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InLOrk: The Indian Laptop Orchestra

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Abstract. The Indian Laptop Orchestra (InLOrk) presents a different way to program Indian music and presents examples of computer-based music-making, through the lens of computer music. InLOrk is a collection of computers designed for the performance of Live Coding and collaboration to generate Indian musical compositions. It is the culmination of a research work on Computer Music at Department of Computer Science, Punjabi University, Patiala, where researcher amalgamates computer science, Indian music and digital music producing techniques into an immersive Laptop ensemble. Members of InLOrk are trained to code new ensemble pieces using the Chuck audio programming language, and to perform with their laptops, computers and other digital devices, which aid in the development of new Indian digital instruments. This paper describes the process of designing this orchestra with Chuck's built-in instruments, such as Mandolin, Flute, Shakers as well as custom built Indian digital percussion instruments, such as Tabla, Geje, Marindanga and Ghatam.

Keywords. Computer music, Laptop Orchestra, Music Technology, Chuck audio programming

1 Introduction

The Princeton Laptop Orchestra (PLOrk) was founded in 2005 by Dan Truman and Perry Cook [1], opening up new avenues for computer music composition, performance, and education. Ge Wang, a key component of PLOrk, established The Stanford Laptop Orchestra (SLOrk) in 2008. This ushered in the "Age of Lork" and stimulated the creation of the world's first assortment of laptop orchestras [2]. The Laptop Orchestra (LOrk) explores new possibilities for computer-mediated musical performances by bringing together traditional musical contexts with cutting edge technology. Additionally, the LOrk explores innovative artistic and pedagogical

possibilities in computer programming, live performance, music composition, and digital instrument design [3].

LOrk ensembles have traditionally focused on Western practices and compositions, and very little work has been done with Indian music. Another research is highlights this western even more [4].

From its inception to the present, Indian music has undergone numerous stages of changes and adjustments. It has both accepted and resisted a great deal of modernity in order to preserve perfect harmony with archaic customs [5]. Particularly when contrasted to Western music traditions, Indian music traditions are highly distinctive; they have produced a wide range of original instruments, music forms, musical practices, and compositions. The Indian subcontinent's diverse musical genres provide a great platform for testing computer music research methodologies. Inspired by all of these initiatives, we set out to create our own laptop orchestra within the framework of Indian music. The project's main goal is to employ Chuck audio programming to create new music in the Indian tradition.

2 Composing with Coding using Chuck Audio Programming

In essence, music is the result of combining instruments and human voice. Melody instruments and percussion instruments are the two categories of musical instruments. If playing traditional instruments and singing live on stage is one aspect of the performance, the other is capturing the music on various storage media and utilizing computers to play it. The following categories apply to computer-based music, or computer music:

1) Use Record/Edit/Sequence tools software tools, also called Digital Audio Workstations (DAWs). Music composers and arrangers often employ one or more of 20 software programs in recording studios, such as FL Studio, Cubase, Logic Pro, ProTools, Reaper, and Audacity.
2) A different technique makes use of Audio Programming Languages, which are specialized computer programming languages. Western artists embrace these languages and use them extensively in the Western music system. Thanks to the growth of digital technology, laptop ensembles in the context of Western music have undergone great development over the past 20 years. The selection of compositions and rhythmic patterns was limited to Western music. It was crucial to select Indian tunes and source materials for the Indian Laptop Orchestra, which is performed live and is programmed using Chuck.

Because of its underlying design, the ChucK programming language is enables the expressive creation, performance, and experimentation of audio and music. With this on-the-fly programmable system, code may be written, edited, compiled, and executed

in real time. With ChucK programming, composers can alter their modules, fine-tune sounds, and swap out composing pieces without having to restart or stop the sound. This makes programming code a real-time expressive tool. It works well for engaging with and managing any kind of digital media, including MIDI, robotics, graphics, and other devices that can communicate with computers. Chuck enables On-the-fly programming with accurate timings and concurrency [6].
Since the author actually sings the voice track live, the programming effort has only concentrated on the instrumental portion. Mandolin, sitar, flute, and other percussion instruments are used in the melody track, while drums, tabla, and other percussion instruments are used in the percussion track.

3 An Experiment on Indian Traditional Composition: *JanaGanaMana*

The engineering process behind creating Indian light music using the audio programming language ChucK, specifically through the composition of Rabindranath Tagore's National Anthem of India, "Jana Gana Mana," with an emphasis on computer music creation by the Indian Laptop Orchestra (InLOrk). The process is divided into three main phases: Music Composition/Design, Technical Design, and Implementation. Let's break down these phases further for clarity: Music Composition/Design Basic Melodic Instrument Tuning: This involves the fine-tuning of instruments to achieve the desired pitch and harmony for the composition. Tuning is critical for ensuring that the melodic instruments are in sync with each other and produce a harmonious sound.Timbre Selection: The timbre, or characteristic sound, of wind, string, and bowing instruments is selected to match the emotional tone and style of the piece. This selection is crucial for creating the intended atmosphere and emotional impact of the music. Percussion Instrument Choice: The composer decides between using Western percussion instruments (like drums, snares, and hi-hats) or Indian classical instruments (like tabla) based on the composition's needs and the desired sound palette.

