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Music from the Net-Check What's the Sound LAN Cable

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Abstract: In this study, a brief historical overview of the field of science in the creation of computer generated music is given. Attempts to present melodic effects resulting from dependencies between frames moving through the computer network are presented. The basic relationships between the sounds according to the theory of music are presented. The study contains some physical basis for understanding the presented set of dependencies. The resulting effect was presented in the form of musical notation in a way that everyone can play it with such a musical instrument. To obtain the relationship between the frames was used Wireshark, a network protocol analyser for Unix and Windows. The study includes discussion of the results, their relevance to the music and shows potential for further research and future use of the results.

Key words: Computer generated music, music theory, linguistic analysis, algorithmic music, Poland

INTRODUCTION

Music surrounding people from the dawn of history has served as a way to convey emotions, it has helped to rest, to communicate. In the process of evolution civilizations started to think how to create music, inventing the rules which would help in the process of its creation-composition. One of trends was to make music based on algorithmic patterns that in fact had nothing in common with music or even sound. Historically, attempts to create music in sometimes very trivial way, e.g., by signing syllable sounds of prayer. These days are known to attempt to match the music parameters to a much more complex issues, at first glance, quite unrelated to music. There are cases in astronomy, chemistry and physics. So, why not try a computer network? In this study, a brief historical overview of the field of science in the creation of this type of music is given. Attempts to present melodic effects resulting from dependencies between frames moving through the computer network are presented.

The study presents the steps of extracting features useful for musical purposes. An analysis of the signal of computer network was performed. It also describes the process of discussion and investigation of the size of network parameters through the base of physics-acoustics for musical significance. It also provides a fairly comprehensive discussion of potential further research in this field. Not only in the field of purely musicological linguistic but also for other applications such as everyday technology.

HISTORY

The idea of technical approach to music appeared in the middle ages. Clock mechanisms and musical boxes are examples of its implementation from that times. The first known reference to mathematics was made even earlier by Pythagoras (500 BC). He claimed that mathematics and music were related. Regardless of these considerations, an 11th century monk Guido d'Arezzo created a scheme Jarvelainen (2000) by assigning different pitch for each vowel in religious text. In the 15th century, monk and composer Guillaume Dufay assigned different tempo values to different parts of his composition. The composition was based on building dimensions of the cathedral. Following these thoughts and ideas in the early 19th century, Ada Lovelace suggested the use of machines in the composition process (Wade, 1994). She translated latest proposal of Italian mathematician Louis Menebreana-analytical machine. When translating the study she made a number of interesting observations which described in details a method for calculating Bernoulli numbers using the machine. It was then when she realized to believe that analytical machine could create graphics or compose music. This description is considered to be the first computer program. However, the first implementation of the analytical machine is a result of scientific work of the German physicist Hermann Ludwig Ferdinand von Helmholtz published as sensations of tone: Psychological Basis for Theory of Music. The researcher was interested in scientific-physics aspects of his research only. Even though, he paid no attention to musical nature of the sound his resonator use to analyse combination of tones, is regarded as the beginnings of electronic music.

Another interesting approach is to use stochastic methods for compositions depending on probabilistic functions. Explicit use of random events in the musical composition can be found in works of such famous composers as Mozart, Haydn and Pollack (McCormack, 1996). The most popular solution now-a-days is a type of composition based on the submission of individual notes (note-by-note) (Roads, 1996).

Yet, another interesting example of these methods is to implement the theory of gas kinetics, i.e., to use speed of gas molecules in the confined space of thermodynamic conditions in relation for creation of violin glissandos by Xenakis. Connection was made between molecules speed and slope of glissandos (Matossian, 1986). On the other hand, the use of parts of the principles of chemical process of autocatalysis-reproduction of molecular chains for the synthesis of chains of music, both pitch and intervals, the idea of Iverson and Hartley (1990). Unfortunately, as with most of compositions created with note-by-note method, the effect was miserable.

Much better quality of composed music was achieved with the usage of relations between parameters describing motion of the planets in our solar system, their speeds and coordinates to the relationships between rhythm, height, length and duration of sound (Keefe, 1991). Based on these dependencies the analog music was created (Fig. 1).

