中国民间歌曲集成电脑音乐丛书（第一卷）

The Musical Curves and Tone Difference Data of the Mongolian Folk Songs

蒙古族民歌的音乐曲线和音差数据

蒙古族巴拉森 其礼印

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第一批书目

1. 蒙古族民歌的音乐曲线和音差数据
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建 筑 是 凝 固 的 音 乐

音 乐 是 流 动 的 建 筑

A Building is Solid Music.

Music is a Fluid Building.

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编者的话

一个新兴的交叉科学————"计算机音乐学"已经诞生并正在迅速发展壮大。电子计算机踏入音乐王国已有三十多年的历史了，事实表明，功能强大的计算机对于音乐的理论研究，对于作曲、演奏、声音的数字信号处理以及音乐教育等都是音乐家们极其有力的工具。

中国民间歌曲历史悠久，丰富多采，是我国音乐文化遗产的宝贵财富。目前，我国音乐界正在整理编辑出版《中国民间歌曲集成》，它的出版必将为研究、继承和发扬我国音乐的优秀传统奠定牢固的基础。《中国民间歌曲集成电脑音乐》丛书，将系统反映使用计算机研究《中国民间歌曲集成》中的民歌的研究成果。本丛书的第一卷是《蒙古族民歌的音乐曲线和音差数据》。随着研究工作的进展，我们将陆续出版其他各卷。

本丛书是奉献给音乐家、音乐工作者、音乐大专院校的学生和研究生的，对于从事或有兴趣于电脑音乐的计算机界的同行们也有一定的参考价值。我们衷心希望朋友们来关心、爱护和浇灌在音乐与计算机接壤的土壤上生长出来的这一朵小花。

From the Editors

It has been more than 3 decades since the electronic computer entered into the realm of music. A burgeoning interdisplinary study,computer music, has long come into existence and speedily developed.All facts show that a powerful computer is a highly effective tool for musicians in the fields of musical theoretical research, composition, performance, digital sound processing and music education.

The Chinese folk songs is a precious treasure of our national cultural legacy with a long history and rich and colourful tradition. Nowadays, a book entitled "A Collection of Chinese Folk Songs" is being compiled and collated by musicians in China, whose publication will surely lay a solid foundation for the study, inheritance and development of the fine traditions of Chinese music. "A Computer Music Series of Collected Chinese Folk Songs" will systematically represent the research achievements of the folk songs from the collection through computer. " The Musical Curves and Tone Differences of the Mongolian Folk Songs" will be the first volume of this series. With the development of the research work, other volumes will follow in succession.

This series is dedicated to musicians and students and graduates who are now studying in musical institutes, and shall also be valuable as reference books to those fellow workers in computer science area who are engaged and have interest in computer music. We sincerely hope that all our friends will have regards for and take good care of this new burgeoning seedling, which is growing in the soil of the borderland between music and computer science.

序

<div align="right">吕　骥</div>

　　运用电脑这个现代科技手段，分析我国民间音乐的构成、特色和它的结构形态，在我国，是近几年来新开发的科学研究方法。作为《中国民间歌曲集成电脑音乐丛书》的第一卷，中国民间歌曲集成《蒙古族民歌的音乐曲线和音差数据》一书出版，填补了我国电脑音乐科研著作的空白。深信一定会得到国内外民间音乐学研究人员以及广大音乐爱好者的收藏、研究。

　　运用电脑对我国传统音乐进行分析研究，今天还只是个别电脑科学技术人员的工作，我国民族民间音乐学科研人员，同样也只有少数人对这一方法感到兴趣。总之，运用电脑技术对我国民族、民间传统音乐进行科学研究，还处在萌芽探索阶段，因此分析项目还不多；另一方面，由于技术设备还不完备、不配套，有些项目还不能进行；但我们在这个新的领域，已经揭开了新的一页。深信未来必将随着研究工作的深入、向多方面发展而日臻完善。

　　今天，电脑分析，输入音乐，处理、计算等专门操作技术，还必须依靠电脑的专业科技人员，我们的音乐科研人员，对于电脑的运用，还完全是外行；而操作电脑的专业科技人员，同样，对于音乐理论基础知识，还缺乏了解，因此操作起来不免感到几分枯燥乏味。我想，这只是这项科研工作刚起步所不可避免的现象。随着时间的推移，事业的发展，音乐科研人员必将对电脑运用的各种技术，列入自己的学习计划之内。同时，电脑方面的科技人员中，也必将产生以音乐分析研究为专业的研究人员，音乐基础理论知识将日益提高。那时，这个新的研究领域就会更加迅速地发展起来。

