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The notion of Ethos in Arabic music: computational modeling of Al-Urmawi's modes (13th Century) in Csound

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ABSTRACT
The notion of ethos in Arabic music is outlined in this paper through the writings and thoughts of al-Kindi, Ziriab, Ikhwan al-Safa, Avicenna and Saffiyu al-Din al-Urmawi. The approach developed by al-Urmawi in his book "The book of cycles" will be studied and the ties woven between 13th Century modes and their ethos will be underlined.

It will then try to model some of the idioms in Arabic music such as its homophonic nature or Arabic techniques of musical rendition based on ornamentation. Finally, this paper will explain how this object library works.

2 The notion of ethos in Arabic musical spirit

The notion of ethos was ever-present in the writings and thoughts of Arabic theorists. On this matter, Philip D Schuyler wrote [2]: "Middle Eastern theorists, like the Greeks before them, recognized that each mode had a certain ethos". Farmer [3] noted: "The doctrine of the ethos (ta'thir) is now definitely linked up with music. This old Semitic idea had been strengthened by the doctrines of the Sabi'a of Harran and the theories of the ancient Greeks and Byzantines." C. Poché [1] defined ethos as "the relation between musical and extramusical". Then he made the connection with maqâm: "that is to say the relation between maqâm, the individual, the world surrounding him, and the cosmos."
The Arabic Maqâm must first be defined.

2.1 Maqâm

The word maqâm means mode in English and "place" in Arabic. It started to mean, in the 18th Century, the location of an area on the handle of a musical instrument and describes a series of intervals grouped by genre or by family (jins) [1].

The word jins, or set in English, describes a distribution of melodic cells, intrinsic to each maqâm, in trichord, tetrachord and pentachord. Below is an instance of maqâm called Bayati, with its endogenous melodic cells and its variants. The jins Bayati in D is a fundamental cell used as a returning point for each modal exploration; when the second cell is a Hijaz, the maqâm changes aspect; and is then called Bayati Churi (see Figure 1).

\[ P.D \text{ Schuyler also noted that: "In Baghdad, philosophers and mathematicians, like al-Kindi and al-Farabi, began to apply Greek theory to the study of music."} \]
2.2 Historical approach of ethos in Arabic music:

2.2.1 The notion of ethos in Arabic musical thought in the 9th and 10th Centuries

According to Farmer [3], Al-Kindi (Arabic philosopher, 801-873) linked music and astrology: “Almost everything terrestrial was influenced by something celestial. The seven notes of the scale corresponded to the planets. The twelve signs of the zodiac were associated with the four pegs, four frets, and four strings of the ‘ud. The four strings were affiliated with the primeval elements, the winds, the seasons, the humours, the mental faculties, colours, perfumes, the quarters of the zodiac, moon, and the world. Al-Kindi deals with this question at considerable length.”

In the same period, Ziriab2 “went further, and developed a system of twenty-four modes – one for every hour of the day, each with inherent temporal, seasonal, and emotional characteristics” [2].

In the 10th century, Ikhwan al-Safa (the brethren of purity) said: “It is clear that to the movement of the spheres and stars are notes (naghamat) and melodies (alhan) [3]. Just like in al-Farabi’s writings, the word “ta’thir” (ethos) can often be found in the writings of Ikhwan al-Safa: “Although he was strongly influenced by Greek thinking, al-Farabi ventured to comment on the pleasure and lack of pleasure provoked by this or that interval type, whether consonant or dissonant. It is already considering that the world of sound may have an impact on the one who perceives it” [1].

2.2.2 The notion of ethos in Arabic musical thought in the 11th Century

Avicenna (Persian philosopher and scientist, 980-1037) is one of the first Arabic theorists who took a radical stand on this issue: “finding a relation between the state of the sky, the states of the soul and musical intervals is no longer an issue” [4], “the study of musical theory, therefore its component, was restricted to physical notions and as such one had to move away from the relation existing between the sound and the individual who was perceiving it” [1].

In the 13th Century, the notion of ethos returned with Saffiyu al-Din al-Urmawi.

2.2.3 The notion of ethos in Arabic musical thought in the 13th Century:

A distinct relation between the mode and its emotional nature appear in al-Urmawi’s writings. In his book “Kitab al-adwar” (The book of cycles) he defined twelve modes⁶ and listed their ethos in a precise manner:

- ‘ussaq, nawa et buslaki: Character of strength, courage and bravery⁷.
- Rast, nuruz, ‘iraq et isfahan: peaceful character and peace of mind.
- Bozorg, rahawi, zirafkand, zangualah and husayni: sad character.

