CHARACTERIZATION OF EMBELLISHMENTS IN NEY PERFORMANCES OF MAKAM MUSIC IN TURKEY

Tan Hakan Özaslan
Artificial Intelligence
Research Institute - CSIC
Bellaterra, Spain.
tan@iiia.csic.es

Xavier Serra
Music Technology Group
Universitat Pompeu Fabra
Barcelona, Spain
xavier.serra@upf.edu

Josep Lluis Arcos
Artificial Intelligence
Research Institute - CSIC
Bellaterra, Spain
arcos@iiia.csic.es

ABSTRACT

The embellishments of makam music in Turkey are an inherent characteristic of the music rather than a separate expressive resource, thus their understanding is essential to characterize this music. We do a computational study, in which we analyze audio recordings of 8 widely acknowledged Turkish ney players covering the period from the year 1920 to 2000. From the extracted fundamental frequency, we manually segment and identify 327 separate embellishments of the types *vibrato* and *kaydırma*. We analyze them and characterize the behavior of two features that help us differentiate performance styles, namely vibrato rate change and pitch bump. Also we compare these embellishments with the ones used in Western classical music. With our approach, we have an explicit and formalized way to understand ney embellishments, which is a step towards the automatic characterization of makam music in Turkey.

1. INTRODUCTION

Each music repertorie has specific characteristics that require specific analysis approaches [11]. This is clearly the case of the makam music in Turkey and there has been very few computational studies that focus on it.

Makam music in Turkey is mainly an oral tradition and thus the audio recordings become a fundamental source of information for its study [1]. For this research approach we need well annotated large data sets, and we need to extract the appropiate audio features from which to then perform musically meaningful computational studies.

Among all the characteristics of makam music, the embellishments are the most relevant ones, they are more than simple expressive resources, in fact they are essentials of the music [12]. Embellishments are not taught even named by teachers. Their places are not marked in the score, the choice and character of the embellishment is the freedom of the performer. Ney is one of the oldest and most characteristic instrument of makam music in Turkey. The way the embellishments have to be performed in the ney is not taught and their places are not marked in the score. The choice and character of the embellishment is very much in the freedom of the performer and thus they are valuable for understanding the difference between performers and between performances.

In this paper we focus on two types of embellishments used in ney performances, *vibrato* and *kaydırma*. This choice is the result of interviews and discussions with well known ney players [1] . To characterize these embellishments we combine the use of well known features used in previous studies with our proposed audio features.

The paper is organized as follows; In Section 2 we provide a brief introduction to the makam music in Turkey and to the ney and its performance practice. Section 3 describes the data set used and in Section 4 we describe the features that we have developed. We summarize and discuss our findings in Section 5.

2. BACKGROUND

2.1 Makam Music in Turkey

Makam is a complex musical concept that cannot be defined in a simple straightforward way. Moreover there are differences between theory and practice of makams. In theoretical terms, a given makam is described by the set of the tones or notes that compose it, but in practice it is often much more complex. The upper and lower extensions of a tone in the makam may be regarded as tones belonging to the same makam.

An important practical aspect of a Makam is the *seyir*, which can be translated as the way that the performer uses the notes or, briefly, his/her *navigation*. The important notes for the seyir are; *baslangic*(start), and *karar* (decision). A possible translation would be the initial and finish tone.

Another complex phenomenon is intervals of makams. There is a long lasting and never ending discussion about makams in Turkey [12], but we can say that there are more than 17 intervals in an octave [12]. Among the different interval systems, it is common practice to use the Holde-

[1] We have interviewed with Osman Erkahveci, Orçun Güneşer, Ali Tan and and Oğuz Mülayim.

Figure 1: Examples of Different Neys.

rian comma (Hc) as the smallest intervallic unit in makam music in Turkey [2].

2.2 Ney

The ney is an end-blown flute which is mainly used for makam music. It is one of the oldest and most characteristic blown instrument of makam music in Turkey. From the beginning of the 20^{th} century a score representation which was developed by extending the Western music is used. However because of the extensive use of embellishments, the written scores are far from the music that is actually performed. Ney is taught and transmitted orally.

