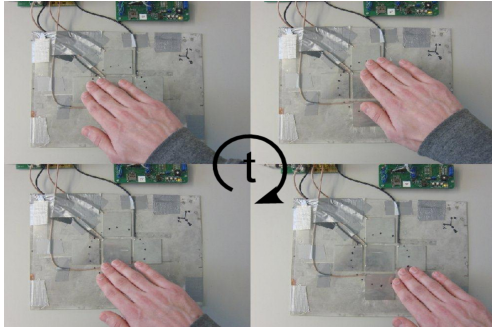Patrick Fleischmann

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Contactless Capacitive Hand-Gesture Recognition
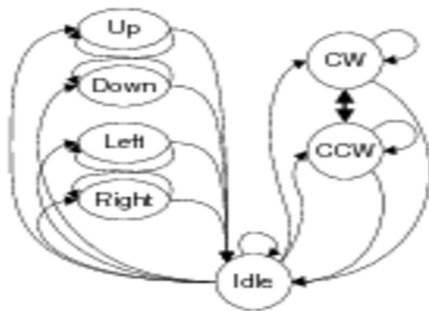
Using a Gesture Spotting Network of HMMs and Viterbi Decoding

The gesture circling clockwise, performed above the electrode board (vertical distance ca. 4cm)


Gesture spotting network consisting of single-gesture HMMs

Task: Capacitive sensors are used in many different ways for human-machine interfaces (HMIs), e.g. as buttons, scroll bars or touchpads. This report proposes a novel contactless HMI using the AD7746, a two channel, high resolution capacitance to digital converter (CDC). Together with two pairs of electrodes that are arranged orthogonally, the CDC is used to detect the relative position of a hand in the vincinity of the electrodes. This enables the recognition of simple hand-gestures.

Approach/Technologies: Hidden Markov Models (HMMs) are used to model a small set of six gestures: up, down, left and right which are modeled with linear left- right models and the gestures circling clockwise and circling counter-clockwise which are modeled by circular models. The spotting or segmentation problem is tackled by using a spotting network and Viterbi- decoding. The spotting network is a meta- HMM which connects all gesture- HMMs plus an additional idle HMM. The decoder continuously looks for state transitions into gesture models. If such a transition is encountered, a set of simple heuristic plausibility-checks is applied. A gesture is spotted if the state durations of the individual states of the gesture model lay inside a valid range.

Result: A prototype of the proposed system was built for testing and demonstration. The hardware, incorporating an AD7746 eval kit and an MSP430 microcontroller board, continuously sends the measured capacitance values to a PC via RS232. This data stream is processed in real-time by an application implemented in C.
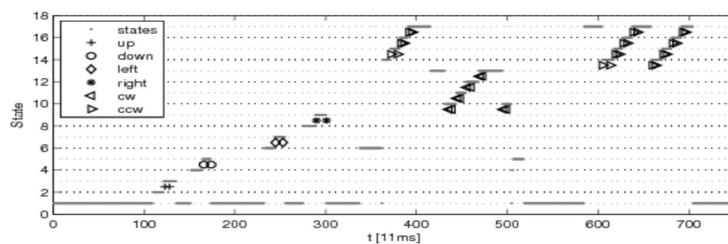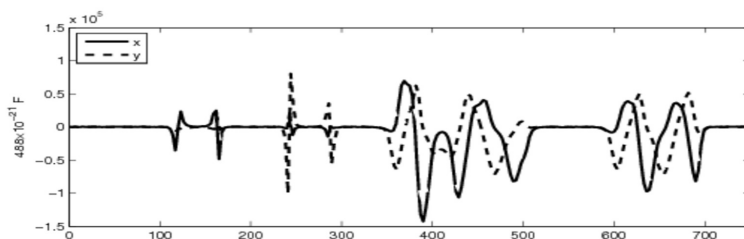
Typical gesture sequence. Original capacitance signals (top) and decoded state sequence with spotted gestures (bottom)