INDIAN MUSIC – ITS ORIGIN AND GROWTH
(PART – 1)

AND

SPECTRAL ANALYSIS OF SWARAS OR MUSICAL NOTES
(PART - 2)

A
DISSERTATION

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ABSTRACT

Music is the art of combining sounds for expressing emotions. The origin of music in India is shrouded in mystery. It is believed that music arose out of Sama Veda. Indian music makes use of different Ragas and Raginis to invoke emotions. In this report an attempt has been made to describe the emotion of Indian music from ancient times up to the model age.

The report analyses the nature of sound according to Indian traditions. Just as everything else in India, music also has its philosophical aspects. These have been touched upon briefly.

Sama Veda is considered to be the origin of Indian classical music. There are several schools associated with the rendering of hymns of Sama Veda. It is accepted that Sama Veda gave rise to six different schools of music itself.

The report traces the gradual modifications which took place in music over a long period of time.

Indian music makes use of Raga to invoke emotions and Tala to provide rhythm. These two, melody and rhythm constitute the ancient elements of music. The emotions evoked by music are divided into eight categories, called the bhavas.

The report closes with a section on benefits of music.

INDIAN MUSIC – ITS ORIGIN AND GROWTH

Chapter 1

1.1. INTRODUCTION:

Music is the art of combining sounds for expressing emotions. It is considered to be a subtle divine thread capable of linking up the Jèvátman with Paramátman, which is the concept of Tañtra Ùástra dealing with Ùabdabrahman, the primeval source of creation.

In India, music has always been considered as a combination of sound or Gètham, drumming or Vádya and dancing or Nøtya. However, in modern times music has become confined to Gètam and Vádyam only.

The origin of music is shrouded in mystery. Traditionally, in India, it is believed that music arose out of Sáma Veda. The Greeks believed that music arose from the planets revolving around the sun. The distances of the planets from the sun were considered to represent harmonic sounds. This they called `Music of the Spheres'.

Music comprises of several factors. The grammar of music deals with tone, melody, rhythm, and tempo etc. Different characteristics and temperaments of musical forms during different ages constitute the history of music. The most important aspect of music is Acoustics. This deals with the nature of voice and sound waves, their characteristics, harmony and scales, simple harmonic motion, frequency and pitch, amplitude and loudness, and tone and tonal quality. It also some times deals with resonance.

Indian music makes use of different rágás and raginès to invoke emotions. These rágás and ráginès are many times described in the form of paintings, especially in the north Indian tradition. This is known as the `Iconography of Music'.

Psychology also plays an important role in the field of music. Human beings at all age levels are attracted by music. Another important element is Aesthetics, which in Indian music is also known as Manodharma. Last but not the least is the philosophy of music. In India, this aspect has been emphasized to such a great extent that music is considered as one of the ways of reaching the Divine, called `Nádabrahman'.

In this report, an attempt has been made to describe the various aspects of music as it evolved in India from ancient times up to the modern age.

1.2 MUSIC AMONG PRIMITIVE PEOPLE

It is difficult to trace the origins of music and how it evolved. According to some philologists, music is considered to be even older than speech itself. Primitive people around the world lived in the midst of nature surrounded by wild animals. It is very likely that both music and speech evolved when primitive people started imitating the sounds of these wild animals. It is also surmised that even dance evolved from the imitation of the actions of animals.

In the initial stages, music must have derived inspiration from primitive religion, which was nothing but nature worship. The passing of seasons, the constant changes going on in the environment, natural phenomena like thunder, lightning, rain etc. must have generated in the minds of primitive people a certain feeling of awe, which culminated in a form of worship to propitiate these natural forces for the welfare of society. With the advent of speech, music took a more concrete form developing a structure of its own. Even today, it is possible to get an idea of what music used to be in early times by absorbing the ritualistic practices of tribes all over the world. The rain dance practiced by many tribes around the world is an example.

A serious study of this kind of primitive music will help us trace the historical development of musical patterns, leading to the modern forms prevalent in the world today.

Chapter 2

SOUND AS NORM OF MUSIC

Sound is mainly divided into two categories, noise and music. Noise is associated with irregularity, suddenness and unpleasantness. It has no definite pitch and is rough and irregular. On the other hand music is comparatively smooth and has an even flow. Musical sounds are those which are smooth, regular, and pleasant and of definite pitch.

The source of any musical tone is always a vibrating system. The vibration generated by a system is communicated to the air in contact with the system. The vibrations picked up by air are longitudinal in character, i.e., the effect is propagated by a constant forward motion of air.

