

RoboSens Ltd: Guitarmaster

Short Development Projects: Abstracts

1. Preamble

RoboSens Ltd of 75 Montpelier Park, Edinburgh, are the developers and sole publishers of Guitarmaster V 2.0 for Windows, a low-cost, software-only notation aid for electric guitarists.

The software allows the user to plug the output from an electric guitar directly into the sound card of a standard PC and produce music notation, guitar tablature and MIDI* files for chord sequences and single-note melodies directly from the audio signal produced by the guitar. No additional hardware is needed except for a simple connecting lead which RoboSens can supply.

The software is currently on sale on the Internet at www.guitar-master.co.uk, where further information on the product and the company can also be found. A demonstration version of the program can also be downloaded free of charge.

The software makes use of FFT and band-pass filtering techniques to convert the raw audio data from the time domain to the frequency domain.

RoboSens Ltd are currently seeking to further develop Guitarmaster technically, and are working in partnership with Nick Wright and Mike Clouser at the Informatics Department of Edinburgh University and the Edinburgh-Stanford Link. Students of informatics are being invited to collaborate productively on this innovative and interdisciplinary project by tackling small, self-contained research projects relating to the functionality of the Guitarmaster product. A number of these projects are discussed in abstract below.

2. The Projects (Abstracts)

2.1 Note/Harmonic Detection

At present, Guitarmaster cannot determine the difference between a note which is actually played on the instrument by the user, and a harmonic (or "upper partial") of that frequency, also present at significant amplitudes in the sound spectrum. This is not a problem when transcribing single-note melodies, but it becomes a problem when transcribing chords.

The current approach is to simply ignore all frequencies which are multiples of lower frequencies in the spectrum, that is, to ignore all frequencies which might be harmonics of lower notes in the chord, and therefore which might not have been played by the user. This has the effect of reducing the number of notes detected as having been played in a chord, usually down to the key constituent notes of a chord (root, fifth, third etc).

In order to produce realistic voicings of these chords, Guitarmaster then applies a rulebase to "put back" some of the notes which were deleted as potential harmonics, but which were probably played by the user when they played the chord (e.g. in a chord of G major, the octave of the low G would probably be contained in the chord

* Musical Instrument Digital Interface

voicing actually played, but would have been deleted by GuitarMaster as the first harmonic of low G).

In certain cases, the deletion of harmonics results in an incorrect transcription of the chord name – for example if the dominant seventh degree of the scale occurs in the second or third octave, it may be deleted as a harmonic. Since cannot be inferred that that note was played by the user, the name of the chord is therefore incorrectly rendered as G major instead of G7.

The task of this project is to devise a means of reliably determining whether a note is in fact a “played” note, i.e. a “fundamental”, or a harmonic of a played note. This will greatly increase the accuracy of chord transcription by the GuitarMaster software.

2.2 Note Start/End Detection

The way GuitarMaster is currently configured, the sharp “attack” (amplitude peak) at the start of a played note (which is characteristic of the guitar’s sound envelope), is used as a means of detecting the point in time where a note or chord “starts”. The decay of the note’s amplitude below a certain level in turn determines where that note “ends”.

This approach works perfectly well for single-note melodies played clearly or for strummed sequences of chords. However, it does not work well for so-called “finger-style” playing, that is, where the characteristic “attack” is not so pronounced, and where one note continues to sound (decay) while another new note is played over the top of the first one, and so on and so forth. An example might be an arpeggiated chord where the notes are left to ring.

We would like to investigate the possibility of developing an alternative “frequency tracking” approach to the detection of note durations, so that this was not dependent solely on the attack characteristic of the envelope, and so that note attacks and decays could overlap with one another. The current system does not allow for overlapping attacks and decays.

2.3 Transcription of pre-recorded guitar music

In some respects, the ability to accurately transcribe pre-recorded guitar music is contingent on the successful implementation of 2.2 above. However, there are two other issues fundamental to this development, namely the detection of the “tuning” of the recorded music (how far it deviates from concert pitch - A = 440 Hz), and detection of the tempo of the recorded piece. The automated detection of these two parameters is the key task of this third project.

2.4 Modification to work with other instruments

It should be a relatively simple task to modify GuitarMaster to work with monophonic instruments such as brass and woodwind instruments, or to work with bass guitar. Essentially, this involves certain aspects of the work required under point 2.2, that is, finding another means of detecting the start and end of notes other than using the characteristic “attack” of the guitar sound envelope. This would be an interesting and highly feasible research project, providing a very high probability of success.

2.5 Re-formulation of Guitarmaster as a 3rd-party Plug-In

Currently, Guitarmaster is a stand-alone application which produces its output as text (.txt) files (for guitar tablature) and as MIDI (.mid) files for music. Guitarmaster can then be used to launch a music notation application which will then load the MIDI file automatically in order to display it as notation.

However, if the user's primary requirement is to display their guitar music as standard notation, the above procedure can become cumbersome. A more efficient solution might be to reconfigure Guitarmaster as a third-party "Plug-In" which could be accessed directly from a notation application such as Sibelius or Cubase VST. An interesting and self-contained research project would be represented by an investigation of the technical issues surrounding the conversion of Guitarmaster to a Sibelius or Cubase plug-in. This would involve researching the proprietary application-programme interface (API) used by these applications and determining how to encapsulate Guitarmaster within this framework.

2.6 Combination of Guitarmaster with speech-recognition

It has been suggested that, if the issues noted under 2.2 above could be satisfactorily resolved, it might be possible to produce a product based on the Guitarmaster technology which could transcribe not just a vocal melody but the lyrics as well, so that a user could physically sing into a microphone and have the software produce a vocal lead sheet containing melody line and lyrics together. This is an advanced project, and would be dependent upon other issues referred to above already having been overcome. It would involve research into how well voice-recognition software operates with sung words, and how one might combine such software with the modules within Guitarmaster to create a hybrid which could achieve the desired result.