　　电脑音乐分析进入我国民族民间音乐学研究领域，明显地将使我们的研究工作，获得更可靠的科学数据，同时也将大大减轻科研人员的计算劳动，大大缩短计算的时间，使科研人员得到更多的时间和更多的精力，从事深层的思考和探索。因此，可以说，这项科研工作对于发展我们的民族民间音乐学，是十分有利的，也是必将获得发展的。

　　我国民族民间音乐蕴藏极其丰富，各民族之间不仅语言文字差别极大，音乐的音调色彩，形式结构，也是多种多样的。民族民间音乐的科研任务极其繁重，如果不借用现代科研手段，其进展必然缓慢，也难达到应有的深度，难以适应客观要求。目前，这方面工作刚处于开发阶段，深望中央和各地方的音乐科研单位与各地音乐院校的支持，设立专门研究机构，列入科研计划，或设立学习专业，使电脑音乐分析科学，得到应有的发展，促进民族民间音乐科研事业更高的发展，以适应日益提高的社会主义民族音乐建设事业发展的需要。

<div align="right">1989. 9. 9</div>

Preface

In recent years, a new method of scientific research in the study of music has been exploited,that is,to analyse the formation, structure and characteristics of Chinese folk songs by means of a computer , the modern medium in scientific and technological research. The publication of the book entitled " The Musical Curves and Tone Difference data of the Mongolian Folk Songs ", as the first volume of "A Computer Music Series of Collected Chinese Folk Songs ", may be cited, which marked the filling of the blank in the scientific research works of computer music in our country. This, I believe, will certainly suit the fancy of the broad musical public and musicologists at home and abroad , who will surely appreciate the book and be willing to preserve and study it.

For the present day, however,the work of analysing and studying traditional music by means of a computer is only confined to a few computer scientists and technicians; similarly, only a small number of musicologists take interest in this method. In short, the work is still in a period of emergence and exploration. Consequently, the range of its analysis is so far limited, and some of the items on the research agenda cannot even be initiated owing to the lack of complete and adequate provision of equipment . Nevertheless, a new page has been added to the history of music in this field; and I am confident that in the near future, the research work of computer music will assuredly deepen and develop in many aspects, and grow into a newer phase of perfection.

Today, we still have to rely on professional scientific and technical workers in computer science for the operational technique in the field of computer analysis; the inputting, processing and calculation of musical information and data , for most of our scientific research personnel in music are new to computer operations. In like manner, those who are engaged in scientific and technological research of computer science are also lacking more than a rudimentary knowledge of musical theory, and therefore, might more or less be bored by such operational work.but I think this is merely a transient phenomenon , which will happen just when the work is at the start. With the passage of time and the de-

velopment of the research work, the scientific research personnel in music will place the various computer techniques within the lists of their own study plan; while a number of researchers who take the analysis and study of music as their personal speciality will undoubtedly spring up from among the scientific and technical personnel in computer science, and their knowledge in the basic theory of music will steadily be on the increase,too. It is, therefore, inevitable, that the day will come when the study in this new field shall make headway with a higher speed.

It is quite predictable that with the entrance of musical analysis using a computer into the realm of research work of our national folk music, we shall be able to acquire more accurate and authentic data for our scientific research, and shall at once have the possibility to alleviate the labour and reduce the time of calculation of our scientific researchers to a great extent, thus saving them more of their time and energy to deal with contemplation and exploration at a higher level.So the work in this field, will, as it were, be greatly conducive to the development of our national folk music and is bound to have a valuable future .

Our national folk music has abundant treasures, in which there is a great diversity among the various nationalities , not only in their languages, but also in their tone colours, formations and structures of music. As a result, it is obligatory that the researchers of our national folk songs be committed to the arduous task of scientific research in this respect; that is, to bend their effort to the operation and application of computers for the study of our national folk music. Without resorting to this modern medium of scientific research, we would be too slowmoving in our progress, and could not hope to attain the necessary depth and to meet the objective requirements in store for us. We are now yet in a period of exploration and exploitation. We sincerely hope to gain the support of the central and local musical institutes and conservatories of various levels. We hope that they can set up relevant special organizations to be in charge of this work and include it within their program of scientific research, or establish some new specialities to set the musical computer analysis rolling on accordingly, thus pushing forward the cause of scientific research in the field of national folk music with an accelerated development, in order to satisfy the growing requirments of socialist construction for national folk music.