Whenever a sound pattern is generated by a vibrating system, it creates a local region of high air density and pressure. This region of high pressure moves forward until the pressure gets dissipated. If however the sound pattern is captured by human ear before dissipating, it stimulates the auditory nerves in the ear leading to a sensation. If the sound pattern is nonmusical, the vibration of auditory nerves is irregular and is sensed as noise. If the pressure intensity is quite high the noise may become harmful or unpleasant. When the auditory nerves are excited by a sound pattern which is periodic in nature the sensation is one of music. But even here if the level of pressure is very high it may lead to unpleasantness or damage of the auditory nerves.

Sound can be produced either by a mechanical or electronic instrument or by human voice. In any case this always involves three major components.

1. The vibration of the source
2. The transmission through the medium
3. The reception by the hearer

Whether the sound pattern generated is noise or music depends on the characteristics of the source. Therefore the kind of music which one would like to produce will depend upon the design of the source.

Music is associated with certain acoustic properties like pitch, intensity and loudness. The pitch of a musical sound is that tone which decides its position in the musical scale. For example, a deep sound is associated with low pitch and an acute sound with high pitch. The pitch is quantitatively decided by the frequency of the vibration.

The intensity or energy of musical vibration depends on the square of the amplitude of the vibration, the frequency remaining constant. If however the amplitude remains constant and frequency changes, the intensity becomes proportional to the square of the frequency. When both amplitude and frequency vary, the intensity becomes proportional to the product of the squares of both.

An important property of musical sound is its tonal quality. It is said that no musical instrument can match the human voice in producing sounds of various types. Each vowel of human speech has its own tone with a distinct musical quality. Tonal quality is represented in musical language by the peculiarity exhibited by the shape of the periodic curve representing the musical sound.

Chapter 3

INDIAN CONCEPT OF SOUND

According to Indian tradition, sound is measured in four parts, of whom three are considered unmanifest and therefore secret. These three parts are Pará, Paùyanti and Madhyamá. The fourth one which is manifested and audible is Vaikhari. It is also considered to be the external manifestation of sound, which has its origin as Pará in the navel or Manipüra cakra. The sound passes through the heart region or Anáhata cakra when it is called Paùyanti. When it reaches the throat region or Viùuddha cakra it is called Madhyamá. When music is manifested and audible it is considered to be the Vaikhari sound.

Chapter 4

PHILOSOPHY OF SOUND

Since music is only the external manifestation of the sound produced as Pará in the Manipurá carka, Indian philosophy has always recognized the divinity of music and called it 'Nádabrahman'. According to this philosophy, the three forms of sound namely Pará, Paùyanti and Madhyamá are lodged in the cave of the heart in the form of Náda. It is when this Náda becomes audible that we hear music. There fore real music is the Nádabrahman, which in the static form is known as Bindu and in the dynamic form as Kalá.

This philosophical interpretation is basically the standpoint of the Tañtra Ùástra. It has been dealt with in great detail in Pataòjali's commentary on Pánini's Aùtádhyáyi and Bhartøhari's Vákyapadèya.

Music is an ordered and structured aspect of sound. Sound itself consists of Swara and Vyaòjana, i.e., vowels and consonants. Just as language is built up around vowels and consonants, which give it a specific structure, music also is derived from a proper combination of various swarás. Not all swarás are audible. For example, Pará, Paùyanti and Madhyama are inaudible and hence called Anáhata or unstruck. Vaikhari on the other hand is Áhata or struck. For music, even though Vaikhari plays an important role, its real heart lies in the Anáhata swara. The most important of Anáhata swara is Omkára. Just as Omkára is considered the most important of all mantrás, music is also the most important form of sound. Just as one can realize the divine by the recitation of Omkára, one can equally well realize the divine through music. This is the philosophy of Nádabrahman.

Chapter 5

MUSIC IN THE VEDIC TIMES

Of the four Vedás, the one closest to music is the Sáma Veda. This is also considered to the largest of all the Vedas. It had been given so much importance in the ancient times that Ùri Køúïa says in the Bhagavad-Gèta, "I am the Sáma Veda among all the Vedas".

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"VEDANÁM SÁMAVEDOSMI"

Even the Øgveda mentions in some places the importance of Sáma Veda.