Worth mentioning at this stage is work of Voss and Clarke (1978) in which they made distributions 1/f while referring the inverse correlation to the audio frequency of the I Brandenburg Concerto of J.S. Bach and also other composers and audio signals of radio stations broadcasting classical music. They synthesized sounds through a random process from the obtained correlation where the generator 1/f was a selector of sound pitch. Random numbers obtained were rounded up and mapped to the sounds of two octaves. A similar approach, based

Fig. 1: Example of composition form Venus planet

Fig. 2: DNA molecules music

on the DNA strings for various characteristics of thymine, cytosine, adenine and guanine, can be found in Wentian Li work (Li, 1998). In turn, consolidating light absorption coefficient of DNA molecules with sound pitch can be found in the work of biologists Alexjander and Deamer (1999) and John Dunn, referred weight of molecules to assigned the sound pitch and other music parameters (Fig. 2).

THE NET (COMPUTER NETWORK)

To obtain the relationship between the frames was used Wireshark. This is a network protocol analyser for Unix and Windows. As a result of analysis of network traffic, on the basis of reports obtained data (Fig. 3), observations of some of the dependencies between data transmitted over this network, arose the idea to look at them more closely and consider what would be the effect on the music composed by assigning different relations to various music parameters. Of course, Fig. 1 shows only the sample data from the analysis of computer network. To reach the conclusions described as, looked much more data. In fact it means many hours listening to the transmission network. Before a thorough investigation several initial tests were performed.

As a result a parameter called frame length was chosen and extracted. Table 1 shows some values of this parameter corresponding to consecutive frames taken from a sample of network traffic. Obviously Table 1 could be infinitely extended. Presented fragment was included to show the observed dependence.

It might seem that the above values are not useful for this purposes. However, if we assume that these are the frequencies of sounds expressed in Hertz (Hz), by looking at values from Table 2 that present sound frequencies corresponding to notes, we obtain a sequence of sounds in musical notation. The basic kit is the scale of musical sounds. In traditional European music is made up of eight sounds which is a repetition of the highest in the lowest interval of an octave. The scope of sounds traditionally used in music is divided into 10 octaves. The basic sound is the sound each octave frequencies of successive tones C. Successive tones C are elements of the geometric quotient 2 with the lowest C is approximately equal to the sound of frequency 16 Hz (cycles per sec). Each octave contains 7 diatonic tones, creating a number determined in the major-minor system as a C major scale are successively C, D, E, F, G, A, H (in English notation, B). Sounds have also other names successively to re, mi, fa, sol, la, si. Last sound of each octave −C is also first sound of next octave.

