Using a Theremin for Micro-Gesture Recognition in an Automotive Environment

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ABSTRACT

The world's first electronic musical instrumented was invented in the 1920ies by the Russian Professor Léon Theremin. It is based on proximity sensing and can be played touch-free. We use this feature for recognition of micro gestures as a first step for future use in a car environment.

1. INTRODUCTION

In increasing awareness for a safe driver interface, several car manufacturers are carrying out research in gesture recognition [2]. Gestures represent a comfortable addition to existing interaction without the decline in recognition accuracy under noisy conditions that speech still suffers from [1]. However, as gesture recognition approaches are mainly camera-based, maintaining accuracy in varying light conditions and with dynamic background, as we encounter it in a car environment, are a major issue. We argue that an approach based on proximity-sensing is superior to audio- and video-based approaches.

2. THEREMIN GESTURE RECOGNITION

While doing research on proximity sensors for the Russian government, Léon Theremin invented an electronic musical instrument in 1920. It was named after him and patented in 1928 [3]. It became popular in the 1950ies trough the work of Robert Moog as well as by being featured in popular movie themes like Bernard Herrmann's soundtrack for *The day the Earth stood still*.
Since the Theremin is based on proximity sensing, it can be played without actually touching it - a fact that we exploit here.
The Theremin is controlled by two proximity-sensing antennae, one controlling the pitch of the produced sound and the other one its volume. The instruments pitch corresponds to the shortest distance of the players hand to the pitch antenna. In our experiment, we plug the audio output of a regular Theremin instrument (a Jupiter 4, manufactured by Golem Instruments, Germany) into the computers sound card. Since the relative proximity to the pitch antenna is equivalent to the current frequency of the instrument, we can track one motion dimension via the received pitch frequency.

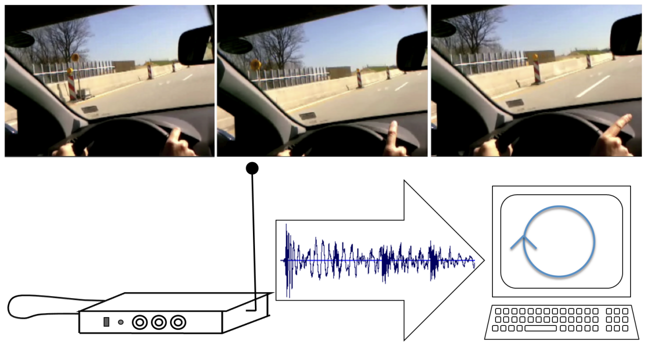

Figure 1: Gesture recognition via proximity sensing

For training, a predefined set of ten gestures (circle, square and triangle, each both clockwise and counterclockwise, as well as motion right, left, up and down) is performed in close proximity of the pitch antenna. The signal pitch is normalized and used as training data for a Dynamic-Time-Warping (DTW) algorithm.
Sub sequentially, gestures performed at the Theremins pitch antenna can be recognized by classification based on the training data.
The recognized gesture is displayed on the screen (see figure 1, bottom). With the prottoype described here, the current recognition accuracy is about 64% (on a 10% chance level), and mainly limited by the one-dimensional input signal.
At the moment, we still use a push-to-gesture button to select the start and end of a gesture, but consider an automatic recognition feasible.
We plan to build a similar two-antennae-device, not based on audio generation, and mount it behind the steering wheel of a car. The improved accuracy of two-dimensional recognition is believed to be reliable enough to use the device as an additional input-modality. As an obvious advantage, the driver can then interact without taking the hands off the wheel (see figure 1, top).

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3. REFERENCES

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