The Sáma Veda was used in Yajòás to be sung by a priest called Udgátø. But the mantrás which are song melodiously by the Udgátø basically belong to the Øgveda. Therefore, one can say that Øgvedic hymns sung according to musical patterns become the Sáma Veda.

It is surmised that the Sáma Veda consisted originally of one thousand branches. Most of them are lost forever. Only three of them are available today, namely Raïayana, Kouthuma and Jaimini. Of the three, the most common in use is the Kouthuma branch, which is also called Taïdya. The famous Chándogyopaniúad belongs to this branch.

Sáma Vedic hymns were recited in ancient times in four ways.

They are

1. Grámageya gána
2. Áraïyaka gána
3. Üha gána
4. Ühya gána

Of these, the first two were more commonly recited than the later two. The Grámageya gána used to be recited in the assembly of human beings. The Áraïyaka gána on the other hand had to be song only in forests and that too in privacy. It was considered inauspicious to sing it in public. Its musical structure is indeed very peculiar, complicated and hence considered too difficult for ordinary singers. It was meant only for experts and as such considered sacred. Üha gána is that part of the Sáma Veda recited only during certain Yajòás like Soma Yága. The last one, namely, Üha gána was considered as sacred and secret as Áraïyaka gána and used to be recited only on special occasions.

Chapter 6

SÁMA VEDA AND MUSIC

It is generally accepted that Indian classical music owes its existence to Sáma Veda. The relation between Sáma Veda and music has been described in a book called 'Nárada Ùèkúa' which is not easily available. This book is supposed to contain the details of the swarás of the Sáma Veda and their relation to musical notes.

The seven swaras of Sáma gana are numbered from one to seven and are usually described as Prathama, Dwitèya, Tritèya, Caturtha, Paòcama, Ùaúûha and Saptama. The first note of Sáma corresponds in classical music to Madhyama. The second note corresponds to Gándhára, the third to Øúabha, the fourth to Ùadja, the firth to Niúáda, the sixth to Dhaivata, and the seventh to Paòcama. It is thus seen that the Sáma swaras correspond to the Avarohaïa or descending order of the classical music. The Madhyama swara of music forms the basic note of Sáma Veda going down to Paòcama or the lower octave. This is the reason for the peculiar musical cadence of Sáma Vedic singing.

It is the practice to write mantras of Øgveda, Yajurveda, and Atharvaveda with notations for the various accents. The basic note here is called Swarita, with the higher note being Udátta and the lower note being Anudátta. The Udátta is indicated by a vertical line over the letter and the Anudátta by a horizontal line below the letter. Some times even higher notes are indicated by double lines. Elongated notes are indicated by a number showing the matras by which the note has to be elongated.

When it comes to Sáma Veda, a different notation is followed. Whereever there is a letter which has to be musically recited, its swara is indicated by writing one of the seven numbers above it. But the system of singing itself is so complicated that it is practically impossible to learn it through books. The guidance of an expert is absolutely essential just as in the case of music.

The singing of Sáma Veda hymns is further complicated by the fact that even words get modified to suit the musical continuity. These modifications are six in number. They are,

1.VIKÁRA	-	which is a total modification of a word,
2.VIÙLEÚAÏA	-	which is splitting a word,
3.VIKARÚAÏA	-	which is elongating a word after splitting it,
4.ABHYÁSA	-	which is repeating the same word twice or thrice,
5. VIRÁÏA	-	which is taking a pause in the middle of a word,
6. STOBHA	-	which are filler words to complete the cadence, like ou, hova, haavu, a.

The two most popular methods of Sáma gana are Rathantara and Bøhat. The most common chandas used in Sáma Veda is SÁMA GÁNA GÁYATRI. There are many other forms or chandas also used which are the same as in the other Vedás.

There is a very special way of reciting Sáma gána. It is said that any hymn of Sáma Veda has to be rendered in five sections called Prastava, Udgèta, Pratihára, Upadrava and Nidhána. The mantra is split into five components, each component being sung by a different individual. These five components or sections are sung sequentially thrice. This is then called a Sthoma. Thus it is seen how complicated the singing of Sáma Veda is and how much training is required. But so far as the current study is concerned, the most important aspect of Sáma Veda is the use of the seven notes.