Technical Design (Music Engineering) Digital Instrument Selection: After the music design phase, the task of music engineering is to select the appropriate digital instrument for each part of the composition. This decision is influenced by the initial music design, ensuring that the chosen digital instrument accurately represents the intended sound of the physical instrument it emulates.

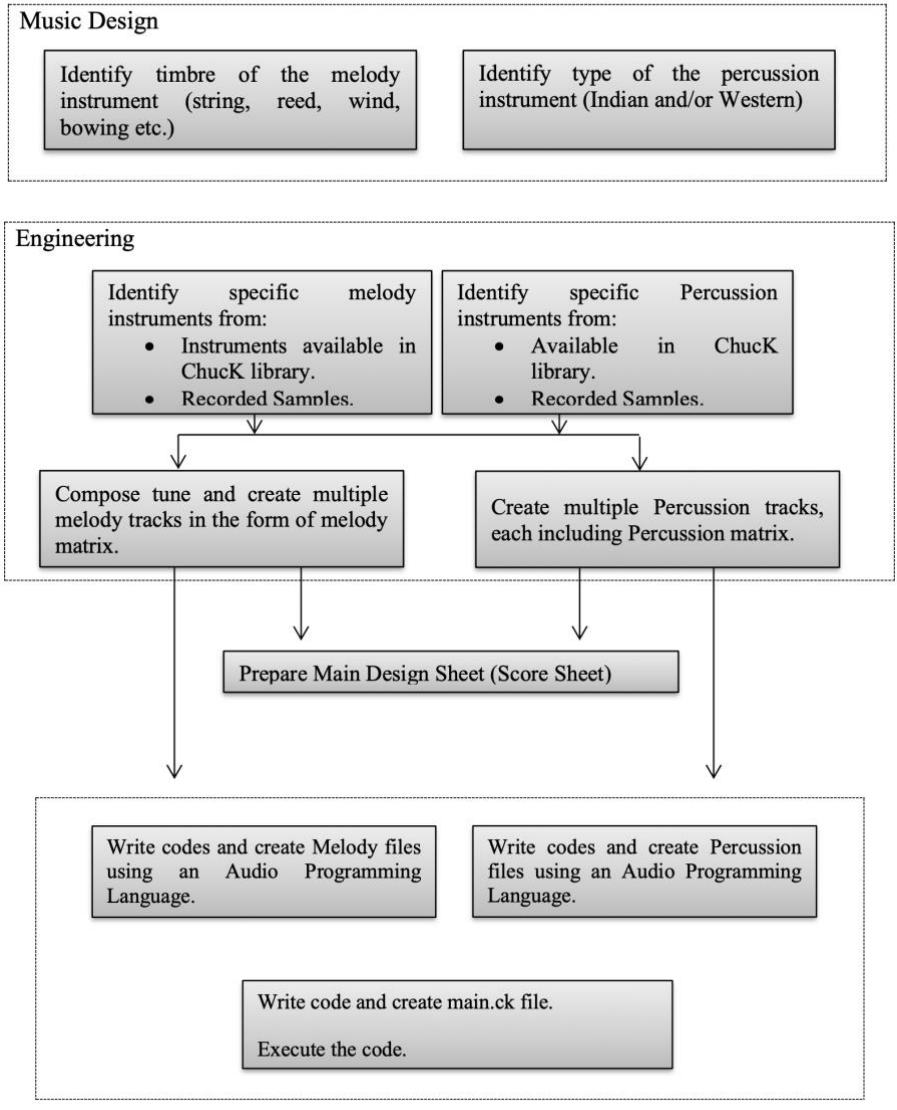

Fig. 1. Music Generation Phase.

Instrument Representation: Whether a string instrument from the music design phase should be represented digitally as a violin, sitar, mandolin, or guitar is decided here, ensuring the digital sound closely matches the chosen physical instrument's timbre.

Implementation

Melody and Percussion Tracks: The implementation phase brings the composed music to life. It involves creating a number of melody tracks, each focused on a different

melodic instrument. These tracks are organized using a "melody matrix," which helps in managing the complexity and ensuring that each instrument's role in the composition is clear and distinct. Similarly, percussion tracks are created and organized using a "Percussion Matrix," ensuring that the rhythm section of the composition is cohesive and well-structured.