Poché [1] pointed regarding the Hijaz mode, the relation of which to ethos in particular was not established by al-Urmawi in his book, characterized by its interval in augmented second: “Regarding augmented second: oral tradition in Turkey as well as Greece and in the Arabic world teaches us that this interval favors a better sleep and this is the reason why it can be found in many lullabies in that geographical areas.”

The modes described by Saffiyu al-Din are based on an intervallic system of the time which was the subject of several chapters in his book.

3 Musical and computational modeling: an object library in Csound

In order to propose a representation of Saffiyu al-Din al-Urmawi's thought concerning ethos and modes, this paper will first model the intervallic system described in his book, then will model modes of his time while focusing on the subtleties of Arabic musical rendition: homophonics aspects and ornamentation.

The model proposed in this section will not only serve to understand the working mechanisms of the Arabic music system, but also to reproduce it via Csound in line with an analysis/synthesis perspective or even of emulation⁸.

3.1 Modeling the intervallic system described by al-Urmawi in Csound

Unlike the transformation Arabic music experienced following the Cairo Congress of Arab Music (1932), especially when a tempered scale of 24 quarter tone was adopted [5], Saffiyu al-Din al-Urmawi’s scale remains

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⁴ Abu Nasr Mohammed ibn Mohammed Farabi (872-950) was a renowned scientist and philosopher of the Islamic Golden Age.

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⁵ Abu l-Hassan ‘Ali Ibn Nafi’(789-857) was a Persian musician, singer, and player and composer.

³ A society of Arabic philosophers.

⁶ Saffiyu al-Din al-Urmawi (1216-1294) was a renowned musician and writer on the theory of music.

⁷ In his book, Al-Urmawi uses the words “adwar” which means cycle and “shadd” which means, literally, to pull. This suggests visualizing intervals on the handle of a string instrument. In this paper, the words maqâm and mode will be used interchangeably.

⁸ He proposed the character of Turks, Abyssinians, Blacks and mountain dwellers as examples.

⁹ Not only can we consider the simulation of the Arabic music phenomenon but also the possibility of emulation with the aim of recreating or transforming it. The notion of emulation was used and adapted by the AFIM workgroup (Sound Visualization) in an artistic perspective: "Artistic emulation of sound". See activity report proposed by Anne Sedes at: gtv.mshparisnord.org/IMG/pdf/rapportGTVisualisation.pdf.
This work proposes to use pitch-class in order to model this system in Csound.

### 3.1.1 Using Pitch-class

In Csound, Pitch can be expressed in frequency or pitch-class. A pitch-class is made of a whole number corresponding to the octave and of a decimal part representing the twelve musical notes in equal temperament (according to the Opcode used). For instance, for a C3, the pitch-class is 8.00, 8.03 for a D#3, 8.04 for an E or 9.00 for a C4. To reproduce a tempered quarter tone on the E note, for instance, simply lower it by half: 8.035. On a non-tempered scale, it only takes to convert the pitch-class of a fundamental note in frequency, to multiply it by the numerical ratio determining the interval then to convert it again in pitch-class. It must be noted that the conversion of a frequency to a pitch-class in Csound is not direct, unlike the opposite. Here is a code example for the maqām rahawi:

```plaintext
; maqam Rahawi
irahawisib = pchoct(octcps(cpspch(8.00) * (16/9)))
irahawilib = pchoct(octcps(cpspch(8.00) * (128/81)))
irahawisold = pchoct(octcps(cpspch(8.00) * (262144/177147)))
irahawifac = pchoct(octcps(cpspch(8.00) * (4/3)))
irahawimidb = pchoct(octcps(cpspch(8.00) * (8192/6561)))
irahawired = pchoct(octcps(cpspch(8.00) * (65536/59049)))
```