The recitation of the hymns of Sáma Veda was some times accompanied by musical instruments. The most common instruments were Vèïa, Veïu and Dundubhi. The vèïa was a plucked instrument, the veïu or flute a blown instrument and dundubhi was a drum. There were several kinds of vèïa with different sizes and different number of strings. There is a mention of a vèïa made of hundred strings, which later became the Ùatatañtri vèïa or Santür. There is also a mention of another vèïa called Kátyáyani, with hundred strings. However, the most popular vèïa was the Kaùyapi vèïa which accompanied chorus songs sung by priests as well as the lady members of the families of the priests. Some times the priests would sing and the ladies accompany them on the instrument or dance in a group around the sacrificial fire. This means that these Yajòás of the Vedic times were joyous occasions celebrated by the people with great enthusiasm. It is obvious that these occasions gave ample opportunity for the people to innovate new forms of music and dance.

Chapter 7

ANCIENT SCHOOLS OF MUSIC

In the Vedic times there were six schools of music

1. Vedic or Sáma Veda school,
2. Gandharva Nárada school,
3. Døhiïa Brahmá school,
4. Muni Bharata school,
5. Nandikeùwara school,
6. Mátañga school.

We can consider that modern music really originated from the Gandharva Nárada School. Gandharvás were a particular group of people who dedicated their entire life to music. Some of the most famous names are Nárada, Tumbura, and Viùvavasu. They were responsible for the development of the classical form of Indian music by combining the features of Sáma Veda and Gandharva music. Details regarding this kind of music are to be found in a book called Náradiùèkúa.

The school of music which was basically responsible for the development of classical music as we know it today is the Muni Bharata school, also known as Nátya school. It was Bharata who collected materials from the Vedic and the Gandharva schools and amalgamated them into a highly structured form. Even today his book Nátya Ùástra is considered to be the basic text for Indian classical music. With the passage of time, folk melodies and tunes were also absorbed into the classical system, giving rise to the Mátañga School.

Chapter 8

MUSIC IN THE EPICS

There is mention in the epics like Rámáyaïa, Mahábhárata, Harivamùa and other puráïas that there were expert singers called sütás, who used to sing musical compositions during auspicious occasions and in the royal courts. The most famous of them are Lava and Kuùa who did Rámáyaïagána before Ùri Ráma himself. They are described in the Válmiki Rámáyaïa as follows:-

"The two brothers appeared like gandharvás, fully acquainted with all the rasás, knowledgeable in the science of music and experts in musical expressions like sthána and mürca. It is obvious that the twins had received full training in the art of music from Válmèki."

It is interesting to note that Muni Bharata in his Nátyaùástra describes a group of story tellers and wandering singers who went by the name of Kusèlava. These singers transmitted the knowledge from generation to generation and used to be accompanied by a vèïa while singing.

Kálidása also refers in Meghadüta to the Gandharva singers. There is a mention that the wife of the banished Yakúa was singing to the accompaniment of vèïa. The Sámagána and Gandharvagána very gradually merged together in the epic period to give rise to Márgagána which in turn evolved into classical music.

Chapter 9

MUSIC IN THE CLASSICAL PERIOD

It is generally believed that Indian classical music assumed its present form some time in the sixth century B.C. At that time there existed three main schools of music namely,

1. Náradèya gandharva school,
2. Nátya ùástra school,
3. Nandikeùwara school.

It is surmised that Muni Bharata flourished sometime between third century B.C. to second century A.D. It can be generally said that Indian classical music received its current systematic form with Bharata's Nátya Ùástra.

At the time of Muni Bharata the Rága system had already come into existence in the form of Jati and Gráma. However, the raga-rágini scheme had not yet come into existence. Nandikeùwara is usually considered to be the founder of the school of Rága- Rágini.

Until the Sixteenth or Seventeenth century A.D. the rága rágini scheme was known as the Janya- Janaka scheme. It is only during this period that Swara Saòcarás gave rise to classification of rágas, and new rága rágini scheme came into existence. This was the origin of the famous Melakarta scheme of the grouping of the ragas.

Chapter 10

RÁGA & TÁLA

Rága is a melodic scale or a set of notes used according to certain rules of musical grammar. There are twelve fundamental notes in Indian classical music in an octave. Of these, seven notes are called principal notes and five are called semitones. The seven principal notes are Ùadja (Sa), Øúabha (Ri), Gándhara (Ga), Madhyama (Ma), Paòcama (Pa), Dhaivata (Da), Niúada (Ni). These seven notes are spread over twelve semitones forming the twelve keys of a piano or harmonium making up an octave. Any key sounded on this instrument may correspond to Ùadja. The thirteenth key from that has a frequency double that of the first key. The interval between these two is called an octave.

