Aiding the Development of Piano Gesture Recognition with a Gesture Enriched Instrument

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1 Introduction

Recognition of instrumental playing movements has recently drawn attention, especially in the domain of bowed string instruments. Peiper et al. have used decision trees to classify bowing movements [1]. Rasamimanana et al. have used k-NN (k-Nearerst-Neighbours) in a feature space spanned by minimal and maximal acceleration of a bowing gesture [2]. Young has used a combination of PCA (principal component analysis) and k-NN to recognize bowing gestures [3]. Although the system of Peiper et al. provides real-time visual feedback, the mentioned studies have not reported the aid of a gesture-enriched instrument to assist the development of a recognition method as it is proposed in this paper.

In this paper we discuss the development of our method that allows to distinguish three piano playing gestures: The method distinguishes a touch with *pronation*, which is a touch with counterclockwise (clockwise) rotation of the right (left) arm, a touch with *supination*, which is the clockwise (counterclockwise) rotation of the right (left) arm, and a touch with no rotation. We have built a gesture-enriched piano that assisted us with the development of our recognition method. The instrument plays unique sounds for each recognized movement by generating MIDI messages. The instrument allowed us to test our recognition method under realistic conditions. This lead to the identification of problems, which we did not anticipate and which were initially not reflected in our training set. After identifying these problems, we extended our corpus and used the new data to improve our method.

2 Recognition Method

The recognition is based on data from inertial sensors, which we have developed and custom-built. Prior to storage or recognition, the values obtained by the accelerometers and gyroscopes are transformed to physical quantities. Our recognition method uses the mean rate of turn in two successive time slices of 8 samples measured at the wrist denoted as *ts1* and *ts2* as main features (see Fig. 1 top).

Because of the many variations when executing a touch, it is difficult to obtain a truely representative corpus of examples. Consider, e.g. our initial corpus (see Fig. 1 top left): It seems possible to recognize the movements based on *ts2* only. This is however not the case because of passive forearm rotation generated by the muscular forces on the fingers and the interaction between the playing apparatus and the key. The gesture-enriched instrument helped us to develop the recognition method as it helped us to spot this and similar issues.

The final version of our method uses adaptive thresholding on *ts1* based on the MIDI velocity of the played note (see Fig. 1 bottom). Additionally, if *ts2* exceeds a certain value the threshold on *ts1* is modified. The method obtains high recognition rates on the examples of the final corpus.

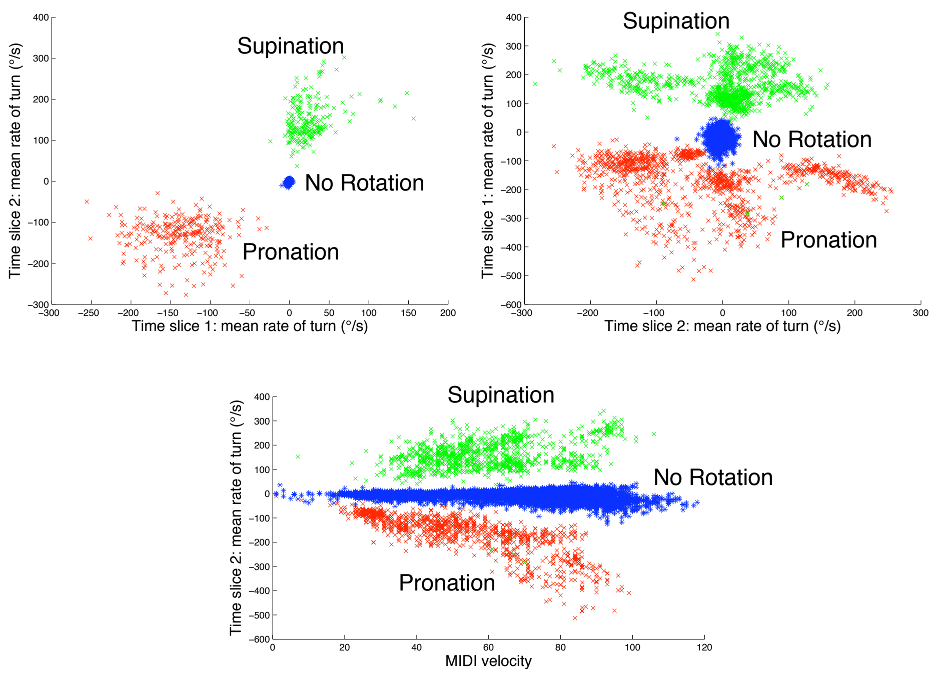

Fig. 1. Initial corpus with 776 examples (top left), full corpus with 11615 examples (top right). The noise on *ts2* depends on the loudness of the played note (bottom)

References

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