

Remote identification of electrical devices using dynamic time warping

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Aim

- Detect and classify electrical devices operating inside a building while making measurements outside
- Remote intelligence of building interiors
- Smart meter applications

Approach

- Measure example current time series for each device while being switched on/off
- Compare new test measurements with library to classify devices
- Devices: fluorescent lamp, CRT TV, laptop & charger (two models of charger), power drill, desk fan, filament lamp, flat screen TV, halogen lamp, LED lamp, and Nokia and Samsung phone chargers

Dynamic Time Warping

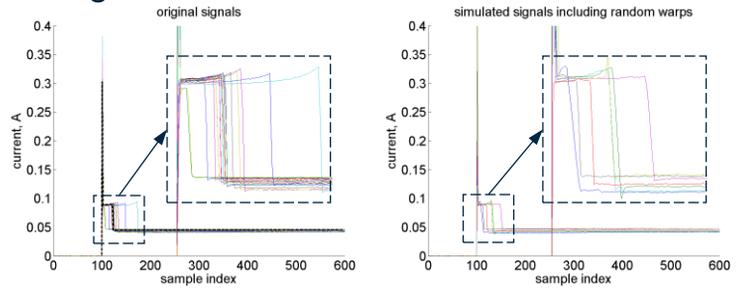
- Technique for finding the distance between time series
- Allows non-linear distortions in time using insertion, retention, or deletion of samples
- Set a window for maximum time shift
- Set a local slope constraint for maximum rate difference between signals
- Correlation classifier is a special case of DTW with a constant time shift

Results

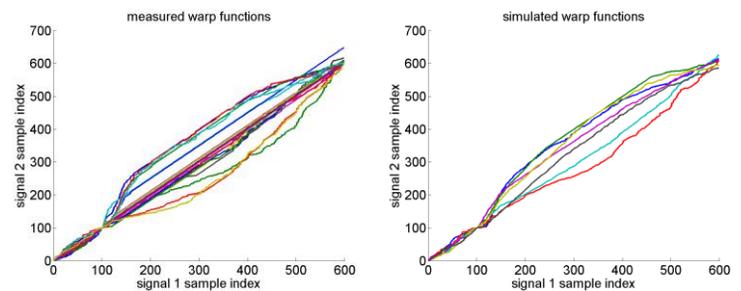
- 233 samples of measured data
- Devices measured on their own
- Nearest neighbour classifier based on correlation or DTW
- Real-time processing speed

Event type	Correct Decisions	
	Correlation	Dynamic Time Warping
Switch On	231 (99.1%)	233 (100%)
Switch Off	166 (72.1%)	230 (98.7%)

Signals



Warp functions



Generating Large Data Sets

- Real systems have multiple devices operating simultaneously
- Large data sets can be simulated based on statistics of individual device signals
- Select a reference signal for each device
- Find warp functions for each non-reference signal
- Warp all signals to reference time frame
- Compute amplitude statistics and use to simulate as many signals as desired
- Compute warp statistics and randomly warp simulated signals
- Superimpose signals at random start times to make complete time series
- Future work: classify multi-device time series