In Indian music, the first and fifth note namely Sa and Pa are fixed, whereas the remaining five have two varieties. Thus, there are two varieties of Ri, Ga, Ma, Da and Ni.

A rága is built up of a combination of notes. A rága is not a mere combination of notes; it should also evoke emotions of some kinds. After experimentation, the founders of Indian music realized that there must be a minimum of five notes to qualify as a rága. These notes are not selected at random, but should obey a set of rules.

If we assume that we can create a rága with five notes out of seven, with the possibility of variations, it is possible to create in theory 34,848 ragas. Obviously not all of them qualify to be a rága, because a rága should exhibit aesthetic values also. Therefore, we hear only a few hundred rágas sung, of which only around fifty are popular.

There is one particular rága which uses the seven basic notes from Sa to Ni in sequence in the ascending mode and the same seven notes in reverse order in the descending mode. This is the famous raga Máyámálavagowla. This rága incidentally is used in south Indian classical music as the first rága to be learnt and practiced. The same rága is also used in Hindustáni music and goes by the name 'Bhairav'.

There are many rágas in the two systems of Indian music, the Hindustáni and Carnátic systems, which are the same but with different names. For example, Bhüpali in Hindustáni and Mohanam in Carnátic are identical so far as the notes of ascent and descent are concerned. However, their melodic pattern sounds differ because of the gamaka added to the notes.

The concept of raga is unique to Indian music. Once a rága is chosen for singing, it is not permitted to add any extraneous notes into it which is not part of its árohaïa-avarohaïa. If during the singing such notes are introduced by mistake or otherwise, the rága loses its emotional appeal. This is known as Rasabhanga or destruction of the mood. This applies only to strict classical music. It is however permitted to a limited extent in light music.

Chapter 10.1

TÁLA

Rága denotes melody, tála refers to rhythm. Each musical composition whether of Carnátic or Hindustáni system set to a particular rhythmic pattern is fixed at the time of the composition of the text which is sung. Tála is very strictly followed in Carnátic music whereas there is more flexibility provided in Hindustáni music. In the text of any Carnátic music composition, the place for each beat of the tála is prescribed in advance and the musician has to follow this strictly. This is the reason why one notices in Carnátic music concerts musicians marking tála by hands.

In Hindustáni music, on the other hand, the musician goes more by the rhythmic sound patterns of the tabla known as theka.

Chapter 10.2

RHYTHM AND MELODY

Rhythm and melody are very ancient elements of music. Melody is more ancient than rhythm. It is the natural outlet for sensation and feeling. Melody requires modulation of the voice, which is a basic characteristic of human sound. For example, when we are angry we raise our voice and when we are sad we lower it. At every stage we give expressions to our emotions in sound patterns. If the same modulation is resorted to in music also, the melody generated finds a response in our hearts. That is why we have different musical compositions for different emotional feelings. The basic notes chosen for any rága automatically give rise to certain emotional feelings to which we respond immediately. It is no wonder therefore that melody is considered superior to speech.

Rhythm forms an integral part of human life. There is rhythm in the rising and setting of the sun, which is known as circadian rhythm. There is rhythm in our breathing, heart beat. The human mind always responds to rhythmic patterns because, by nature we are used to the internal patterns. For example, when we hear a musical phrase, which is rhythmic in nature we naturally start tapping our feet or clapping our hands. It is this human tendency, which is exploited in full in music.

Rhythm is highly mathematical in character. The number of beats in a rhythmic cycle can be varied depending upon the capacity of the musician so long as the rhythmic cycle is maintained.

Chapter 11

MUSICAL FORMS

There are two musical forms generally recognized. They are the abstract form and concrete form. Abstract music is generally known as Nibaddha Saïgèta. The Aïibaddha form is also known as álápa, which gives an image of the form of the rága. Alápa manifests music without the limitations of rhythm and tempo. On the other hand, Nibaddha Sañgèta is associated with a literary composition, rhythm and tempo. Both the forms are used to evoke aesthetic feelings.

Alápa is a very ancient form of music. In the earlier times álápa, even though abstract, made use of texts like OM, HARI OM etc. In the medieval period mainly due to muslim influence meaningless letters came to be used like tum, nana, tere, neri etc. This tradition has continued till today, especially in the álápa of the northern style, and the tánam of southern style. One of the latest innovations is to sing tánam to a rhythmic pattern.