Lu Ji
Sept.9,1989

前　言

　　　音乐家在研究民歌或其它音乐作品时，常常需要使用分析的方法，分析一首歌曲的曲式和构成曲调的各种基本要素（如调式、音阶、节奏、节拍、装饰音和典型乐汇等）及其相互关系。在分析的基础上，再进行比较、归纳，找出一个民族或一个地区的民歌的风格特点。这项工作若全部用人工来作，工作量非常大，往往不易获得足够的，可靠的数据，而且作结论有时也难以避免受到研究人员主观感情因素的影响。因此，为了促进我国民歌和其它民族民间音乐的研究工作，我们感到有必要运用电子计算机这--先进的工具，使之成为音乐家的得力助手。为此，几年来，我们在吕骥等许多音乐家和有关单位的大力支持下，在这个领域中进行了尝试，对信天游（155首），蒙古族民歌（150首，为了便于比较研究，其中还包括部分爬山调和漫瀚调）和中外名曲（45首）使用计算机进行了分析研究。方法是先将歌曲及其有关资料编码输入计算机，建立数据库和素材库，然后根据分析项目的要求，编制相应的程序存入计算机，并运行程序，输出有关的分析结果。到现在为止，我们已建立起一个程序库，其中包括乐谱输入程序，简谱打印程序，音乐曲线绘制程序，音符统计程序，音差序列建立和音差、邻差统计程序，起音、结音和音列统计程序，旋律分类程序，旋律和节奏的复杂性分析程序和旋律相似性分析程序等。以上程序已产生了很多的数据和结论。本书反映了对蒙古族民歌进行分析研究的以下两方面的结果：

　　　1. 音乐曲线.

　　　音乐曲线是对每一首歌曲，以音高为纵坐标，以音的时值为横坐标，在二维空间绘出的曲线。这种曲线也可以看作是一种新的记谱法，在显示音高和时值变化的准确性和直观性方面，比现有的任何一种记谱法都要好。例如，在音乐方面，五线谱记法中，升降音与原位音是在同一高度上，面在我们的音乐曲线图中，不仅能把原位音和变化半音分别表示出来，而且能反映四分之一音的变化。在时值方面，五线谱中是采用符号表示，而在曲线图中时值的相对长短、起止，都能非常清晰地显示出来。"音乐是流动的建筑"，音乐家将能从每首歌曲的曲线图更加直观、更加深刻地感受到。音乐家常要分析歌曲的旋律线的形状和旋律的种种发展手法，如同音反复、级进、跳进、模进、倒影、扩展、压缩和对比

等都可以从曲线图上清晰地看出；节奏的急促、徐缓在曲线图中也能明显地呈现在你的眼前。两首歌曲或两首歌曲的片断在风格上的异、同或相似，只要对比它们的音乐曲线，常能得到不少有意义的结论。可见，音乐曲线图这样一种记谱法是音乐家分析研究音乐的一种很好的工具。

2. 音差统计

音差序列是一首歌曲每相邻两个音的音高之差（以全音和半音计）所形成的序列，它从一个方面反映了歌曲音程的变化。音乐家在分析音乐时，常常需要了解一首歌曲的全部或部分的音程序列，揭示出这种序列的特点。音乐家也常常需要找出一首歌曲中或一个地区民歌中各种音差，比如四度以上大跳的出现次数等。所有这些都可以从音差统计表中得到。

在音差序列的基础上还给出了邻差的统计表，邻差反映了相邻三个音的音程关系。这是由于具有某种特征的三音列在一首歌中有着特别重要的意义。例如有的地区的民歌曲调中，一个大二度和一个纯四度相联结构的三音列是该地区民歌的重要特征之一。各种性质的三音列在一首歌曲中出现的次数都可以容易地从邻差的统计表中得到。

