REAL-TIME GUITAR STRING DETECTION FOR MUSIC EDUCATION SOFTWARE

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ABSTRACT

In this paper, we present a novel approach to real-time detection of the string number and fretboard position from polyphonic guitar recordings. Our goal is to assess, if a music student is correctly performing guitar exercises presented via music education software or a remote guitar teacher. We combine a state-of-the art approach for multi-pitch detection with a subsequent audio feature extraction and classification stage. Performance of the proposed system is evaluated with manually annotated chords recorded using different guitars.

Index Terms — multiple fundamental frequency estimation, string classification, fretboard position, fingering, electric guitar, inharmonicity coefficient, tablature

1. INTRODUCTION

Over the past few years, there have been several new software products that promise to enhance learning a musical instrument by means of assistive software. Acoustic or electric guitars are often the main supported instrument due to their popularity among starters. On the one hand, there are gaming oriented applications such as RockSmith[1], RockProdigy[2], GuitarBots[3], Songs2See[4], Jamstar[5], and Bandfuse[6]. They rely on game mechanics inspired by popular music video games such as GuitarHero[7] or RockBand[8]. That means, the user plays along to a song while playing instructions are presented on screen in sync to music. In contrast to GuitarHero and RockBand, the above mentioned applications allow the user to play real acoustic or electric guitars instead of guitar-shaped plastic controllers. The opposite is done in applications such as FretLight[9] or GTar[10]. Here, the user has to play along to a given song or short exercise on a modified guitar with LEDs lighting up the sequence of strings and frets that are to be played. In the case of FretLight, the playing instructions are usually generated in real-time by a remote guitar teacher. Moreover, there are online services like SoundSlice[11] and YouTab[12] that enable users to create and publish so called guitar tabs synced with the corresponding song or video. Guitar tabs are short for tablature notation, which is probably the most popular music notation format among guitarists. The tablature is based on the geometry of fretted string instruments. It specifies the string and fret number for each note and thus resolves the ambiguity between note pitch and fretboard position. The guitarist can immediately see where he has to place his fingers on the strings and frets (so-called fingering). Figure 1 illustrates the correspondence between common music notation and tablature for the guitar. Large amounts of guitar tabs are already available on the internet. However, since most of them are created by amateurs, these tablatures are often incomplete and erroneous. The first application scenario for the method presented here is the semi-automatic extraction of tablatures by means of automatic transcription and string detection from guitar recordings. Secondly, for a remote guitar teacher, it would be helpful to have his playing on a real instrument translated in real-time to corresponding playing instructions for the student. The third application scenario is to assess, if the guitar student is truly following the given playing instructions by means of real-time detection of played notes and strings.

Fig. 1. Score and tablature representation of the first bars from Eric Clapton's Layla. The six horizontal lines in the tablature correspond to the six strings with the tuning E2, A2, D3, G3, B3, E4 (from bottom to top). The numbers correspond to the fret numbers on the strings that are to be played.

2. GOALS & CHALLENGES

As introduced in Section 1, our goal is to estimate the notes and string number n_s from monophonic and polyphonic (monotimbral) recordings of electric guitars. Based on the note pitch and the string number, we can apply knowledge about the instrument tuning in order to derive the fret number n_f. The first challenge is to get a good real-time estimate of the notes being played. Since we focus on the electric guitar, frequencies between 82.40 Hz and 659.25 Hz need to be investigated as potential f_0-candidates[13]. The second challenge is the selection of suitable audio features that allow to discriminate between different strings. The automatic classification of the played string poses a challenging task since the physical differences

[1] http://rocksmith.ubi.com/
[2] http://www.rockprodigy.com/
[3] http://ovelin.com/guitarbots/
[4] http://www.songs2see.com/
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[9] http://www.fretlight.com/
[10] http://www.incidentgtar.com/
[11] http://www.soundslice.com/
[12] http://www.you-tab.com/

[13] This corresponds to the most common guitar string tuning E2 to E4, and a fret range up to the 12th fret.

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