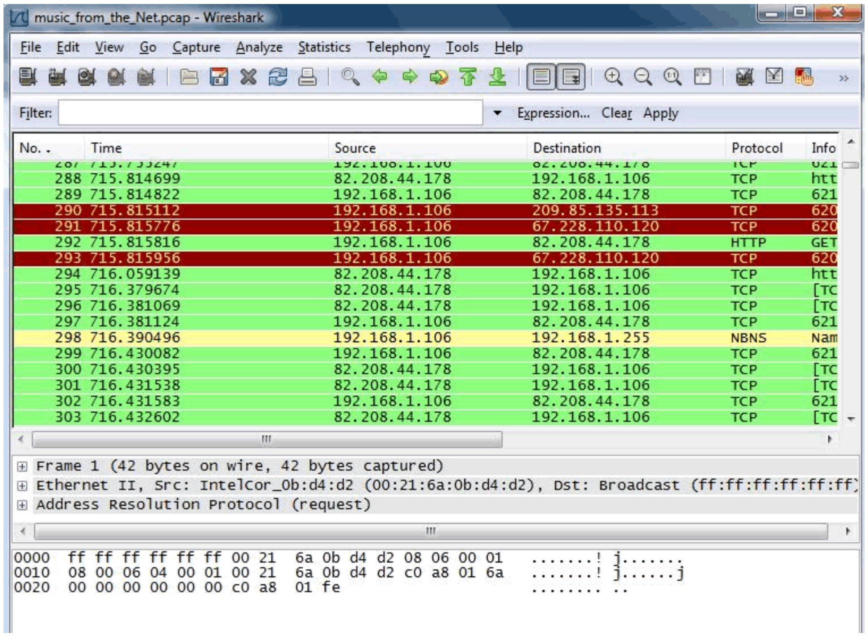

Fig. 3: Example of data received from the network

Table 1: Frame length paramter values corresponding to frame number

Frame No.	Frame length
1	54
2	1060
3	1426
4	669
5	54
6	1426
7	1426
8	54
9	1426
10	1426
11	54

Table 2: Values of frequencies corresponding to notes

C	D	E	F	G	A	H
0033	0037	0041	0044	0049	0055	0062
0065	0073	0082	0087	0098	0110	0123
0131	0147	0165	0175	0196	0220	0247
0262	0294	0330	0349	0392	0440	0494
0523	0587	0659	0698	0784	0880	0988
1047	1175	1319	1397	1568	1760	1976
2093	2349	2637	2794	3136	3520	3951

Table 3: Octave name versus octave number

Octave No.	Octave name
1	16 foot
2	08 foot
3	04 foot
4	02 foot
5	01 foot
6	03 line
7	04 line

Eight sounds occurring in the range of C major is a natural number called diatonic chain. These sounds correspond to the white keys of the piano.

Table 4: Values of frequencies corresponding to notes

Sound literal name	The sound raised a semitone	Sound lowered a semitone
c	cis	ces
d	dis	des
e	eis	es
f	fis	fes
g	gis	ges
a	ais	as
h	his	b

As presented in Table 2, numbers located in the first column indicate the successive octaves starting from 16 foot octave to 4 line octave. In this study, introduced simplified version limited to 7 octaves but selected octaves cover most of the human audible band. More detailed description is presented in Table 3. Table 2 does not include half tones but they can be easily calculated using Eq. 1:

$$f = \sqrt{f1 \times f2} \qquad (1)$$

Where:

f = The frequency of the half tone

f1, f2 = Adjacent frequency sounds, such as C and D

Naming and the relationship between the semitones with respect to the main sounds in alphabetic notation are shown in Table 4.

It is easy to see that values in Table 1 do not exactly correspond to specific sounds. In order to obtain a match between values from the net and notes from Table 2 a simplified approach was taken. Instead of exact numbers

Table 5: FL parameter to note mapping

Note	Frame lenght
1A	54
6C	1060
6F	1426
5E	669
5A	938
6E	1302
2C	66
5C	535
4D	288
6C	1041
6C	1045

each note from Table 2 was assigned a band. Then the value from the net was mapped to a note provided that its value fit into the band. Results of this mapping are shown in Table 5.

This procedure was carried on until sufficient number of FL-Note pairs were created. Choosing eight as a rhythmic value we can present the notes obtained in musical notation (Fig. 4). In this example, the notes follow rhythmic value we can present the notes obtained in musical notation (Fig. 4). In this example, the notes follow one another in a stream, without division into bars. From the musicological point of view, the approach is not correct. But, if you listen to the melody presented by the notation on the Fig. 4, you can hear the natural rhythm. It is certainly the effect of the existing network timing, the result of synchronization of transmitters and receivers carried by the ISO OSI layer model. Of course for the purposes of formal writing, you would enter the meter but at this stage of the presented approximations it is not necessary.

To further improve the end effect, instead of using the simplified model we can extend the simplified approach by adding the half tone calculated from Eq. 1 and singing new bands.

During the study of fragments of network communications, attention was paid to one more parameter closely associated with each frame, the parameter called TimeToLive and expressing lifetime of the frame. For previously observed frames, this parameter is put into Table 6. The simplest representation is to assign the TtT values to their metric equivalents, e.g., 128 would correspond to note 128 and 1 would correspond to a whole note. However, due to the size of this parameter music generated with this approach would not be ear-friendly. Therefore as in case of sounds pitches, bands for TimeToLive parameter were created for better mapping, what is shown in Table 6. The result of introducing it to discussed example is shown in Table 7. Taking it into musical notation Fig. 4 can be drawn.