我们仅以此书献给音乐家。对于从事蒙古族民歌研究的音乐家，我们希望本书将成为你们进行研究工作的工具和资料，在对它们进行简单的推理，计算和比较后，将能够得到你们所需要的结论；或它将有利于你们提出新的研究项目，由你们自己或由我们编制程序，直接利用我们已经建立好的民歌的数据库、素材库中的数据得出新的结论。对于其它音乐家，我们希望本书将向你们展示使用计算机分析研究音乐的一种方法，从中得到启示。并欢迎向我们推荐你们所研究的歌曲，我们也可以向你们提供你们所需要的数据。

我们的工作还刚刚开始，本书也仅具有抛砖引玉的性质。我们衷心希望音乐家和我们计算机工作的同行携手合作，提出更多的研究课题，更好的研究方法和更多的建议，使计算机在音乐分析和其它各方面的应用能更加迅速地发展起来。由于我们对音乐知识了解很少，本书中一定存在不洽当甚至错误之处，希望能得到音乐家，计算机同行和广大读者的批评指正。

Foreword

In his study of a folk song or other musical works, a musician often has the need to use the techniques of analysis to understand its musical form,the various fundamental elements that constitute its tune (the mode,the scale,the rhythm,the metre, the grace, the typical melodic members, etc ., for example) and their mutual relationships; and on the basis of this analysis, through further comparison and generalization, he shall be able to find out the stylistic characteristics of the folk songs of a nation or a region. However, this work is particularly complex and tedious. If it is to be done all by hand, the workload will be too onerous and troublesome; and more often than not, it will be quite unlikely to have the authentic and adequate data secured. Moreover, it is sometimes inevitable that the conclusion thus drawn will too easily be subjective under the influence of the researcher's personal perceptions. This being the case, for the purpose of promoting the research work in our national folk songs and other folk music , we feel obligated to use the advanced modern medium , the electronic computer, in our research work, so as to render a great service to the musicians . With this end in view, we have made some attempts in this field in recent years under the complete support of the famous musician Lu Ji and other musicologists and relevant organizations. We have conducted some analytical research through a computer, into 155 songs of the Xintianyou (a kind of Chinese folk song), 150 Mongolian folk songs and 45 famous songs of China and foreign countries.(In order to make it easier to have a comparison , we have included in the Mongolian folk songs some parts of the Pashandiao (a kind of Chinese folk song) and Manhandiao (a kind of Chinese folk song) and other non–collected Mongolian Songs).The steps we have taken are: first to encode the songs and relevant materials, and input them into the computer, so as to establish the database and material base; then to create appropriate programs according to the demands of analytical items into the computer;and lastly, to operate these programs and output the required results of analysis. As of the

present we have established a program library, which includes a program of music score input, a numbered musical notation printing program, a program of drawing the musical curves, the program of the notes statistics, a program of establishing the tone difference sequence and statisticizing the tone differences and adjacent tone differences, a program of statisticizing the beginning and ending notes and note series, melody—classifying program , a program of analysing the complexity of melody and rhythm, a program of analysing the similarity of melody, etc. A considerable amount of data and conclusions have now been drawn from the abovementioned programs. This book is hereby to represent the outcome of the analytical research into the Mongolian folksongs in the following two aspects:

1. Musical Curves

The musical curves are curved lines drawn for each song in the two—dimensional space with the pitch of the note as the vertical coordinate and the duration as the horizontal one. This curve diagram may also be regarded as a new type of musical notation, which shows a higher accuracy and clearer visualization in pitch and duration than any of the present notations. In the notation of staves, for example, the sharp and flat notes are indicated on the same line or space as the natural one ; but in our musical curve , not only can the natural note or the altered semitone be distinctly indicated, but even a quarter tone can also be lucidly displayed . In the notation of staves , the duration of a tone is indicated by different note shape ; but in the musical curve, the relative length of duration and the beginning and end of a note can all be vividly shown.It is said that music is a fluid "building", but this fluidity shall be more visually and more thoroughly perceived by a musician through the musical curve of a song . Furthermore, a musician often wants to analyse the melodic line of a song, and to understand the various means of the melodious develop—

ment, such as the repetition of the same tone, the step-wise progression, the skip progression,the melodic sequence, the mirror, the extension, the compression,the contrast, etc., all these can be clearly seen on the musical diagram. Even the quickness or slowness of a rhythm can also be palpably shown before your eyes.A comparison alone, between two songs or the fragments of two songs in their musical curve, will enable you to see their stylistic identity, difference or resemblance , through which you can often form a number of significant conclusions. Thus, it is obvious that the musical curve diagram is a new type of notation which can render a greater service to musicians and musicologists in their research and analysis of musical works.

