ENCODING BYZANTINE MUSIC NOTATION (ca. 1600-1814)

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ABSTRACT

This paper discusses a new method for encoding Byzantine Music Neumatic Notation (especially the one developed during the 'transitory' period 1670-1814). The Notation of this period is characterized by difficulties and peculiarities. The difficult access to Byzantine manuscripts and their deteriorated condition, complicate reading. In addition, our incomplete knowledge of the interpretation of signs impedes the comprehension of the musical text leading in results that are often in dispute. The fact that sign unions are complex enough together with their presence in various places in a composition make electronic transcriptions the ultimate challenge. Moreover, there does not exist a framework for data encoding and analysis. This work presents a proposal for the development of such a model for the old Byzantine Neumatic Notation in Python. The implementation of this project is still at an initial stage, and focuses, mostly, on the efficient digitization of old manuscripts. The system, even though fully functional, has certain limitations. Some signs are missing, and the musical text is created using microphotographies. Future developments of the program will focus on resolving these deficiencies and adding more features to the system.

1. INTRODUCTION

Byzantine Music is particularly interesting not only because of its musical elements but it also incorporates cultural and anthropological aspects. This music prevails in the region of Eastern Mediterranean shaping culturally the populations of a wider region. It is estimated that approximately 7000 to 10000 manuscripts were written in the old Notation, and are currently scattered in monasteries and public or private libraries, [1]. There exist approximately a thousand known composers, whose work (thousands of chants) can be found in old manuscripts and books.

The evolutionary course of Byzantine Notation according to Gr. Stathis [2] is separated in four periods: Early (950-1175), Middle Complete (1177 – ca. 1670), Transitory Explanatory (ca. 1670 – 1814), and New Analytic (1814 - today). This division is based on a) the birth and chronological appearance of new signs, b) the function of the same signs, c) the stultification or disappearance of some signs, and d) the transcription or transformation of Notation in a New System [1] [2].

During the 1st period, which was studied at great length by Oliver Strunk, the Notation is archaic and comes across in two forms, Chartres and Coislin [3]. The signs do not have explicit intervalic value and do not have a one-to-one correspondence with all the syllables of the poetic text. The evolved form of Coislin Notation, coexists (mid. 12th century.) with the Medium Complete Notation. During the 2nd period, all signs acquired concrete intervalic value, all great subsidiary signs appeared, while others disappeared. The 3rd period is characterized, mainly, by the appearance of kalophonic style, the beautification and explanatory - analysis, that is to say the more analytic recording of chants. At the same time, the subdiary (voiceless) signs disappeared. Finally, during the 4th and last period, with the reform of the Three Teachers, (Grigorios, Choyrmoyzios and Chrysanthos) a new Notation system was created. This system is completely analytical and, based on the old Notation. Some new signs were inverted and the functionality of others changed. In the new Notation, which is in use today, the function, value, and spelling of all signs are completely defined. This work refers to the encoding and analysis of the old Notation system for the reasons mentioned below.

2. COMPUTATIONAL MODELS OF BYZANTINE MUSIC NOTATION

Prospective music researchers will sooner or later find themselves in the need for electronic transcriptions, facilitating archiving as well as research. Several people have realized this need in the past [4–6] but the few attempts made are either incomplete of still in progress Barton et al. [7] proposed an online repository of Byzantine manuscripts, as well as a system (Neumes Progect) in which users can input digital copies of manuscripts online, and retrieve its transcription [8, 9]. This encoding is following the MusicXML model [10, 11]. The first step towards the creation of a Byzantine Music score involves the import of musical text into a processing environment. The easiest way to achieve this is via automatic (musical) character recognition (OCR) of the Byzantine Notation. Such implementations

[1] As for example it happens in the case of the transition from Coislin to Round Notation.

have been attempted by Gezerlis [12] and Dalitz et al. [13], and remain still in experimental phases. The most commonly used method of digitizing musical text, though, is through direct typing. Various such software exist for the New Byzantine Music notation, both commercial (Melodos [14], Byzantine Kalamos [15]) and open-source (Musical Texts [16], Byzantinografos [17], Byzantina 1.1 [18], EZ Byzantine Music [19], PANDOURIS [20], Software for Byzantine Music solfege BZQ [21], ABC Notation and XeLaTex [22]). Some of them are autonomous (Melodos, BZQ model, PANDOURIS, ABC Notation and XeLaTex) while others exist as Microsoft Word add-ons (Musical Texts, Byzantinografos, Byzantine 1.1, EZ Byzantine Music, Byzantine Kalamos). In the past few years, the use of such encoding software facilitated research pertinent to Computational Byzantine Musicology. As an examples of such work we selectively report the research of Mavromatis [23, 24], and Pikrakis [25] on the melodic analysis of Byzantine transcripts written in the new music Notation, as well as on audio [26] and Maria Panteli's project concerning the pitch patterns of the Cypriot traditional music with regard to the Byzantine and Ottoman music [27].

