Computer Recognition and Transliteration of Mridangam Mnemonics

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INTRODUCTION

Even though computers are basically counting devices, they can also perform many sophisticated operations. Today the computer is used as a tool in many disciplines and music is no exception. During the last two decades the computer has been applied to music in many different ways. Firstly, computer-assisted musical compositions have been produced. Secondly, the computer has been used to analyse musical compositions. Thirdly, the computer has been used for musical information retrieval; fourthly, for sound analysis and synthesis, and finally for recognition of musical scores.

Computer-assisted Musical Compositions

Computer-assisted musical compositions were experimented with about twenty years ago in the United States of America and a little later in Europe when computers became accessible to music researchers and composers. Western music composers have been experimenting with non-traditional music even before the advent of the computer, and computer-produced compositions could thus win acceptance without too much opposition.

The main principle used in such compositions was to analyse at first a certain body of music and extract from it the different proportions of the musical notes and other related statistics. Using detailed statistical information, new compositions were made reflecting certain characteristics of the original body of music. A fine balance had to be maintained between too much and too little adherence to the original body of music.

Application of such principles to Karnatic music had been presented in 1976 to the Music Academy, Madras, and the Computer Society of India by K. R. Ananthanarayanan.

The Computer for Musical Analysis

The computer has opened up new possibilities of analysing musical compositions exploiting the vast data-processing potentialities offered by the computer. It is now possible to compare in detail the style of different composers and to quantify them and with the availability of computers in Madras the scope for such work has widened.

Musical Information Retrieval

The computer has been found quite useful in the general area of information retrieval and musical information retrieval is part of the general problem. First, it can relate to the different musical compositions. If all the known works are stored in a computer with details such as the *raga, tala* and the name of the composer, then catalogues can be produced in terms of the *raga, tala* and the composer, all arranged in alphabetical order. Such programmes are common with reference to library books. Musical information retrieval methods have been applied to Karnatic music compositions and such applications were experimented with in the U.S.A.

Another kind of application in this area would be to store musical compositions in some standard form and compare the works of different composers for common phrases. This could also establish unsuspected borrowing between composers.

The Computer: Sound Analysis and Synthesis

Along with the developments in computers, electronic sound equipment has also been developing at a rapid rate. The musical characteristics of musical instruments and vocal singing have been analysed and attempts have been made to synthesise musical sounds to produce required tones. Such a development has made the electronic organ possible. Attempts have been made to use a computer to analyse patterns of sound waves and to simulate the characteristics of different Karnatic instruments. Given a particular melody and the physical parameters of any given musical instrument, the experiment would reproduce the melody with the characteristics of the desired instrument. Such experiments were conducted at the Tata Institute of Fundamental Research, Bombay.

Computer Recognition of Musical Scores

Musical researchers wishing to use computers normally convert the musical notation into some form suitable for punching on to computer cards. In recent years attempts have been made to write programmes that will make the computer recognize the musical scores directly after digitization. Western music notation engraved and printed can be successfully recognized and converted and stored in an alphanumeric form called Ford-Columbia music notation.

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ABSTRACT

Mridangam is a harmonic drum used in classical Indian music and a variety of tones can be produced from a single instrument. In order to remember many complicated rhythm patterns a well-developed system of mnemonics is used by a drummer. It is shown that mridangam mnemonics printed in Tamil can be recognized by computer methods. Each letter, once it is recognized, is first represented by a numeral and then transliterated into the corresponding Roman letters. This is treated as a problem in the area of computer pattern recognition. The method used for recognition of mridangam mnemonics is an adaptation of a method recently developed by the authors for the recognition of all Tamil characters.

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Modern composers of western music and music researchers are now making use of the wide range of possibilities offered by the computer in experimental music composition and research.[1] The computer can be effectively used in stylistic analysis and in other direct statistical applications.[2] There is a major area of research in the field of pattern recognition which is now being applied to the recognition of musical notation. Prerau has developed a method of computer recognition of standard engraved western musical notation.[3] In this paper we demonstrate a method of recognition of mridangam mnemonics printed in Tamil characters in a standard type.

The mridangam or matthalam is one of the most ancient of the musical drums of India.[4] It is a barrel-shaped drum about 60 cm long with a girth of about 90 cm in the center. The ends have a diameter ranging from about 15 to 25 cm and the left end is a little larger than the right.[5] The shell is now made of wood. A recently discovered ancient Tamil work called *Pancha Marabu*[6] prescribes, in its prose commentary, Neem wood or clay for the shell of the matthalam. It also gives the dimensions of the instrument. The two heads of the instrument are covered with parchment strained by six-

teen leather braces interlaced and passing through the length of the instrument. The right head of the instrument is often tuned to the tonic and the left head to the fifth.