There are several types of musical compositions like Gána, Gèti, Sañgèta, etc. Some times all these three words are used as synonyms. The earliest interpretation was that the difference between gána and gèti was only in the fact that one of them was masculine and the other feminine. Many authorities however have rejected this. In some places, the word gána is used to indicate long compositions where as gèti is used to indicate short compositions.

The word sañgèta denotes a musical style, which is a combination of three arts, namely vocal and instrumental music, dance, drumming. It is only in recent times that dance has become a separate form from music, the latter being confined to vocal or instrumental music and drumming.

Chapter 12

VALUE OF MUSIC

Music is considered to be superior to all other forms of art. This does not mean that the other arts are valueless. It only means that music is the closest to life, unlike other art forms. For example any other art forms like painting, sculpture, etc. do not come naturally to human beings. But music is so integral to human beings that it spans from the crudest form of folk music to the most sophisticated form of classical music. The value of music in any society cannot be underestimated.

Indian musicology recognizes eight emotional sentiments and their corresponding moods as representing a set of values and beauty in music. These are called Stháyi-bhávás and are

1. Ùriñgára or love,
2. Hásya or laughter,
3. Krodha or anger,
4. Utsáha or courage,
5. Bhaya or fear,
6. Jugupsa or aversion,
7. Vismaya or wonder,
8. Ùoka or sorrow.

These bhávás find their best expressions in a combination of music and dance. However bringing out these bhávás in a musical concert is possible only by experts with manobháva.

It is generally expected that music should be pleasant to hear, evoking positive feelings in the listener. It is with this idea that classical music evolved, not only in India but also in the west. Non-harmonic music has never been accepted as a musical form in India whereas it has been experimented upon in the West. But it was realized very soon even in the West that unless music has the values of tone, tune, melody and rhythm, it can never appeal to the human ear. Therefore one finds today in all forms of music, classical, light, folk or even film music these four values emphasized.

Chapter 13

BENEFITS OF MUSIC

The human mind is emotional in character. It not only is the medium of expression of emotions, it also responds to emotional situations. Music forms a very important part of the expression of human emotions to which our heart responds immediately. For example, when a child is disturbed and is crying it is usually calmed down by the mother singing softly to the child. The easiest way of putting a child to sleep is by singing a lullaby to it softly.

The fact that music can be a soothing influence has been recognized for a long time and has played an important role in the development of music. It is such a powerful medium it has the capacity of capturing in one of the classical Sanskrit plays that King Udayana of Ujjain able to entice a deer through his music and capture it. There is no need to talk about the birds, because they themselves are natural singers.

Does music have any influence on plants? Many people believe so. Recently some studies were conducted in the Tamil University of Tanjore, on the effect of music on plant growth. But, the results have been inconclusive.

Music is also claimed to influence weather. For example, the raga Megamalhár of Hindustáni style and Amøtavarúini of Carnátic style are supposed to produce rain. Of course, no systematic scientific investigations are available.

The greatest benefit of music is in calming down the human mind. It has now been recognized that even natural sounds produced by birds, the wind and flowing water can have the effect of soothing the mind. This has given rise to a big industry of CD'S and Cassettes containing Nature music.

One of the most interesting developments in the field of the effect of music on human beings is the research being done in many hospitals in the United States on exposing unborn babies to western classical music. The entire hospital resounds to the soft strains of classical music. When a mother leaves the hospital with the newborn baby, she is gifted with a musical CD of soft classical music and advised to play it at home. Doctors claim that this has a profound influence on the development of the brain and the mind. Even in India a pregnant woman stays in an environment in which she is flooded with soft music. That is why so many family functions are organized in which women sing songs before the pregnant women.

Recognizing the importance of music in the development of human mind the **sVYASA** has developed an advanced technique known as **MEMT (MASTERING THE EMOTIONS TECHNIQUE)** in which bhajans sung melodiously are used to calm down the agitations in the mind or citta. The feed back from therapy participants practicing MEMT is highly encouraging. Thus it is seen that music can form an integral part of therapy also.

Chapter 14

CONCLUDING REMARKS

The subject of music is indeed vast there are many more aspects to music which have not been covered in this report. For example we have the parallel system of Western classical music, which developed independently of Indian music. But, this also makes use of the same seven notes. It is only recently that there has been recognition of the fact that there has been recognition of the fact that there are certain commonalities between these two systems of music. This was brought about by the famous recoding given by Pandit Ravishankar and Yahudi Menuhin. It is also recognized that Jazz music of the United States can be blended with Indian music, because both of them encourage improvisation.