This paper presents the design of an open-source system for the encoding of Old Byzantine Music Notation manuscripts. Such manuscripts can be found in anthologies and collections, usually not easily accessible. Some are stored in public libraries, but most of them are located in monasteries or private collections. Unfortunately, they are not well-preserved as they can be dated back several centuries ago. The sign unions are particularly complicated as they include formulas which are often difficult to interpret. The use of signs is not fully comprehensible. The older the manuscript is, the harder to decode it. A mechanism allowing the digital encoding of such manuscripts will resolve some of the aforementioned issues, by making the data easily accessible to a larger number of researchers, hence, facilitating musicological research.

3. OVERVIEW OF BYZANTINE NEUMES

The developed application, was based on the study of the pre-theory of *Papadike* [28], from a manuscript written by John the Protopsaltes. This book contains an explanation of the Old Byzantine Music notation signs and their unions (p. 2v). Only the *voice* (intervallic) signs were included, as well as from the rhythmical ones the so-called *Klasma*.

The standard separation of voice signs (*Semadia Phonetika*) bodies (*Somata*) and spirits (*Pneumata*) is clearly described in the p. 1v of the aforementioned pre-theory. Three rules are found there with regard to the combinations of signs, a) the ascending steps submit to descending and the *Ison*. b) when the ascending spirits are placed in front of (on the right) or under the bodies, they dominate. c) two new signs are created with the same process of submission, the *Argosyntheton* and the *Seisma*.

What Figure 1 presents is that each combination of signs is developed around a central point, that presupposes two additional spaces, one on each side, and two lines (one above and one below it). We distinguished and pointed out these possible positions of alignment, separated into three

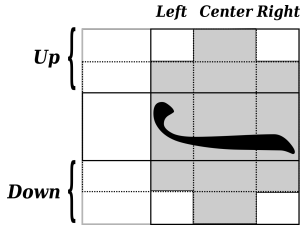

Figure 1. The positions of signs.

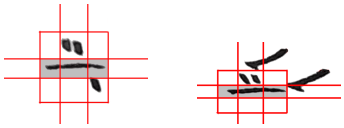

Figure 2. Neume positioning examples.

columns (grey areas). Hence, sign unions can be created by placing sings around a central neume, in the aforementioned positions marked in gray (see Figure 1).

3.1 Encoding the neumes

The aim of this work is the development of a computer program for typesetting the voice signs examined in the previous section. The objective is to encode a music as a text file and then digitalize in thw form of a music score. As foe the technique, which was uses, LilyPond, the technique of another widespread system was chosen to perform thw specific project [29].

The first step towards this goal involves the design of a system for recording /encoding Byzantine signs. In this system, each sign is represented by a keyword created from the first 4 letters of its name (Table 1).

As previously seen in Figure 1, each sign union follows a rhombus shape. This can be applied on the coding of combined signs. Each simple combined sign consists of a main sign and two lines above and under it. The length of the sign is subdivided in three columns. Every additional sign is placed in one of those empty positions. This division of combined sign assists the encoding process. An example of such placement can be seen in Figure 2a. In this union the main sign, *Oxeia*, appears in the grey region. A line above and in the central column *Kentemata* are placed while a line under and in the right column a *Kentema* is placed. On the left and on the right of the main sign there are two additional positions for minor signs such as the *Bareia*, *Kentema*, or *Hypsele*.

Figure 2b depicts a case where the main sign, *Oxeia*, is placed in the center combined with the *Kentemata* which are place a line above in the same column over the *Kentemata*, in the central column, a *Hypsele* is placed. The combination is completed with a second *Hypsele* on the right of *Oxeia*. It is obvious that such a layout requires groups of appropriate lengths and cannot be applied to the remaining signs such as the *Kentema* or *Aporrhoe*. This is the reason why such signs are not subdivided in more than one column and such writing not met in the manuscripts.

