Studio Report: A New Icon Musical Notation System - TAL*

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Introduction

This research presents a new conceptual approach to writing notes of computer music. It gives freedom to use notes from a continuum of frequencies rather than from a set of discrete frequencies. It also incorporates timbre parameters into the icon notes, thus enabling easy and continuous movement through different timbres, instead of using fixed timbres.

In this new musical notation icon symbols replace and expand the meaning of the "circles" of notes in the Conventional Musical Notation (CMN). The icons include in their format hints of the physical parameters of the timbres of the tones.

Using this notation the composer can shift icons continuously in the plane of Pitch (or log of fundamental frequecy) vs. Time, and can use freely and continuously microtone sounds, as seen fit. He can also change freely the timbre of tones by changing the icon parameters, such as Wave Form (WF, i.e. the spectrum of sound), amplitude envelope (AM, the Attack-Decay-Sustain-Release characteristics) and frequency modulation dependence (FM, effects like vibrato, pitch slides, portamento, glissando etc.).

A psychological advantage of the icon symbol is that the human eye is sensitive to small changes in closed figures, and forms of icons can be easily recognized. A musician can therefore easily identify the changing icons in a musical score and follow the timbral changes.

This unique concept of icon notation is realized in the computerized TAL system, built in our Lab, which is an integrated system of hardware and software. The hardware includes an advanced personal computer (or workstation, in a future configuration), peripheral units, a multi-oscillator real-time sound generator, audio sound equipment and optical scanner.

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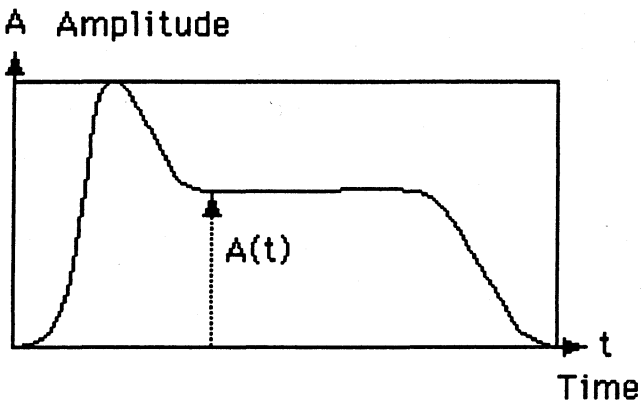
The software package deals with the input, graphics, editing, printing and driving the sound generation. A composer working with this system can either write his music on a computer screen by using the computer keyboard and a mouse, or alternatively can write it on paper. In the latter case the page with the icon notation is scanned optically and converted into bit-map image of the page. This is interpreted and edited. The music can then be heard through the audio system, as the built-in sound generator follows the notation instructions.

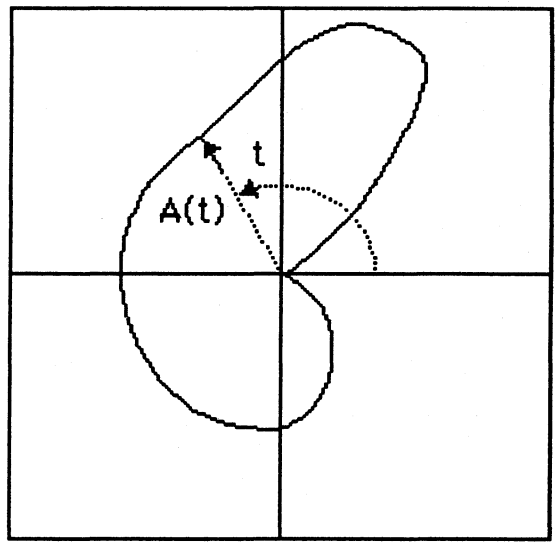
Principles of writing notes in TAL

1) The written icon music can be heard at any time, short or long sections. Thus interactive music writing is possible, as well as learning the association between the written icon notes and their sounds.

2) Time dependence is measured along the horizontal coordinate of the score, in the Pitch-Time plane, from left to right, as in CMN. The horizontal position of the point of origin of the note defines the exact timing of the beginning of a note. The beginning of a note can be defined contiuously in time, and is not restricted to discrete time points.

3) The pitch of a note is defined by the height of its origion along the vertical axis, as in CMN. Here again it is not restricted to a set of discrete pitch points (such as the 12 pitches per octave), and can be moved continuously by using microtone marking.