In this sense this report is only an entry in to the subject. It is hoped that it will motivate others to go into the subject more deeply.

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ABSTRACT

Music forms an integral pat of the human culture. In India, music is considered to have originated from the Sāma Veda with its seven notes. Even though musicologists have given lot of importance to the recitation of the svaras, their arrangements in the form of rāgas etc., no attempt seems to have been made to study the spectral characteristics of the seven svaras.

Attempts have been made in the West to conduct such studies on the English alphabet. This has been done from the point of view of speech recognition and speech synthesis. The result can be seen in human voice reproduction by computer. Similar study on musical notes has not been done so far.

In this report we present some preliminary results of the spectral analysis of the seven notes of Indian classical music.

CHAPTER 1

INTRODUCTION

In the first part of this report, the origin of music and its developments through the ages in India has been discussed. Today, music is founded upon the concept of the seven notes with their half tones.

In this part of the report, an attempt has been made to analyze the spectral characteristics of these seven notes. This kind of study is currently available for the English alphabet, which is used in speech recognition and speech synthesis similar studies are also being attempted to analyze Sanskrit vowels and consonants with the same objective in view.

Very recently, in our own institution a study was conducted on the identification of the spectral characteristics of Omkāra. The work reported here refers to a similar investigation on the identification of the spectral characteristics of the seven svaras.

CHAPTER 2

AN OVERVIEW OF SPEECH COMMUNICATION

Speech communication has developed rapidly during the last few decades because of enormous progress in the field of Satellite Technology. However, its origins go back to the 18th century to the development of Fourier analysis, which is its basic Mathematical tool. Even earlier to this there had been many attempts to synthesize human speech through mechanical devices. However, it is only in the 20th century that scientists were able to understand how the human voice is produced or heard.

Modern research in this subject can be considered to have commenced in the 1930's with the invention of Pulse – Code Modulation, which was a practical digital transmission method for sound. This led to the invention of a Mechanical Synthesizer called Voder or Voice Coder.

Speech Analysis became possible in 1946 with the invention of the Sound Spectrograph, which could display the acoustic output of the human vocal tract. The 1950's saw the advent of Electronic Speech Synthesizers called Pattern Playback. Efficient digital speech coding became then possible, leading to the first human speech, synthesized by a Computer (2).

Within a short time, Digital Signal Processing became a major discipline (3). With the introduction of integrated circuits and the computer chips, there was an explosion in techniques of analysis and synthesize. Today, the Computer has become the major instrument for recording, analyzing and synthesizing human speech. Even though computational power has been increasing by leaps and bounds, major breakthroughs have become less common. However, research continues to be done to improve the available techniques.

In our study, we have made use of some of the latest techniques to record and analyze Saptasvarás, the seven notes in Indian karnátic Classical.

CHAPTER 3

LITERATURE

There is hardly any literature available on this subject. All literature dealing with the several aspects of music have been discussed in the first part of the report. The only study available on the spectral analysis of this type is that of Heisnam Jina Devi in the form of a dissertation submitted to the HINDU UNIVERSITY OF AMERICA, Florida. Details of this work are found in the reference cited in suggested reading.

CHAPTER 4

OBJECTIVES

The objective of the study is three-fold.

I)   Recording the Saptasvarás with the help of a sensitive microphone, digitizing the Analog Waveforms with the help of a Computer at the rate of 44100 samples/sec, analyzing the digitized data to extract information about the frequency and the energy spectra of the wave form and to identify the predominant frequencies.

II)   The study initially concentrates on the Saptasvarás recited by both male and female voices to understand the nature of the characteristics of the voices and the signals.

III)   To build up an archive of as many Rágas (in karnátic classical) as possible, for both male and female voices, their waveforms, energy-frequency spectra and frequency-time spectra.

The current study has concentrated itself only on these three objectives, since it is a pilot study. However in view of the results we have so far obtained, we can confidently extend the work to include.

CHAPTER 5

SPEECH ANALYSIS

Speech analysis is the process by which signal properties are extracted from a given speech signal. The objective of speech analysis is to extract features directly relevant to the application at hand, at the same time suppressing unwanted information. The original signal as recorded by a human voice may appear optimal from the point of view of speech recognition: but, it will contain a lot of repetitive data, which are brought out when processed by a Computer. Eliminating such redundancy makes analysis and interpretation easier. This also simplifies data manipulation.

An efficient representation of information, which helps speech recognition, is a set of parameters, which is consistent across speakers, yielding similar values for the same words uttered by different speakers.