VOICE	VOICELESS
ison: *Ison*	para: *Parakletike*
isak: *Isaki*	krat: *Kratema*
olig: *Oligon*	lygi: *Lygisma*
oksi: *Oxeia*	kyli: *Kylisma*
peta: *Petasthe*	anky: *Antikenokylisma*
koyf: *Kouphisma*	trom: *Tromikon*
pela: *Pelaston*	stre: *Strepton*
ken2: *Kentemata*	tros: *Tromikosynagma*
ken1: *Kentema*	psif: *Psephiston*
ypsi: *Hypsele*	psyn: *Psephistosynagma*
apo1: *Apostrophos*	gorg: *Gorgon*
apo2: *Dyo apostrophoi*	argo: *Argon*
synd: *Syndesmoi*	stay: *Stavros*
kryp: *Kratimoyporrhoon*	anti: *Antikenoma*
elaf: *Elaphron*	omal: *Omalon*
apor: *Aporrhoe*	teso: *Thematismos eso*
cham: *Chamele*	teks: *Thematismos ekso*
	epeg: *Epegerma*
	paka: *Parakalesma*
	eter: *Eteron*
	ksik: *Ksiron klasma*
	arsy: *Argosyntheton*
	gosy: *Gorgosyntheton*
	oyra: *Ouranisma*
	apod: *Apoderma*
	tapo: *Thes kai apothes*
	tapl: *Thema haploun*
	xore: *Choreuma*
	tzak: *Tzakisma*
	pska: *Psyphistoparakalesma*
	trka: *Tromikoparakalesma*
	pias: *Piasma*
	seis: *Seisma*
	syna: *Synagma*
	enar: *Enarxis*
	bare: *Bareia*
	ifon: *Imiphonon*
	ifth: *Imiphthoron*
	klas: *Klasma*

Table 1. Old Notation signs and their encoding names.

3.2 Placement of signs

The exact placement of the sign is specified using the English alphabet letters "D", "U", "L", "C", "R", indicating "Down", "Up", "Left", "Center" and "Right" placement, respectively. Letters "D" and "U" are susceptible to additional numeric definitions "1" or "2", according to the line they refer to. Analytically, the determination of each place is portrayed in Figure 3.

The writing direction of signs imported in the musical text is upwards and from left to right according to picture 3. That is to say, the following layout is applied beginning from the central(main) sign.

```
DIRECTION of WRITING
CENTRAL SIGN>
D2C>D1L>D1C>D1R>U1L>U1C>U1R>U2C
```

The encoding of a sign and its place is achieved by specifying its 4-letter label, followed by an indication of its placement. Thus, for example, the *Kentemata* [2] above the

[2] Two kentemas.

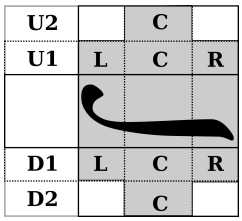

Figure 3. Possible positions of signs and their encoding

Figure 4. More examples from the encondings.

Oligon in the combination are defined as "ken2U1C", where "ken2" means *Kentemata* and "U1C" means a line above, in the center. In a second example, *Elaphron* is described as "elafD1R" by an underscore "_" as seen below.

Some additional combinations of signs which are indicative, are also included in the Figure 4 in order to make it easier to comprehend the proposed model system .The total number of combinations exceeds 200 - all of them can not be mentioned in such a limited space.

The lyrics of the chant are added a syllable at a time after each sign in curly brackets. Bellow follows an example code of the very popular musical exercise "*di efhon ton aghion pateron imon*" (p. 7v, Figure 5).

Here can be seen, both the encoding of sign unions as well as of the lyrics.

```
ison{di}
ison{ef}
peta_isonU1C{chon}
apo1_klasU1C{ton}
elaf_apo1U1L{a}
ken2{a}
olig_diplD1R{gi}
olig{i}
ison{on}
bare_olig_elafD1R_klasU1C{pa}
```

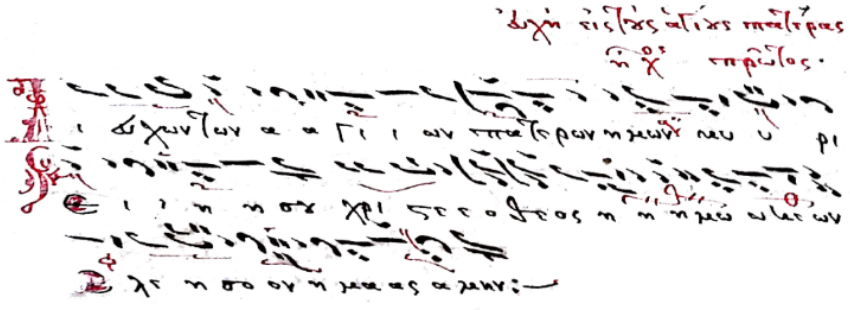

Figure 5. Manuscript of the popular musical exercise "*di efhon ton aghion pateron imon*" (*Papadike*, p. 7v).

```
olig_diplD1R{te}
apo1{ron}
apo1{i}
ison_diplD1R{mon}
olig_diplD1R_ken2{ky}
peta_ken2U1C{y}
elaf_apo1U1L{ri}
apo1_klasU1C{e}
elaf_apo1U1L{i}
ken2{i}
olig_diplD1R{i}
olig{i}
ison{soy}
isak{}
ison{chri}
peta_ken1U1C{ste}
apo1{e}
bare_ison_apo1D1R_klasU1C{o}
bare_ison_apo1D1R_klasU1C{the}
ison{os}
olig_kratD1C_ken1{i}
apo1{i}
apo1_klasU1C{i}
apo2{i}
ison_diplD1R{mo}
olig_diplD1R{o}
oksi_ken1D1R{ne}
apo1_apo2D1R{on}
olig_ken1{e}
ison{le}
peta_isonU1L_ken2U1R{i}
elaf_apo1U1L{so}
ken2_piasD1C{on}
elaf_apo1U1L{i}
olig_diplD1R{ma}
olig_klasU1C{as}
elaf_diplD1C{a}
ison_apodD1C{min}
```