2. Data of Tone Differences

The sequence of tone differences is a series of pitch differences (to be counted by a whole or half tone) between every two adjacent notes of a song. It reflects the song's interval changes in one aspect . In analysing a musical work , the musician often needs to understand the whole or part of the interval sequence, so as to discover the characteristics . Likewise, he often needs to find out various tone differences of a song, or the folk songs of a whole region, such as the frequency of wide leap for fourth, fifth, sixth and so on. All these characteristics can be obtained through a statistical table of tone differences.

On the basis of the tone difference sequence, a statistical table of the adjacent tone differences can also be worked out. The adjacent tone difference represents the interval relations of three successive tones . This is very important because in a song,the three successive tones often have a certain characteristic which is of particular significance. For example, in the tunes of folk songs of a certain region,there is a combined structure with one major second and one perfect fourth forming the adjacent three tones, which becomes one of the most

important characteristics of the folk songs of that region. Through the statistical table of the adjacent tone differences, all descriptions of three successive tones occurring in a song can be easily obtained.

We are going to dedicate this book chiefly to the musicians. To those who are engaged in the study of Mongolian folk songs, we hope that this book will serve them as an instrument and a reference material, and enable them,through simple reasoning , calculation and comparison to draw the necessary conclusions they require ; or otherwise , it will help them to find out new research themes; and directly making use of the data from the database or material base of folk songs we have already established , through programs written by you or by us, to draw new conclusions for their research work . To other musicians, we hope that this book will give them the suggestion that to use a computer would be a new approach to their research and analysis of music. We welcome them to recommend to us the songs they have researched ; we are willing to provide them the data they want.

Now our work is just at the start; and this book is also a mere attempt that entails better works in the field of computer music, just as the Chinese proverb says ," Cast a brick to attract jade". We sincerely hope that there would be many musicians , as well as our collegues of the computer science circles , who would collaborate with us, providing us with more research items, more suggestions and better approaches to make the application of computer to the work of musical analysis and other areas enjoy a more rapid development . Owing to our smattering of musical knowledge , there must be many errors and even absurd mistakes in our book. We hope that the musicians,and those who are engaged in the work of computer science , as well as our reading public, will give us their criticism and comment, so as to enable us to make the necessary revisions in the next edition.

音 乐 曲 线 图 符 号 说 明

<1> 每首歌曲被人为地分成若干组,在图形的下方有一排离散的数字标明了组号,在图形的最下面有×作为组的分界符号,这个符号往往与小节线|重合面形成↓.

演唱顺序标明了演唱时的组号顺序,以 30 作为结束．对演唱顺序以"不重复,不遗漏"的原则进行选择,得出作图的顺序.

<2> 演唱顺序的下一行先标明了调号,然后标明拍子:PZ＝a／b 表示以 b 分音符为一拍,每小节 a 拍,++表示散拍子．速度 T＝XXX 表示每分钟唱XXX 拍．一首歌中有多种调号、拍子、速度时,都一一标出．

<3> 在图形中有横、竖虚线格．横向每大格是一拍．在图形内的最上一行标明第几拍．每一大格中又分四小格．

竖向每小格为半音,两小格为一全音．

"*":表示中央 C,其上方有五条较密的虚线分别对应高音谱表的五条线(E,G,B,D,F)．因为每两条线之间的距离与音差有关系,所以这五条线是不等距的．

<4> 图内的第二、三行标出了该列下面所对应的图形曲线上音的修饰信息．它们的顺序是先左后右,先上后下．

N：表示从该音符开始直到改变以前的音符都唱常音．
L：表示从该音符开始直到改变以前的音符都唱连音．
⌒：表示该音任意延长．
↗：下滑符号．
↘：上滑符号．
,：乐句．
.：乐段．
>：渐弱开始符,直到渐强结束符或渐弱结束符"|"出现为止．
<：渐强开始符,直到渐强结束符或渐弱结束符"|"出现为止．
∨：呼吸符号．
∿∿：颤音符号．
∧：顿音符号,表示从该音符起直至改变前的音符都唱顿音即唱指定长度的3／4.
‖：反复记号,该记号成对地出现.

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