Ney has a real importance and solid place in Turkish classical and religious music. Ney is made of reed, and it is a rim-blown, oblique flute. The Turkish ney has six finger-holes in front and a thumb-hole in back. Although it is highly dependant on the talent and experience of the performer, a ney can produce any pitch over a two-and-a-half octave range or more. Nearly all Turkish neys have a mouthpiece made of water buffalo horn, or sometimes ivory, ebony, plastic, or a similar durable material. Also there are different sizes of neys', ranging from the Davud ney (95 cm long), to the highest, Bolahenk Nısfiye ney (52.5 cm long).

2.2.1 Ney and Its Performance Practice

Ney tradition is transmitted via master-pupil relationship in Turkey. Written scores only represent the border lines of the pieces. The embellishments, which are distinctly important, are never marked or even explicitely taught. The main way to learn how to apply these embellishments is to learn from masters via listening, which makes it very hard. On the other hand, without embellishments makam music is considered dry, monotonous and not deemed as acceptable [12]. This is specially so in ney music. Although we have not found any documents describing the techniques used, our study shows the existance of clear patterns in the performance of these embellishments, (Section 5).

From our interviews with experts we realized that the naming of ney embellishments is a problem in Makam music. The Ney players we interviewed agreed on naming frequency and amplitude modulation as *Vibrato*. However they all had difficulty naming the embellishment that is widely used for connecting two consecutive notes and that in some Makam literature is called *Kaydırma* [2] .

[2] The literal translation can be *sliding*, however the purpose of this behavior is to give the feeling of non-edge connections all through the piece rather than sliding between notes. Possible the most similar embellishment in western music is the *portamento*.

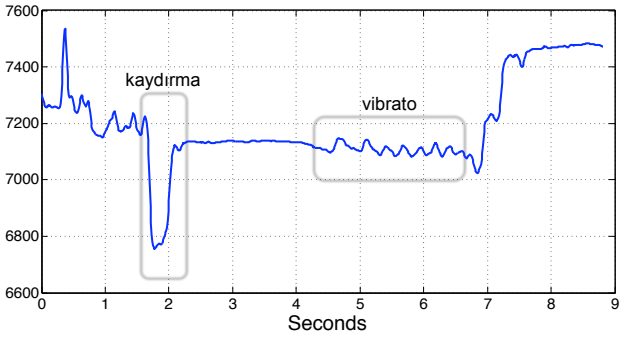

Figure 2: Example note sequence.

Performer	Time (Minutes)	#Embellishments
Hayri Tümer	7.75	16
Ulvi Ergüner	7.33	16
Aka Gündüz	7.12	45
Niyazi Sayın	7.66	53
Sadrettin Özçimi	11.20	66
Salih Bilgin	8.50	44
Ömer Bildik	2.33	21
Burcu Sönmez	5.50	66

Table 1: Performers with their test data.

From our inital quantitative studies we found that vibrato and kaydırma are the most used embellishments. We will further explain the behaviour of both embellishments but lets just say that the vibrato is a much more precise musical entity than kaydırma (Section 5) and that the kaydırma includes several subsets of embellishments.

3. DATA COLLECTION

For our analysis we annotated 8 different performers from different eras. Our set contains recordings starting from 1930's to now. Our concern was to analyse and characterise the ney embellishments rather than differentiating among them. Since our study is one of the first about embellishments in makam music, our first concern is to understand which embellishments were and are used by well known ney performers and then characterize these embellishments by using fundamental frequency analysis.

Our data set includes 58 minutes of audio and a total number of 327 hand annotated embellishments, summarized in Table 1.

Except Hayri Tümer and Ulvi Ergüner, there are around 6-8 embellishment for each minute of audio. For Hayri Tümer and Ulvi Ergüner, embellishment per minute is between 2 to 4. One of the reason for this difference is that these two players are the oldest ones, from 1930's, and that they shared a different style. However, this hypothesis should be given with further studies with a much more larger data set.