Using this encoding method, a computer program was developed, which uses musical text as an entry and produces a score using the old Byzantine music notation. The program was built in Python 3, because it is open source and cross-platform. No additional Python tool was used apart from ReportLab for the export of the music score in pdf. An example of the program output for the aforementioned "di efhon ton aghion pateron imon" exercise can be seen in Figure 6. Precious aids in the above project was the book of Manaris, Brown [30], the articles of Hankinson, Roland, Fujinaga [31], Laskov, Dimov [32] and Baird [33].

4. CONCLUSIONS AND FUTURE WORK

In conclusion, this paper refers to development of an application, designed in Python so as to create Byzantine Music scores by using thw old notation. This work is applied on music of the 17th-18th century. Manuscripts of this period are frequently stored in inaccessible areas. They are in bad condition and usually incomplete. The presented signs are many and they shape formulas that are not clearly defined and concrete. Moreover, a complete theory of transcription from the old into the new Notation is not in use, so that the comprehension of texts and their transport in other Music Notations are not easy. In the old Notation, because of its complexity and incomplete comprehension, a satisfactory development of typesetting as well as the import of musical information in a computer have not been achieved yet.

The concretization of the project is still in initial stage. At present, a disadvantage is the manually-operated import of music score, a fact that includes a big probability of errors on behalf of the user but also requires much time for its completion. The optimum scenario would be if the music score could be automatically imported, through some kind of OCR. However, at present it is very difficult to be implemented at this stage, because of the poor condition of the manuscripts. As it appears in the produced PDF, the poetic text is not in satisfactory distance from the musical line, something that should be corrected. The *Isaki* (Little Ison) is not in short distance from the followed sign. The voiceless signs and moreover the ones written into a different (red) color have not been included. Ideally, the unions of signs should not be created from ready icons as there are cases when they are not represented by the existing ones but with characters of special font that will involve important qualitative improvement of the produced result. Moreover, a different font for the musical and poetic text could be used, and different page sizes and multi column text could be supported. It is also in our intention to create graphic environment, to facilitate text imports. Spelling and syntax check at the import of the musical text, the possibility of

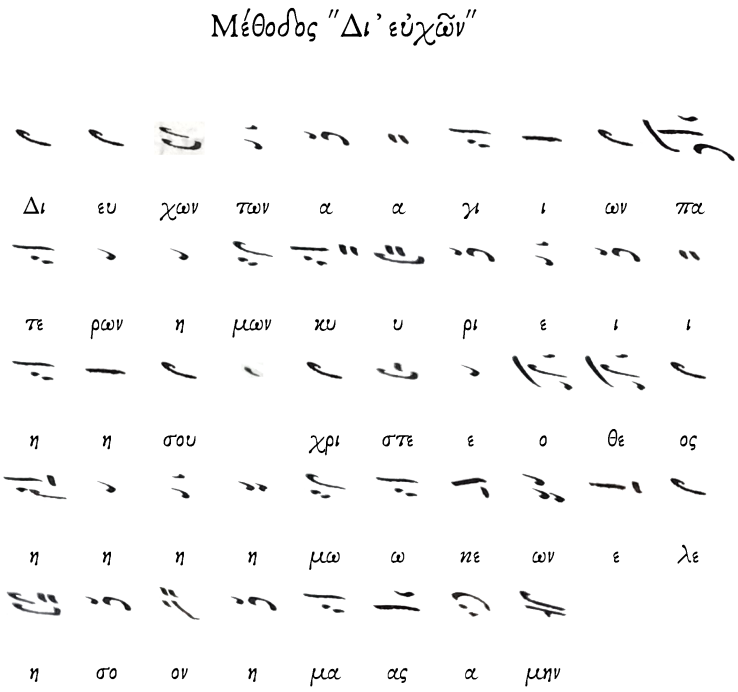

Figure 6. Example system PDF output of the popular musical exercise "*di efhon ton aghion pateron imon*" (*Papadike*, p. 7v).

numeration of musical lines and the insertion of Metrophonia of the melody, in the Latin alphabet, written above the musical line, are currently being incorporated in the system.

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