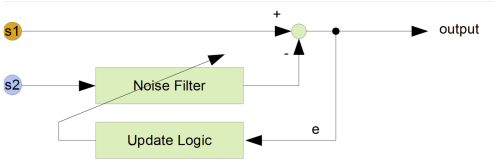


Network topology of a Kernel Affine Projection Algorithm: At every iteration a new unit (green) is added and some weights (yellow) are modified.

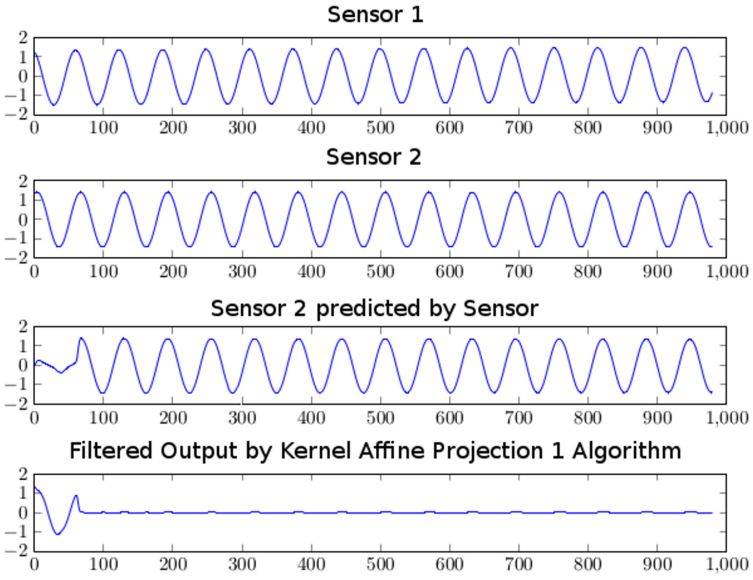
Introduction: A new approach converges the world of signal processing with the world of machine learning: Kernel adaptive filters. These are non linear adaptive filters derived from basic linear adaptive filters. Instead of mapping the inputs into a multidimensional feature space, the problems can be solved elegantly with kernel functions in the time domain.

Proceeding: In this project, these new kernel filters have been derived and analyzed mathematically and implemented in Matlab. Furthermore, the filters have been compared to linear adaptive filters in terms of filter and computational performance in space and time. An additional aim was to develop a kernel filter which improves the performance of the currently implemented linear filter with at least two sensors in a confidential application.

Result: Unfortunately, the results of the complexest kernel filter, the kernel recursive least-squares algorithm, were not as good as the results of the linear recursive least-squares filter. Furthermore, the performance is heavily dependent on the input data and the parameters. In addition, the computational complexity is exponentially growing. Finally, it could be stated that the new kernel filters currently have severe lacks in practical applications and some work needs still to be done in seeking the best parameters and sparsification or pruning.



The filter scheme shows both input sensors (s1, s2), the actual filter and update connections as well as the output.



The inputs are sine waves with different phase and additional white noise. The output shows the learning phase and nearly perfect prediction.