

# A TEMPO- AND TRANSPOSITION-INVARIANT PIANO MUSIC COMPANION

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## 1. INTRODUCTION

In [1] a prototype of a piano music companion was presented that is able to follow and understand (at least to some extent) a live piano performance. Within a few seconds the system can identify the piece that is being played, and the position within the piece. It then tracks the progress of the performer over time via a robust score following algorithm and continuously re-evaluates its current position hypotheses within a database of scores. Thus, it is capable of detecting arbitrary ‘jumps’ by the performer (e.g., leaving out repetitions, re-starts at any position) – not only within a piece, but within the complete database of classical piano scores. The companion can be used in multiple ways, e.g., for piece identification, music visualisation, and automatic page turning, both during piano rehearsal and during live concerts.

For this demonstration, we extended this prototype with the ability to cope with arbitrary transpositions by the musician. This is achieved by using a transposition-invariant fingerprinting approach presented in [1], in combination with the automatic adaption of the underlying score following algorithm to possible transpositions.

## 2. SYSTEM OVERVIEW

Figure 1 gives an overview of the piano music companion. The system is provided with a database of sheet music in symbolic form. The companion is listening to the performance via a single microphone. An on-line piano music transcription algorithm based on a recurrent neural network [3] is used to translate the audio stream into symbolic information (a list of pitches with timestamps).

The extracted notes of the last few seconds of the live performance are then matched to the database of sheet music via a tempo- and transposition-invariant fingerprinting method [1]. This process is continuously running in the background, regularly providing new piece and (rough) po-

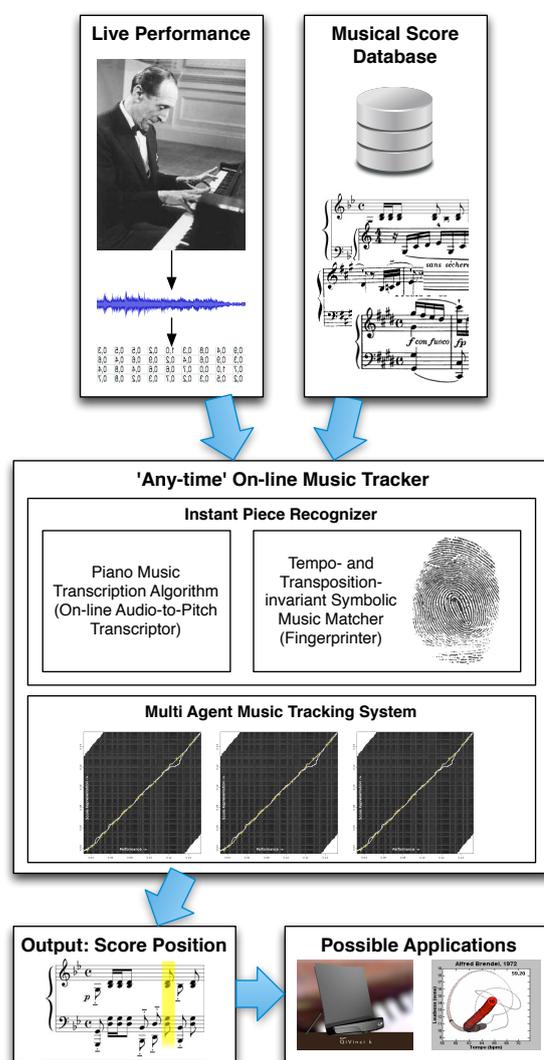


Figure 1. System Overview



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sition hypotheses for the multi-agent tracking component. In addition, these hypotheses also contain information on a possible transposition, i.e., how many semitones lower or higher than notated in the score the piece is being played.

The multi-agent tracker consists of multiple instances of a score following algorithm based on audio-to-audio matching via DTW [2]. Using the provided hypotheses, each instance is matching the current live audio stream to a position in the database of sheet music, taking into account possible transpositions. At any point in time, the position of the highest scoring agent (i.e., the one resulting in the lowest alignment costs) is reported as the current position in the database.

This prototype enables multiple applications. A basic use case is *music identification*, where, given only the live audio stream, the piece that is being played is identified and the metadata (e.g., composer and title) is returned. The system can also be used as a basis for *music visualisations and performance enrichments*, ranging from a simple marker showing the score position, to more sophisticated enrichments, like showing information about the structure of the piece and the most important themes, and giving hints about what to listen for at specific moments. Furthermore, the companion can be used during *piano rehearsal* and during *piano concerts* by the performer for showing the sheet music, without the need to turn the pages manually.

### 3. DEMONSTRATION

The demonstration is designed as a brief live show with a professionally trained pianist at the piano. In this setting we will demonstrate the capabilities of the companion (music tracking, music identification, transposition- and tempo invariance) in a coherent way. After some prepared examples, to explicitly demonstrate these capabilities, we will invite the audience to participate in the demo and select the pieces for the pianist to play. The duration of this show is about 15 to 20 minutes. Afterwards, we would like to encourage members of the audience to try our piano music companion. We are very interested in their feedback.

For the live demonstration we ask the organisers to provide us with:

- a piano (either an acoustic piano or an electronic one plus loudspeakers)
- a projector
- a microphone
- a stage or room, where we can play the piano without disturbing other demos

We will bring all the remaining equipment.

### 4. ACKNOWLEDGMENTS

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