Additional Insights:
Melody Matrix (Section 3.1): This feature likely involves a systematic approach to organizing and managing different melodic lines within the composition, possibly through software or a conceptual framework that allows the composer and engineers to visualize and manipulate the interaction of these lines.
Percussion Matrix (Section 3.2): Similar to the melody matrix, this system organizes percussion tracks, likely providing a framework for composing, arranging, and synchronizing rhythmic elements within the piece.

3.1 Melody Matrix for the Composition

Chuck refers to the Melody Matrix (see Table 1) as the foundation of the InLOrk Compositions, which are used to create music. Melody Matrix essentially provides the characteristics of each note that is to be performed. The three primary characteristics are: gain, which denotes the note's intensity or volume; note number, which defines the frequency that must be generated; and duration, which determines how long the note must be played.

TABLE 1. MELODY MATRIX.

Note	Duration	Gain	Other attributes
N1	d*	1	Reverb
N2	2d	0.5	
N3	4d	1	Reverb
N4	8d	0.5	
N5	6d	0.5	Echo

*d is the Basic Melodyd is the Basic Melody Unit (BMU) duration. A BMU is a note that has a set frequency. The length of the BMU is determined by the requirements of the composition. Each BMU in the JanaGanaMana melody track is combined into a Basic Melody Sequence Unit (BMSU). The Chuck software selects the element from

each matrix row and generates the music. Mandolin and flute, two of Chuck's built-in instruments, are used to compose JanaGanaMana.

The notation part of the song represented as:

Ja	**Na**	**Ga**	**Na**	**Ma**	**Na**	**Ad**	**Hi**	**…**	
[61, 8]	[63, 8]	[65, 8]	[65, 8]	[65, 8]	[65, 8]	[65, 8]	[65, 8]	…. .]	@=>int swara[ ][]

3.2 Percussion Matrix for the Composition

The basis for producing the beats' rhythmic patterns is the same principle that the percussion matrix (Table 2) uses in conjunction with the melody matrix. The beat number, duration, and gain are the common characteristics of a percussion matrix. Echo and reverb are optional features that give the note a unique effect. The two components that give the matrix structure are the Basic Percussion Sequence Unit (BPSU) and the Basic Percussion Unit (BPU). Multiple BPSUs can be used in a percussion track.

TABLE 2. PERCUSSION MATRIX.

Beat	Duration	Gain	Other attributes
B1	d*	1	Reverb
B2	2d	0.5	
B3	4d	1	Reverb
B4	8d	0.5	
B5	6d	0.5	Echo

The ChucK library offers a vast array of sounds for western percussion. However, using Indian Percussion Tabla—the beating heart of Indian music—was essential to creating InLOrk. In order to do this, as seen in Figure 2, the seven strokes are captured and saved in the computer in the format of .wav.

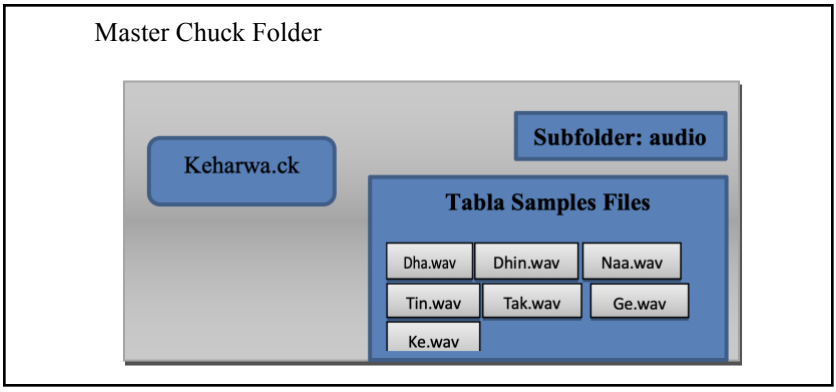

Fig.2. File structure of Percussion Instrument Tabla used for Project.

By using SndBuf to import the necessary samples from the audio folder and by putting together a full file path and file name, three Tabla Patterns are produced. Similar to tabla, the samples of gejje, maridanga, and ghatam from other Indian instruments are recorded in a studio and prepared for the live performance.

Over five Indian musical compositions have undergone successful testing in order to use the aforementioned constructed technology. This work presents one composition from among them. The melody and instrument track used to compose JanaGanaMana are displayed in Table 3 that follows.

TABLE 3. JANAGANAMANA INSTRUMENTAL TRACKS.