3.1 Performers

We are covering some of the most acknowledged ney players. According to our oral discussions with professional

Turkish ney players, Niyazi Sayın and Aka Gündüz Kutbay are considered as one of the most influential ney players of today. However because of the sudden death of Aka Gündüz Kutbay at the age of 45, most of the recent players are influenced by Niyazi Sayın. Through the oral discussions with Ali Tan [3], he stated that even in Turkish Conservatories teachers follow the way of Niyazi Sayın. Moreover, most of the ney players (both amateur and professional), who even did not have a chance to study with Niyazi Sayın, they consider themselves as students of his by listening and studying his recordings . In our test set Salih Bilgin and Sadrettin Özçimi are one of the most famous students of Niyazi Sayın. Burcu Sönmez is a student of both Salih Bilgin and Niyazi Sayın. Ömer Bildik is a student of Sadrettin Özçimi. All these ney players have the influence of Niyazi Sayın.

In our analysis set, in order to avoid lineage bias we also include some old ney players recordings like Hayri Tümer, Aka Gündüz Kutbay and Ulvi Ergüner, who are also well-known and highly respected ney players with distinct styles.

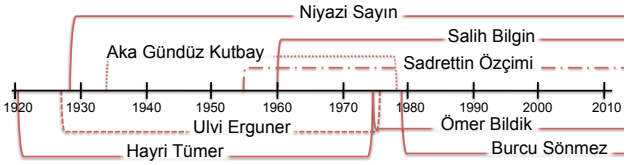

Figure 3: Lifespan of ney performers we used for our analysis. We carefully chose these performers in order to cover most of the recorded era of ney.

4. ANALYSIS

Our method is a combination of state of the art signal processing techniques and empirical observations. From the audio files, we obtain first the fundamental pitch of each recording. After that, we analyze the annotated sections one by one. Each embellishment is analyzed according to the behavior of its fundamental frequency (Section 4.1).

4.1 Fundamental Frequency

To obtain a fundamental frequency estimation of each solo ney recording, Makam Toolbox was used [1]. Makam Toolbox uses an implementation of Yin [3] with hop size of 10ms for fundamental frequency estimation. On the top of the f0 implementation Makam Toolbox makes a post-processing for octave correction.

All embellishment samples are measured in the 1/3 Holderian Comma (HC) resolution. We choose this resolution because it is considered as the highest precision we could find in theoretical pitch scale studies [1]. All measurements were taken manually. For the statistical significance, all pieces vary in tempo and also chosen from different Makams. HC is widely considered as the smallest interval therefore we used HC in our tables.

[3] Ali Tan is a full-time research asistant in Istanbul Technical University Turkish Conservatory in the Ney performance department. http://www.neyzenalitan.com/.