Both the right and left heads of the instrument are made up of three layers. Only one layer represents a complete head and the other layers are partially cut away to form rings. The right head is loaded at the center by applying a black mixture made from iron slag. The left head also has a central load but unlike the load for the right side, it has to be prepared afresh each time the drum is used and a paste made of coarse wheat flour is used.

Different tone qualities are obtained from the instrument[7] by striking with the full hand, or the several fingers at different places and by dampening or releasing. Books on mridangam playing recognize seven major 'sound words' and four minor 'sound words'.[8] The first four sound words or mnemonics taught to mridangam players today are *tha, thi, thom* and *nam*. The tradition of representing the different tones of the instrument by sound words is very old. *Pancha Marabu*, already referred to in this paper, has a small section on the subject entitled *ezhuthu marabu*. The sound words mentioned in that work are *tha, thi, tho, ta* in the section under drums and *tha, thi, thu, tho, ki* in the section on dance.[9] The method of forming compound words are also given. Letters that form the sound words are referred to as *vaachiya ezhuthu* (instrument letters) or *vaachiyam* for short.

Text books are available in Tamil[10, 11] that present mridangam sound words for the different *tala*-s or time-measures. If one wishes to analyse any sample of mridangam words with the aid of a computer, the normal procedure will be to code the different sound words and transfer the data on to punch cards and feed the cards with a suitable program into a computer. Here a punch operator who knows the Tamil letters recognizes each letter for coding. However we address ourselves to a different problem. Can the Tamil letters that form the sound words be treated as different patterns in black and white and be recognized as different letters by a computer? It is this pattern recognition problem to which we address ourselves. Treating the engraved printed music in staff notation as patterns, it has been possible to recognize the different notes by a computer. Similarly we wish to demonstrate a method that can recognize the mridangam words printed in *Bharathi Antique* type.

In pattern recognition work, the required patterns will be converted into binary pictures of tiny black and white dots and the patterns stored in the computer as binary matrices. Such digitization is normally done by special equipment. However we have performed the digitization manually. We have already worked out a method of automatic recognition of printed Tamil characters.[12] In this problem we have to reckon with a few additional features not met with in the recognition of Tamil characters.

A horizontal bar is often marked above a line of sound words to indicate that the tempo of playing should be doubled. A double bar above the line indicates that the instrument should be played four times the speed

of mridangam words represented without any marking. This is similar to the system of representing musical notes in Karnatic music. However the double line above a mridangam sound word is rarely met with.

A dot after a sound word represents a silent pause or rest of one unit. A series of dots below a line indicates that the sound word *thom* should also be played simultaneously. A line under a sound word indicates that the sound word *tha* should be played simultaneously.

Lengthening of vowels in a sound word indicates the increase of the duration of a stroke. For instance if the word *tha* has a duration of one unit then the word *thaa* would indicate a duration of two units.

In our recent work on the recognition of Tamil characters we had not made provision for Grantha letters such as *ja* which occur in mridangam mnemonics. We provide in this method for the letter *ja* as well as its combinations with vowels. A vertical line is used to denote the end of a phrase called *arai avardhanam* and a double vertical line to denote the ending of a full phrase called *avardhanam*. In our program we have made provision for the computer recognition of the vertical line. We also provide for the recognition of the horizontal bar below and above the lines. The dot which occurs between and below the letters is also taken care of. If the input text contains a symbol that cannot be recognized by the program then an asterisk mark will be printed in the place of the unrecognized symbol. Once the symbols are recognized by the computer, the result is printed in Roman letters. Figure 1 gives a sample of input mridangam mnemonics and the corresponding computer output. Table 1 gives a result of Tamil characters that occur in the mridangam words and the corresponding Roman equivalents. There are three *n*-s in Tamil and for the sake of simplification of notation they are all printed as *N*. Table 2 gives the important sound words and the computer transliteration in Roman letters and the conventional text book representation in Roman letters.

For recognizing the different patterns, we use the method of 'symbolic runs' already developed by us. The method is relatively simple and we shall describe it informally as follows. First each character to be recognized is converted into a rectangular binary matrix in which a '1' represents a black, and a '0' a blank or white. Information is extracted from each array and stored in the memory. Letters and symbols that are likely to occur in the text are stored in the computer as string patterns. Each pattern is represented by a numeral inside the computer. The sample that is fed into the computer is read character by character. Each character that is read, is first tested as to whether it has a horizontal line above it. If such a line exists, it is recognized and removed. The rest of the picture is reduced to a string pattern using a special method described later, and compared with the original characters already stored. If there is agreement with any of the original characters the pattern is recognized as that character. A similar procedure is followed for the dot below a letter. The occurrences of symbols that represent the medial *a* (long) and medial *o* are taken note of and the combination of the characters recognized as a vowel following a consonant.