4) The AM envelope for each note is represented in polar coordinates, forming a closed iconic form, as seen in the Figure. The magnitude of amplitude is represented by the distance to the note origin (i.e. the polar radius vector). Time change of the amplitude is represented by the polar angle (also called the azimuth angle).

Typically, the icon note has a "kidney" shape, since the amplitude starts with zero value at polar angle 0, and ends with zero value at polar angle 360.

In order that the same icon represent the same timbre irrespective of its duration the following conventions are adopted:

- The AM envelope of the note is divided into three AD-S-R segments, Attack+Decay, Sustain and Release.

- The whole polar angle of 360 degrees is divided into three parts, the first sector of 180 degrees is assigned to the Attack+Decay segment, the next sector of 90 degrees is assigned to the Sustain segment and the last sector of 90 degrees is assigned to the Release segment.

- Within each sector the polar angle increases proportionally with time. However, time scales for each sector is different, depending on the actual total time duration assigned to each segment.

An additional statistical element may be introduced into the playing of icon notes, if the musician prefers it. Two AM envelopes are drawn for each note, e.g. by two different colors. These two co-origion icons mark the minimum and maximum magnitude between which the actual amplitude can play. It is controlled within these boundaries by statistical functions, fractals, wind, etc.

5) The actual duration time of each icon is represented by a horizontal line section drawn from the note origin to the right direction. The actual duration of each of the three AD-S-R segments is marked on this line.

6) Volume is defined separately for each icon note. For graphic reasons, all the notes in the score of Pitch-Time plane appear the same size, with their envelopes normalized according to peak values. However, when the score is played, each icon is played according to its assigned volume.

7) The FM function is drawn horizontally as a cartezian curve. The duration time line (described above, 5) drawn to the right of the icon, serves as a reference axis to this curve which represents the pitch (or frequency) deviation relative to the note's center pitch.

8) Between one and four waveforms (WF) are associated with each AD-S-R segment of an icon note. Time evolving mixes of two WFs out of four is possible, by changing the weights of any two of the WFs.

WFs may be defined by either one of three ways: A) The WFs are taken from a library of pre-defined or recorded WFs. The interpreted icons extracted from scanned icon score written on paper, are also included in this group. B) A WF is formed by superposing harmonic Fourier components. C) A WF can be drawn graphically on the screen using a mouse.

Smoothing of WF is provided to avoid high frequency components which might cause aliasing and distortion.

9) Coincidence of two note icons with the same pitch and different timbres may lead to ambiguity. Therefore, when the situation gets complicated, with many coincident notes of the same pitch and different timbres, two or more parallel and synchronous scores are written, as is common practice in CMN. The parallel scores are played together.

10) Every icon note can have an Echo option activated. It is then followed by a series of delayed identical icon notes with diminishing amplitudes. These amplitudes can decrease linearly in time, or as a decaying exponential, or as any other function programmed by the user. In the score the Echo function is marked by "E" to the right of the icon.

Technical Details

The latest software version is called TAL3. It was implemented on a 386-PC with Super VGA graphics using Object-Oriented Turbo Pascal 6.0. A new version, TAL4, uses Windows and is being written in Turbo Pascal Windows.

The sound generator hardware is a PC pluggable board called Music Magic System. It is capable of simultaneous real-time generation of up to eight oscillators, using the additive synthesis method. Up to three such cards can be plugged in one PC.

A new transputer sound generation hardware unit is being developed [2]. It is a multiprocessing unit of hardware and software in which several transputers operate in parallel. A tree configuration which can be expanded by adding more transputer cards, can provide hundreds and thousands of real-time simultaneous oscillators.

IconEye is the name of the associated software package that interprets and identifies the icon parameters from the image of the scanned paper-written icon score [3].

TLP (TAL Learning Program) is a software package [4], whose aim is to teach musicians how to use the TAL system. It takes the user on a learning tour along the various features of the system, asks him to do some exercises and to perform certain tasks, making the user learn the various possibilities by doing them himself.

Conclusion

The full control of all sound components brings about a wealth of information which demands very exacting perception in quantity and quality. Without a notation in combination with the computer instrument, the composer cannot fully exploit the new possibilities in musical thinking.

The iconographic notation allows full command of all prameters. The computer, able to learn the reading of the iconographic score, realizes all intentions of the composer. In this way the history of music opens a new area of compositorical thinking, a perfect example of seamless amalgamation of science into arts.

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