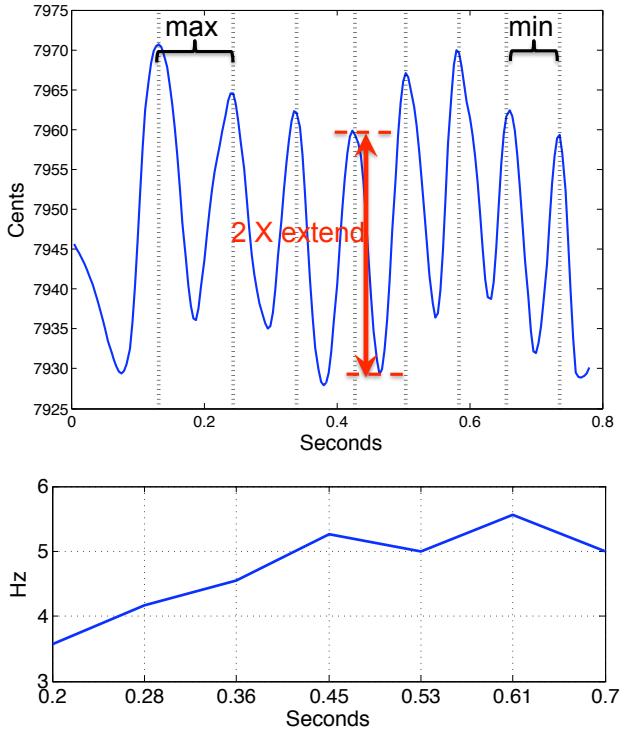

Figure 4: Top figure, is an example of the change in fundamental frequency in a vibrato. Bottom figure provides the change in rate of Vibrato that is shown in top figure.

4.2 Vibrato

According to Tura [12], the extend of the vibrato in Makam music in Turkey is around 1 HC. Both from oral discussions and written resources [5,12], we could not obtain any particular information about the structure of the vibrato in ney.

For the vibrato analysis, 170 different vibratos from 8 different ney players were analyzed. Each embellishment was analyzed one by one manually. In Table 2, the vibrato rate is given in Hz and the extend value is given in HC resolution. We also propose another feature for the deep analysis of the vibrato in Ney, *Vibrato Rate Change*.

4.2.1 Extend

Extend value is calculated according to the change in the mean f0 during vibrato. On the top graph of Figure 4, extend value is shown with red arrow. For the analysis, we followed the definition of Tura [12]. In his book he defined vibrato in makam music as the upper and lower change in f0 in Holderian Comma. Therefore, the extend value that is shown in top graph of Figure 4 is actually 2 times the values that are shown in Table 2. For each vibrato of each performer, we calculated its extend.

4.2.2 Rate

For each performer and for each vibrato, we measured the maximum and the minimum rate values, top graph of Fig-

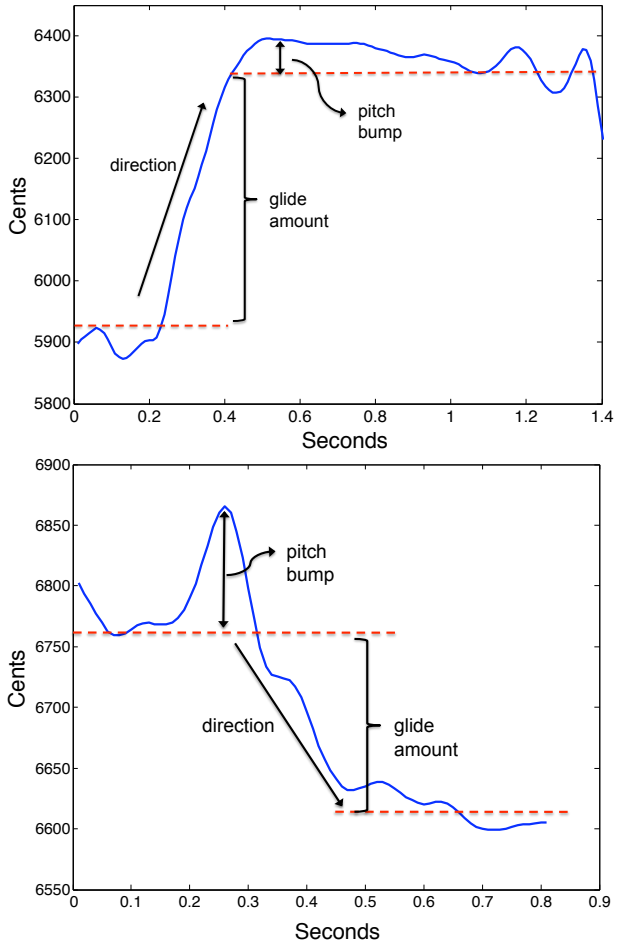

Figure 5: Kaydırma pitch graphs.

ure 4. These values are reported in Table 2.