### 3.1.2 Using function tables:

The `ftgen` Opcode allows us to create a table referenced by a chosen number that will be named depending on the maqām involved and which allows us to stock eight pitch-classes corresponding to the musical notes of an octave. Here is an example of code relative to the maqām Rahawi:

```plaintext
; maqam Rahawi
3.1.3 Classification of modes according to their ethos:

After having modeled the intervallic system described by al-Urmawi, a base with the twelve modes of his time, classified according to their ethos, is obtained (Figure 3):

In order to represent the notion of ethos in Saffiyu al-Din's work, not only do we need to model his intervallic system and modes, but also the Arabic musical rendition, by taking into account its main features such as its homophonic character, its ornamentation and other musical rendition techniques.

### 3.2 Modeling subtleties typical of Arabic musical rendition

#### 3.2.1 The homophonic aspect of Arabic musical rendition

Musical creation in Csound goes through two phases: from instruments of the orchestra, generated by operation codes (Opcodes), and according to events in the score part. We chose to work with the Opcode `pluck`, which produces a sound with a naturally decaying plucked string, based on the Karplus-Strong algorithms.

Taking the homophonic nature of a musical piece into account means creating successive events, belonging to a perspective of horizontal writing.

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9 As far as Csound is concerned, event will mean the onset of a sound hereinafter
3.2.2 Ornamentation in Arabic musical rendition

As far as ornamentations are concerned, modeling is done automatically using UDOs (User Defined OpCodes) in order to generate the macro-ornaments. Below is an example of how a macro-ornament works (Figure 4):

![Figure 4: How macro-ornaments work in Csoud](image)

The isochrony of events generated by macro-ornaments is done automatically with the metro Opcode. Fundamental notes are notes extracted from the maqâm table on which specific fluctuations must be applied, respecting the macro-ornament framework, which creates four melodic parts. The change of root is done by incrementing an index counter. Dynamics and phrasing effects are added to this working principle with decreasing sound intensity and a reproduction of the legato with marked picks in the case of the first and last events.

Starting from a pitch-class in the score, a macro-ornament runs the contents of the table of a given maqâm. However, if the pitch-class of the score does not correspond to the first pitch-class of the table, the macro-ornament must generate automatically update the other values.

The semitone function serves to calculate a factor to raise or reduce a frequency by a given number of semitones. Here is the code of the macro-ornament illustrating the whole operating process described previously:

```c
opcode macroornement11, 0, kkkkkkkk
klegato init p10
kmetro init 0
kindextable init 0
kamplitude init p4
kmetronome metro (1/0.06)
if kmetronome == 1 then
kfrequency table kindextable , p14
kmetro = kmetro + 1
kamplitude = kamplitude + p12
kamplitude = kamplitude - (p3/10)
if kmetro == 8 || kmetro == 9 || kmetro == 10 || kmetro == 11 || kmetro == 19 || kmetro == 20 || kmetro == 21 then
kindextable = kindextable + 1
else if kmetro == 13 || kmetro == 16 || kmetro == 18 then
kfrequency table kindextable - 1 , p14
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Pitch treatment is based on kvib and kgliss with a low frequency oscillator to reproduce fluctuations and glissandos, drawing a series of line segments between the spots specified. The effects of the phrasing are reproduced with an envelope that applies a motive of an attack and of decay as line segments obtained with the Opcode linen.

3.3 General operation of the library

The event in the score sends control parameters either to the control instrument that transfers them later to the object library, which updates them and dispatches send to the instrument controlled to perform them with this new data, or directly towards the latter to reproduce the sound occurrence (Figure 5):

![Diagram of object library operation in Csound](image)

Figure 5. General operation of the object library in Csound.

4 Conclusion

This paper first dealt with the notion of ethos thanks to a historical approach through the thought of al-Kindi, Zirib, Ikhwan as-Safa, Avicenna and Saffiyu al-Din al-Urmawi. We underlined the classification of modes according to their ethos in “The book of cycles”.

In order to feel concretely the modes described by al-Urmawi in the 13th Century and their ethos, a computational model of the non-tempered intervallic system and modes of his times was created in Csound while taking the subtleties of Arabic musical rendition into account. This work will now serve to compose Arabic music according to “The Book of Cycles” in Csound and will enable a direct link between the modes and the notion of ethos described in the 13th Century. In other words, this library will allow us to rethink the ethos, not only when listening, but also in the composition process. In the future, the creation of musical demonstrations via this library is considered in order to determine the impact and the feel on groups of listeners to establish a comparative study of the ethos defined by Saffiyu al-Din al-Urmawi.

Acknowledgments

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5 REFERENCES