

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 RockSmith¹, RockProdigy², GuitarBoss³, Songs2See⁴, Jamstar⁵, and BandFuse⁶. They rely on game mechanics inspired by popular music video games such as GuitarHero⁷ or RockBand⁸. 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 FretLight⁹ or GTar¹⁰. 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 SoundSlice¹¹ and YouTab¹² 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



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.

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 tablaturs are often incomplete and erroneous. The first application scenario for the method presented here is the semi-automatic extraction of tablaturs 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.

2. GOALS & CHALLENGES

As introduced in Section 1, our goal is to estimate the notes and string number s_i from monophonic and polyphonic (monostimbral) 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 f_i . 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 -candidates¹³. 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

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

¹<http://rocksmith.sabi.com/>

²<http://www.rockprodigy.com/>

³<http://vevlin.com/guitarboss/>

⁴<http://www.songs2see.com/>

⁵<http://jamstar.co/>

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⁷<http://tab.guitarhero.com/>

⁸<http://www.rockband.com/>

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¹²<http://www.you-tab.com/>

Real Time Guitar String Detection For Music Education

Elizabeth C. Axford



Real Time Guitar String Detection For Music Education:

Springer Handbook of Systematic Musicology Rolf Bader, 2018-03-21 This unique reference book offers a holistic description of the multifaceted field of systematic musicology which is the study of music its production and perception and its cultural historical and philosophical background The seven sections reflect the main topics in this interdisciplinary subject The first two parts discuss musical acoustics and signal processing comprehensively describing the mathematical and physical fundamentals of musical sound generation and propagation The complex interplay of physiology and psychology involved in sound and music perception is covered in the following sections with a particular focus on psychoacoustics and the recently evolved research on embodied music cognition In addition a huge variety of technical applications for professional training music composition and consumer electronics are presented A section on music ethnology completes this comprehensive handbook Music theory and philosophy of music are imbedded throughout Carefully edited and written by internationally respected experts it is an invaluable reference resource for professionals and graduate students alike

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Music Performance Gary McPherson, 2022 The two volume Oxford Handbook of Music Performance provides the most comprehensive and authoritative resource for musicians educators and scholars currently available It is aimed primarily for practicing musicians particularly those who are preparing for a professional career as performers and are interested in practical implications of psychological and scientific research for their own music performance development educators with a specific interest or expertise in music psychology who will wish to apply the concepts and techniques surveyed in their own teaching undergraduate and postgraduate students who understand the potential of music psychology for informing music education and researchers in the area of music performance who consider it important for the results of their research to be practically useful for musicians and music educators *Advances in Visual Computing* George Bebis, Richard Boyle, Bahram Parvin, Darko Koracin, Daniela Ushizima, Sek Chai, Shinjiro Sueda, Xin Lin, Aidong Lu, Daniel Thalmann, Chaoli Wang, Panpan Xu, 2019-10-25 This book constitutes the refereed proceedings of the 14th International Symposium on Visual Computing ISVC 2019 held in Lake Tahoe NV USA in October 2019 The 100 papers presented in this double volume were carefully reviewed and selected from 163 submissions The papers are organized into the following topical sections Deep Learning I Computer Graphics I Segmentation Recognition Video Analysis and Event Recognition Visualization ST Computational Vision

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