4.2.3 Rate Change

For the initial tests we applied the *AR Prediction* method [10] and the *Automatic Detection* technique [8]. Both implementations have its pros and cons. AR prediction technique was successful for detecting vibratos regions with having more than 4-5 periods. Automatic Detection technique could detect vibratos with having less than 4-5 periods but since it is specialized for string instruments, it also gave false positives if the player performers non-periodic f0 deviations.

In both techniques features of the vibrato are the rate and extend. Although we are not aiming to propose an automatic detection algorithm, after these initial tests with the existing algorithms, we realized that for the characterization of vibrato in ney, rate and extend features are not enough.

As shown in the top graph of Figure 4, the distance between peeks decrease. Thus, as shown in the bottom graph of Figure 4, the vibrato rate is increasing. According to our analyses, we discovered that this increase in rate is a characteristic behavior that most of the ney players apply. Vibrato Rate change in Table 2 is the ratio of maximum rate versus the minimum rate for a single vibrato. Minimum value represents the minimum rate change the performer applied among all his/her vibratos and maximum is vice versa.

4.3 Kaydırma

As we stated in Section 2.2.1, the main purpose of kaydırma is to give the feeling of a smooth transition between notes. However, after analyzing 157 different kaydırmas from 8 different performers, we discovered that its characteristic is much more complicated than a simple transition. Different from the possible equivalent study on string instrument, [7], kaydırma has a distinct difference; its glide amount is not constant. Moreover as shown in Table 3, in the glide column in both ascending and descending kaydırmas, the Standard Deviation σ, values are so high that, we can conclude that the glide amount is not predictable.

Thus, we add a new feature named *pitch bump*. It models the pitch deviation just before the ascending or descending transition. These features are shown in Figure 5.

4.3.1 Direction

This feature represents the movement direction of the glide. Performers use both ascending and descending glides.

4.3.2 Glide Amount

Glide amount is the difference between the target note and the base note in Holderian Commas. It is observed that there is not a fixed amount of glide, Table 3. However, we observed that most of the time during the ascending kaydırma, the difference between the base note and the transition note is much more higher than the descending kaydırma.

4.3.3 Pitch Bump

As shown in Figure 5, for both ascending and descending kaydırma, there is a lower or higher bump in the f0 just before the transition note. According our observations, this is a characteristic movement for kaydırma. We also confirmed this behaviour with our oral discussions with ney performers.

5. DISCUSSION

In this study we analyzed two distinct embellishments of ney, vibrato and kaydırma. Both embellishments have similar counterparts in Western classical music.

Vibrato has different characteristics for different instruments. For string instruments of Western classical music, vibrato extend ranges from 0.2 to 0.35 semitones which corresponds to 0.9 to 1.5 HC, and for the singing voice of Western Classical music it ranges 0.6 to 2 semitones, 2.7 to 9 HC [13].

As reported in Table 2, vibrato extend has a strong regularity among performers. If we check the mean values for the performers, we may observe that except Hayri Tümer, all of them either have a regularity of 1 or so close to 1. These results match with the analyzes of Tura for the vibrato of makam music in Turkey [12]. Hayri Tümer is the oldest ney player among the performers we analyzed. We

		VIBRATO				
		Extend (HC)		Rate (Hz)	Rate Change	
Performer	**#**	min / max	μ / σ	min / max	min / max	μ / σ
Hayri Tümer	9	**0.5** / 0.7	0.57 / 0.1	1.8 / 7.6	1.3 / 2.7	1.69 / 0.58
Ulvi Ergüner	10	0.8 / 1.2	0.9 / 0.19	3.21 / **9.01**	1.23 / 2	1.61 / 0.32
Aka Gündüz	31	0.7 / 1.5	1.1 / 0.2	2.8 / 6.2	1.18 / 1.96	1.49 / 0.26
Niyazi Sayın	29	0.5 / 1	0.9 / 0.15	2.6 / 6.6	1.12 / 1.94	1.41 / 0.25
Sadrettin Özçimi	31	0.8 / 1.3	0.9 / 0.21	2.7 / 5.5	**1.05** / 1.94	1.38 / 0.26
Salih Bilgin	25	0.8 / 1.2	1 / 0.1	3.2 / 6.66	1.15 / 1.73	1.34 / 0.21
Ömer Bildik	14	0.5 / **1.7**	0.98 / 0.14	2.7 / 4.5	1.43 / 1.8	1.57 / 0.19
Burcu Sönmez	21	0.8 / 1.4	1.1 / 0.23	**1.7** / 6.2	1.19 / **2.8**	1.67 / 0.39
All Performers	170	0.5 / 1.7	0.93 / 0.18	1.7 / 9.01	1.05 / 2.8	1.44 / 0.25