As can be seen, example shown on Fig. 5 is much more interesting sonically. However, it should be noted that even a simplified version from Fig. 1 is also interesting.

Table 6: TimeToLive parameter sections according to metric values

Section	Metric value
1-32	Whole note
33-64	Half note
65-96	Quarter
97-128	Eight
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Table 7: Example of using section to set proper metric value for music sequence

Note	TimeToLive	Metric value
1A	128	Eight
6C	117	Eight
6F	128	Eight
5E	117	Eight
5A	117	Eight
6E	128	Eight
2C	128	Eight
5C	54	Half
4D	128	Eight
6C	54	Half
6C	62	Half

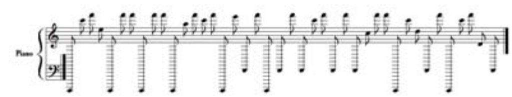

Fig. 4: Example of music from the net with constant metric values

Fig. 5: Example of music from the net with miscellaneous metric values

One reason for that is the fact that data in computer networks is transferred rhythmically because at some level there is the network clock synchronization of the sender and recipient.

CONCLUSION

Synchronization of the network means that in the presented examples, there is rhythm. The rhythm of the composition gives an interesting sound. In this way, we avoid a random stream of random sounds. The following examples and the way to create them is an interesting presentation of compositional possibilities present in the world around us, even in the computer networks.

You may wonder why the result obtained from the network is so surprisingly good. One could suppose that the get a cacophony of unrelated sounds. That is not happening. Significant impact on this are two things. The first is the fact that for statistical reasons, the network is finite, contrary to appearances, the variety of datagrams length. Given that we introduce additional frequency bands for the resulting, we get more quantized effect. Further research on developing this type of approach can be performed, e.g., to introduce the additional values of music. You can enter more volumes of music. Meter can be set based on the rhythm of the network. In addition by analyzing the composition of the parameters of the frame, depending on the type of Ethernet frame field and its value to the interpretative element to enter the resulting composition.

With further analysis can also include aspects of colors. Color is one of the elements of a musical work which involves implementing measures work. It allows you to perceive differences between sounds about the same height played or sung by different instruments or voices. Here, the dependence of the sound coming from the additional parameter of the network will give just such an effect.

The terms of the concepts of color are not formal but are paramount in everyday language. Names music colors can be: soft, rich, bright, full, mild, calm, cheerful, contrasted, sophisticated, dark, off, loud, subtle, etc. Such a determination also to network composition may be introduced as a result of further research.

Additionally, please note that the sound quality of the work affects articulation which means extracting and combining sounds, a summary of instruments (voices), their number, the register in which they are used, the dynamics, the types of consonance and harmonic connections. This opens another way for further work. The issue of harmonization but not discussed in this study is located in the main area of research and interests of the researchers (Zabierowski and Napieralski, 2008a, b, 2009; Zabierowski, 2010).

The introduction of the principles of tonal harmony, for example, the interpretation of data from the computer network for the principles of tonal harmony seems to be a very interesting issue. It can be used for the purposes of musicological and so purely related to a linguistic approach to music. Certainly take into account the dependence of harmonic obtained enriched compositions and make them even better. Use of these ear-friendly sounds in some technical solutions to improve attractiveness of computer equipment leaves field for further research in this area.

One can imagine that the sounds of a computer network, what happens in the cables, get some other meaning than just musicological-linguistic aspect. Perhaps thanks to analysis conducted, conclusions reached will be used somewhere in the technical solutions that surround man. Maybe will be important in creating devices emitted sounds less tiring for the users.

If we are able to read and translate the language of music data in a computer network, maybe so we are able to adjust the signals from the network to their musical spectrum was simply pleasant. Perhaps the parts or the conclusions of the study will be used for people with disabilities, for whom just the sound is the main language of describing the world around them.

I hope that these questions can be answered soon. After all even a few years ago, nobody thought about making effective use of sound in military technology-well, maybe the movie lovers of science-fiction.

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