Category	Indian Anthem
Language Original Song	Indian National Language - Hindi
Title	*JanaGanaMana*
Total Duration	1 minute 31 seconds
Voice track	Performed Live
Number of Melody Tracks	2
Melody Instruments used	Mandolin and Flute
Available in Chuck Library	Mandolin and Flute
Numbers of Percussion Instruments used	Tabla, Western Drum, Shakers, Mridanga, Gejje, and Ghatam
Available in Chuck Library	Shakers and Drums
Samples Recorded	Tabla, Mridanga, Gejje, and Ghatam

4 First InLork Performance

Members of the orchestra convened at the music studio of Punjabi University to execute a novel form of composition in which laptops and computers are utilized as musical instruments. This piece is the first attempt to build a single music world using MIDI (controlled by Chuck) and a group live performance (3 persons and laptops) (see Figures 3 and 4).

Fig. 3. First Indian Laptop Orchestra (InLOrk) Performance.

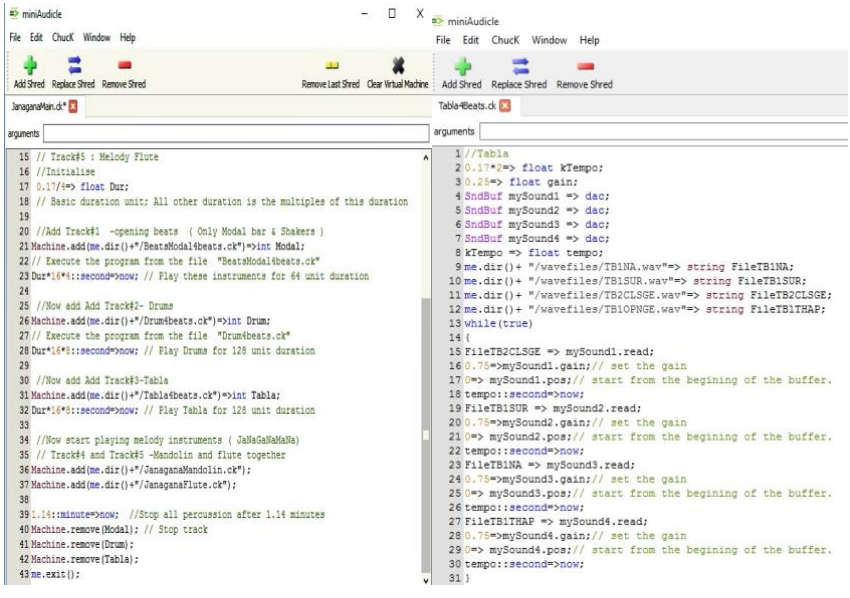

Fig. 4. Coding for InLOrk.

The YouTube video [7] for the InLOrk Final Performance is titled "Indian Laptop Orchestra (InLOrk) - where Technology meets Music." In addition to the enjoyment that comes with creating music and writing creative code, InLOrk aims to monitor the context, culture, and societal implications of the fast-evolving field of computer music. The group actively looks to work with researchers and artists in India, with the goal of contributing to the local computer music scene.

5 Conclusion and Future Work

The efforts described here have added significantly to the Laptop Orchestra field. Nonetheless, one of the most innovative aspects is using the advanced technology to create live performances of Indian compositions created using computer music programming. A variety of rhythmic patterns were created and exported as .Wav files using recorded Tabla, Gejje, Mridanga, and Ghatam samples. These files can be utilized as loops for studio recording as well as live performances. Western music has served as the primary inspiration for a large portion of computer music research. This study thoroughly explores using programs and resources created within the Indian music setting.

Additionally, live coding is used to construct the first-ever Laptop Orchestra performance in India. To the best of our knowledge, InLOrk is the first work that transcribes and performs traditional Indian music using code written using programming abilities. The corpus of work showcased here is a true artistic endeavor that draws on programming expertise and experience from a variety of musical genres. It has empowered musicians, enriched audiences, and fostered creativity through the use of the ChucK audio programming language

Many different musical instruments that are connected to certain Indian states and cultures can be heard in Indian music. Indian classical instruments including the tabla, gejje, mridanga, ghatam, piano, flute, sitar, and mandolin have traditionally been the focus of the InLOrk system for music compositions, audio programming, and live performance. Implementing additional Indian melody and percussion instruments is the next stage of this effort. Furthermore, just five of the more than 300 tabla strokes used in Indian music are used for the final performance. The rest need to be investigated.

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This book presents a collection of selected papers that present the current variety of all aspect of music research, development and education, at a high level. The respective chapters address a diverse range of theoretical, empirical and practical aspects underpinning the music science and teaching and learning, as well as their pedagogical implications. The book meets the growing demand of practitioners, researchers, scientists, educators and students for a comprehensive introduction to key topics in these fields. The volume focuses on easy-to-understand examples and a guide to additional literature.

Michele Della Ventura, editor

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