EXTRACTION AND CLASSIFICATION OF ORNAMENTATION IN FLAMENCO SINGING: AN EVOLUTION-BASED APPROACH

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1. INTRODUCTION

In music traditions around the world, melodic ornamentation is used by performers as an expressive resource to embellish and add individual interpretation to a melody. In flamenco singing, *cante flamenco*, it is precisely the ornamentation which defines the flamenco aesthetics and without it the *cante* would not be flamenco.

Each flamenco style is characterized by a distinct prototypical melody (melodic skeleton), which can be subject to a great range of ornamentation and variation (Mora et al. (2016)). Despite the commonly referenced presence of ornamentation in flamenco music, only few systematic approaches have studied this phenomenon. To this day, there does not exist any established taxonomy of ornaments and the structural importance of melisma remains unexplored. Gómez et al. (2011) proposed a computational approach to recognition and characterization of flamenco ornamentation. A set of pre-defined ornament types, mainly borrowed or adapted from classical music theory, is extracted from a corpus using a the Smith-Waterman algorithm (Smith & Waterman (1981)). Other approaches to recognition and characterization of ornamentation have been proposed in the context of popular ornamentation, see for example Puiggròs et al. (2006); Perez et al. (2008); Giraldo & Ramírez (2016). In this work we propose a new computational strategy to detect and characterize ornamentation in flamenco singing.

2. METHODOLOGY

We approach the problem of extracting and characterizing ornamentation by focusing on a specific type of flamenco *cantes* which have evolved from traditional popular chants. Flamenco singers extend the popular melody by introducing melodic ornamentation and variation, mainly in the form of melismatic ornamentation. Consequently, by comparing flamenco performances to popular version of the same melody, we can quantitatively assess, extract and characterize the ornamentation introduced by the flamenco artist.

The outline of the approach is as follows. We process a corpus containing recordings of the popular melody and various flamenco interpretations of the same chant. For each recording, we first perform a computer-assisted singing voice transcription using the CANTE (Kroher & Gómez, 2016) software. We then use the gap-tolerant Needleman-Wunsch (Needleman & Wunsch, 1970) alignment algorithm to align the flamenco performance transcriptions to the popular melody. Assuming that unmatched notes in flamenco performances correspond to added content with respect to the popular melody, we can isolate sections of the song where ornamentation occurs. An example is shown in Figure 1 (top), where notes marked in red correspond to the popular melody and the black segments are the extracted ornaments. We use the isolated ornaments to establish a taxonomy of typical ornamentation in flamenco music, borrowing and extending concepts defined in the context of classical and medieval music. More specifically, we represent the isolated the ornaments in *Parsons* code (Parsons (1975)) as a concatenation of basic *neums*. In this way, we can analyze the occurrence of small melodic atoms and their combinations.

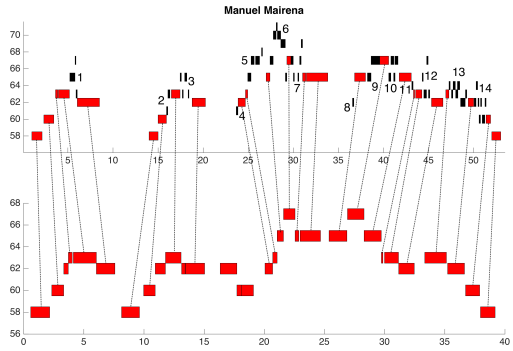

Figure 1: The "differences" in the melodic contour contains the ornamental resources. Bottom: the popular version. Top: the version performed by flamenco singer *Manuel Mairena*.

3. CASE STUDIES IN RELIGIOUS CONTEXT

In this pilot study we consider the case of a religious chant ("Santo Dios") which is performed in a social-religious context of Mairena del Alcor (Seville, Spain) and has evolved into a flamenco style. For this case, we collected several versions (including the popular and flamenco versions) in order to find the ornaments representing the formal change to the flamenco form.

This method is proposed in Marqués et al. (2012) to study the process of flamenco evolution. The case of ("Santo Dios") is considered as a live model to investigate the cultural preferences that influence the creation and evolution of flamenco music.

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