A linguistic unit is called a Phoneme. Even though the set of parameters mentioned earlier should show consistency, they should also reflect the variation for different phonemes.

Speech analysis can be done either in the time domain i.e. operating directly on the waveform or in the frequency domain i.e. operating on the spectral transformation. Analysis usually is done over a limited time-range known as a Window. The choice of the window depends upon the time and frequency resolution. However, it is usually 100 seconds.

During slow speech, the shape of the vocal tract remains unaltered up to 200 milliseconds. However, if the signal is from a compound sound, the phoneme duration may come down to 80 milliseconds. Therefore, the procedure adopted usually is to divide the signal into short-time windows of approximately 100 milliseconds and analyze their spectra.

Analyzing speech in the time-domain has the advantage of simplicity in calculation and physical interpretation. This analysis transforms a speech signal into a set of parameter signals, which usually vary much more slowly in time than the original signal.

The frequency range for the human voice is usually from 20 Hz to 20000Hz. However, the contribution of frequencies above 8000Hz is usually negligible. Still, it is the practice to use a sampling rate of 44100/seconds. This gives us about 4000 samples for 100 milliseconds, the cut-off frequency being approximately 8000Hz. These are illustrated later in the chapter on Results.

For certain purposes, where speech recognition is as important as speech analysis, the frequency domain is used. This is all the more useful when there is likely to be a noise component within the periodic waveform. For example, the same word uttered by a speaker repeatedly is likely to show variations temporally, but the spectrum shows similarity and consistency.

Also, human recognition of speech pays more attention to the spectral aspects i.e. amplitude distribution relative to frequency, than time aspects. For example, if the same set of words is uttered slowly at a low pitch or faster at a different pitch, we are able to recognize the speech, neglecting the slowness or the speed of utterance and the pitch of the voice.

The traditional method of spectral analysis makes use of Fourier Transforms. These methods provide the speech representation in terms of amplitude and phase as function of frequency. Since speech is not stationary and depends on time, a short-time analysis using windows becomes necessary. The short-time- Fourier transform is thus an alternative speech representation.

When this transform is plotted with time on the horizontal axis and frequency on the vertical axis, with the magnitude indicated by degrees of shading, it is called a Spectrogram. In the spectrogram, weak energy is shown as white and very strong energy as black. All intermediate energies are represented by grades of gray.

Spectrograms are useful to identify the pattern of sounds produced. For example, it is easy to identify the fundamental frequency and its separate harmonics, known as Formants, with the help of a spectrogram, since they are displayed by thick dark bands separated from one another. The spectrogram is a three-dimensional representation of the signal, with frequency and time as the two axes and intensity of sound as the shades of grey.

The spectrum is usually generated by passing the signal through a bank of band pass filters. Each filter has a very small frequency range and passes only those component waves, which fall within this range. By altering the frequency range using different filters, one can easily obtain the distribution of sound-energy as a function of frequency. This is the energy-spectrum, in which the frequency is plotted on the horizontal scale and the sum of the squares of the amplitudes of the component waves is plotted in the vertical scale. Whereas spectrograms display the formants i.e. predominant frequencies and harmonics as thick bands of dark colour, energy spectra display the same as peaks. Thus, the two methods of representation are complementary to each other.

All these methods have been used in this study to analyze basic sound patterns.

DESIGN OF THE EXPERIMENT

The experiment consisted in recording the sounds of the swaras on a computer and analyzing in it. A sophisticated microphone attached to a desktop computer, fitted with a proper software was used or this purpose. The recordings were done in a room quite ambience. The level of background noise was low as seen from random recordings, as well as from the waveforms.

The recording was done for the ten male and female voices, of which six were selected, three male and three female. The criteria for inclusion were the steadiness of the voice and perfection of svarasthāna. All the six members received intense training in singing so that the recordings could be reliable.

Only the seven notes of the ārohaṇa were chosen. The Rāga was Māyāmālavagowla which is the standard used for musical training. It was felt that avarohaṇa would be redundant since for this Rāga avarohaṇa contains the same notes in a reverse order.

CONCLUDING REMARKS

This is a pilot study; the main purpose of the study was to start an activity, which has not been attempted before. As a consequence of this study if can be seen that it is possible to define the spectral characteristics the seven swaras for both male and female voices.

We see an internal consistency in the data presented, indicating that they are reliable and lead to dependable results. Such a study will help in voice synthesis and voice reproduction.