The method of converting a binary matrix pattern into a string pattern can be described informally as follows. Each binary matrix is examined by the computer column by column and the number of runs of 1's is noted. These values form a string of numerals and any one numeral may occur in consecutive positions forming a short, medium or long runs. This information is noted and a new string called symbolic run is formed. Similarly another symbolic run string is formed after a row-wise examination of the picture matrix. These two strings together form the string that represents the given picture matrix representing a Tamil character. The different symbols that are used in mridangam mnemonics have unique representations.

This method can be extended to recognize printed Karnatic music in Tamil characters. The output of these programs can be used as input to music analysis programs and music-playing programs.[13]

The program was written in FORTRAN IV and was executed on an IBM 370/155 computer at the Indian Institute of Technology, Madras.

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V. 122.

தத்தித்தோ டெவ்வென்று சத்தம் பிறக்குமென
முத்தமிழோ ரெல்லா மொழிந்தார்கள் - எத்திறமுந்
தன்வழி யொன்றித் தனித்தனியே வாராவாம்
பின்னு மடைசொல்லாம் பேசு.

V. 145.

தவ்வென்றும் திவ்வென்றும் துவ்வென்றும் தொவ்வென்றும்
மவ்வென்றும் தோழிநீ யாயுங்காற் - கவ்வென்ற
வொற்றே டிகரத் தொடுங்கி யியங்கியதோம்
மற்றுந் தொடுத்து வரும்.

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INPUT

நம். தின். நம். கிடதக

நம் தொம். தின். நம். கிடதக

OUTPUT

NAM. THIN. NAM. KITATHAKA

NAMTHOM. THIN. NAM. KITATHAKA

Fig. 1. A sample input of mridangam mnemonics and the computer output in Roman letters.

TABLE 1
List of Tamil symbols and the Roman equivalents

Tamil	Roman	Tamil	Roman
ங்	NG	ஜ	JA
ண்	N	சா	CHAA
த்	TH	தா	THAA
ம்	M	ளா	LAA
ன்	N	கி	KI
ஜ்	J	தி	THI
க	KA	மி	MI
ச	CHA	ரி	RI
ட	TA	தீ	THII
ண	NA	கு	KU
த	THA	டு	TU
ந	NA	தொ	THO
ள	LA	நொ	NO
ன	NA	ஜொ	JO

TABLE 2
Mridangam mnemonics and their Roman representations

Tamil	Conventional representation	Computer transliteration
த	THA	THA
தி	THI	THI
தொம்	THOM	THOM
நம்	NUM	NAM
ட	TA	TA
ச	CHA	CHA
தின்	DHIN	THIN
கி	KI	KI
க	KA	KA
ளாங்	LONG	LAANG
தாம்	THAM	THAAM

He is perhaps the world's first great artiste to rebuke man's desire for immortality. The classical arts were founded upon this desire. The contemporary artist, watching men frightened into servility by his own creations, wishes the audience to destroy them immediately after use. For fear that the individuated life of his art, instead of being cremated after its death, should be used as an instrument to deaden others by example!

Chaplin had accused Hitler of stealing his butterfly moustache. Imagine what Gandhi, Marx and Einstein could accuse us of! Perhaps, after all, this new search to be mortal is futile. Chaplin is dead.

—KUMAR SHAHANI

Ustad Karamatulla Khan (1915-1977)

Ustad Karamatulla Khan, one of our finest tabla players, died in Calcutta on the morning of December 3, 1977 after a long illness. He was 62.

Khan Saheb was associated with All India Radio, Calcutta, since its inception. In fact, his association with broadcasting started in 1927 with the creation of the Indian Broadcasting Company's Calcutta Station. Because of this connection, his performances outside Bengal were not too frequent, though he missed few major 'Conferences' of India in the last forty years.

Karamatulla Khan belonged to the Faridabad Gharana. It was his individual impeccable style and his qualities as the 'gentle, perfect' accompanist that endeared him to instrumentalists and connoisseurs alike. To describe him as a virtuoso would be to limit the range of his musicianship. The National Centre's Archives have some extended recordings of his art at its best, a reminder to students what fine tabla-playing — solo or accompanied — can be.