Piano Keys Detection Using Hand Movement

EE 368 – Project Proposal

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Motivation: There are various tools and software in the piano/keyboard musicians' community that helps one learn the keystrokes of the songs. Most of them, however, requires special functions in the keyboard to record the piece. Recent tools make use of the sounds (such as MIDI files) to produce other learning tools. Some applications of these tools include creating music sheets from Youtube videos with no sheets provided, recording or creating music sheets of the player's own composition when he or she is not good with writing music scores, etc. However, these tools are still not accurate. Moreover, they cannot incorporate the hands motion, which is an important part of learning to play piano. To solve this problem, we need image-based approaches. We can detect the keys pressed and hand positions at each video frame and collect notes played information.

Goal: Our goal is to utilize image/video processing and computer vision techniques to detect the piano keys played. The tasks will be divided into two parts: detection of keys that are being pressed and detection of the hands. To simplify the scope of the project, we will place the camera above the keyboard so as to limit the viewing angle. It is easy to detect where the keyboard is as it contains black and white keys in certain patterns. We will record the first background frame as a reference frame that will be compared to other frames for detection of foreground objects as well as keystrokes.

Challenges: The hard part is to detect the keys that are being pressed. Previous work utilizes the depth sensor to detect the depth of the keys [1]. In our case, we cannot afford using other external tools except for a simple recording camera. To approach this problem, we will try different techniques such as image subtraction since the keys that are pressed will contain shadows that are different from the reference frame. Edge detection might also be useful in this case. As for the hand detection part, previous works include marking each finger with different colors to differentiate them [3]. To simplify this problem, we will assume that the five fingers are all present in normal order. We will first try the techniques described in [2], which utilize the fact that piano playing hands are mostly convex and fingers often touch each other. Combining the two parts, we hope we will get a promising result.

Implementation: This project involves video editing and might require large amount of memory. It might not be suited for mobile. But since our algorithm will try to be minimal and real-time, it might be worth implementing this on mobile device. Please advice.

References:

[1] Oka, A. and Hashimoto, M., *Marker-Less Piano Fingering Recognition using Sequential Depth Images*. The 19th Korea-Japan Joint Workshop on Frontiers of Computer Vision, pp. 1-4, Jan 30 – Feb 1, 2013.

[2] Gorodnichy O., D. and Yogeswaran, A., *Detection and tracking of pianist hands and fingers*. CRV '06 Proceedings of the 3rd Canadian Conference on Computer and Robot Vision, pp. 63, 2006.

[3] Takegawa, Y., Terada, T. and Nishio, S., *Design and Implementation of a Real-Time Fingering Detection System for Piano Performance*. International Computer Music Conference Proceedings, vol. 2006, 2006.