Table 2: Vibrato analysis table. The Extend column, min is the minimum value among all vibratos and max is the vice versa. We also computed the mean μ, and standard-deviation σ, values for all vibratos of each performer.

		KAYDIRMA							
		Ascending				Descending			
		Glide Amount		Pitch Bump		Glide Amount		Pitch Bump	
Performer	**#**	min / max	μ / σ	min / max	μ / σ	min / max	μ / σ	min / max	μ / σ
Hayri Tümer	7	12 / 23	16.5 / 5.06	1 / 7	2.75 / 3	7 / 10	9 / 1.73	1 / 3	1.67 / 1.15
Ulvi Ergüner	6		-	-	-	3 / **17**	9.6 / 5.02	1 / **6**	3.66 / 2.51
Aka Gündüz	14	7 / 35	18.6 / 13.7	1 / 2	1.1 / 0.3	1 / 7	4 / 4.24	1 / 2	1.5 / 0.7
Niyazi Sayın	24	**3** / 53	19.5 / 13.8	1 / 4	1.8 / 1.13	1 / 10	4.27 / 3.23	1 / 2	1.34 / 0.53
Sadrettin Özçimi	35	5 / 59	28.7 / 20.4	1 / 3	2.17 / 0.75	1 / 12	8.25 / 2.98	1 / 4	2.46 / 1.05
Salih Bilgin	19	7 / 23	20 / 15.3	1 / 3	1.8 / 1.15	2 / 15	7.45 / 2.45	1 / 3	2.2 / 0.8
Ömer Bildik	7	10 / 18	14.7 / 12.1	1 / 8	3.7 / 1.14	3 / 15	6.2 / 3.1	1 / 3	2 / 1.1
Burcu Sönmez	45	5 /**114**	28 / 25.78	1 / 5	2 / 1.49	3 / 9	4.58 / 2.14	1 / 5	2.75 / 1.89
All Performers	157	3 / 114	21.87 / 17.3	1 / 8	2.13 / 1.75	1 / 17	5.67 / 3.43	1 / 6	2.51 / 1.43

Table 3: Kaydırma analysis table. μ represents the mean value and σ represents the standard deviation of all the kaydırma excerpts.

do not have the exact dates for the recordings but we are assuming that they were recorded between 1930 and 1950. He is the only player that has the vibrato extend around 0.5 Holderian Coma. This distinction also can be heard in his recordings. He has smoother and lighter vibrato compared to all other players.

In Western music vibrato rate changes from 4-12Hz [4]. In our analyses, vibrato rate changes from 1.8 to 9Hz. If we avoid the extremes we can say that in ney vibrato rate changes from 2 to 7Hz. As reported in Table 2, in the Rate column, performers have different choices.

On the contrary, the rate change feature has a strong regularity. When we analyze the mean values of rate change, they are between 1.34 to 1.69 and the standard deviation values are less than 0.5. This means that the vibrato rate changes between 30% to 60% through the end of the vibrato. In western music, rate change is common for violin and soprano singers [9]. However, their rate change is much less, around 15%.

In his thesis [6], Mallikarjuna described the features of portamento. He considered portamento as a smooth transition between two notes. However different from the portamento, kaydırma has different characteristics. As shown in Table 3, in the Glide column, minimum and maximum values vary a lot. Although mean values are close, the high standard deviation values show that there is no regularity for the glide amount. It can be 1 Holderian Coma or 114 Holderian Coma (around 2 octaves).

The important finding we obtain for *glide amount* is that ascending kaydırma has typically much bigger glide amount then descending kaydırma. Mean values for ascending kaydırma are around 16 to 28 Holderian Coma whereas for descending kaydırma they are around 4 to 9 Holderian Comas.

The unique feature for ney kaydırma is, *pitch bump*. It is common for both ascending and descending kaydırma. Moreover, different from the glide amount, pitch bump has the same characteristics for both ascending and descending kaydırmas. For all of the players except Hayri Tümer, the amount of pitch bump is, for ascending 1-8 and for descending 1-5 Holderian Comas. If we check the mean values, for both ascending and descending it is around 1-3 Holderian Coma. Therefore we can conclude that there is strong regularity for pitch bump for both ascending and descending kaydırma. Low standard deviation values support our observation.

6. CONCLUSION

In this paper we characterize the most commonly used embellishments in ney. Our analyzes show that there are differences between ney embellishments and their Western equivalents. One of the important step was to characterize these differences. We proposed two new features for this characterization, vibrato rate change and kaydırma pitch bump. We analyzed 327 embellishments of 8 different performers from different eras of makam music in Turkey.

We believe that with our study, understanding of ney embellishments are much more clear for both musicological and computational studies.

7. ACKNOWLEDGMENTS

We would like to thank Barış Bozkurt for the insightful discussions. Also we would like to thank Osman Erkahveci, Ali Tan, Oğuz Mülayim and Orçun Güneşer for sharing their valuable knowledge with us.

8. REFERENCES

[1] Barış Bozkurt. An automatic pitch analysis method for turkish maqam music. *Journal of New Music Research*, 37:1–13, 2008.

[2] Barış Bozkurt, Ozan Yarman, Kemal Karaosmanoğlu M., and Akkoç. Weighing diverse theoretical models on turkish maqam music against pitch measurements: A comparison of peaks automatically derived from frequency histograms with proposed scale tones. *Journal of New Music Research*, 38, March 2009.

[3] A. de Cheveigné and H. Kawahara. Yin, a fundamental frequency estimator for speech and music. *The Journal of the Acoustical Society of America*, 111(4):1917–1930, 2002.

[4] P Desain and H Honing. Modeling continuous aspects of music performance: Vibrato and portamento. In *Proc. Int. Conf. on Music Perception and Cognition*, 1996.

[5] Suleyman Erguner. *Ney Method*. Erguner Muzik, 2007.

[6] T. Mallikarjuna. Towards expressive melodic accompaniment using parametric modeling of continuous musical elements in a multi-attribute prediction suffix trie framework. Master's thesis, Georgia Institute of Technology, USA, 2010.

[7] T. Özaslan and J.Ll. Arcos. Legato and glissando identification in classical guitar. In *7th Sound and Music Computing Conference (SMC)*, pages 457–463, July 2010.

[8] T. Özaslan and J.Ll. Arcos. Automatic vibrato detection in classical guitar. In *Technical Report IIIA*, 2011.

[9] E Prame. Vibrato extent and intonation in professional western lyric singing. *Ac. Soc. of America*, 102:616–621, 1997.

[10] S. Rossignol, P. Depalle, J. Soumagne, X. Rodet, and J.-L. Collette. Vibrato: Detection, estimation, extraction, modification. In *In Proc. Digital Audio Effects Workshop (DAFx)*, 1999.

[11] Xavier Serra. A multicultural approach in music information research. In *Int. Soc. for Music Information Retrieval Conf. (ISMIR)*, Miami, Florida (USA), 24/10/11 2011.

[12] Yalçın Tura. *Türk Musikisinin Meseleleri.* Pan Yayıncılık, 1988.

[13] Vincent Verfaille, Catherine Guastavino, and Philippe Depalle. Perceptual evaluation of vibrato models. In *Conference on Interdisciplinary Musicology (CIM05)*, pages 1–19, 2005.