Mountain Guitar: a Musical Instrument for Everyone

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ABSTRACT

This instrument is a part of the "Gangu Project" at IAMAS, which aim to develop digital toys for improving children's social behavior in the future. It was further developed as part of the IAMAS-Interface Cultures exchange program.

"Mountain Guitar" is a new musical instrument that enables musical expression through a custom-made sensor technology, which captures and transforms the height at which the instrument is held to the musical outcome during the playing session. One of the goals of "Mountain Guitar" is to let untrained users easily and intuitively play guitar through their body movements. In addition to capturing the users' body movements, "Mountain Guitar" also simulates standard guitar playing techniques such as vibrato, choking, and mute. "Mountain Guitar's" goal is to provide playing pleasure for guitar training sessions. This poster describes the "Mountain Guitar's" fundamental principles and its mode of operation.

Keywords

Musical Expression, Guitar Instrument, MIDI to sensor mapping, Physical Computing, Intuitive Interaction

1. INTRODUCTION

1.1 Background

"Mountain Guitar" is inspired by the observation that professional guitar players often exhibit strong body movements during their performances. Taking this into consideration, we aimed to develop an interface that lets untrained users experience the pleasure of guitar playing by using their own body movements. Normally, professional guitar players hold the chord by their left hand and pick the strings with their right hand. They also move their guitar up and down when they play a vibrato. These subtle musical expressions are very important for the quality of the overall sound and performance. However, these expression are difficult for learn for inexperienced users. To solve this problem, we conceived the "Mountain Guitar" project wherein pitches of the sound change according to the height at which the instrument is held. The overall goal was to design an instrument for non-musician and beginners. The concepts behind "Mountain Guitar" are threefold, it aims to be:

1. An instrument that is played by moving the entire body. One aim is to create "music expression using the whole body".

2. An instrument that allows one to experience pitch. The instrument should enable users to recognize sounds not only through the ear but also through the entire body.

3. An instrument that allows one to join a jamming session very easily. The instrument should become like a communication tool through which one can jam easily with others.

1.2 Related instruments

Related MIDI guitar instruments are for example the Virtual Air Guitar [1], GXtar [2], and the AirGuitar02 [3]. Virtual Air Guitar [1] is an interface that resembles "Mountain Guitar" in that anyone can play rock guitar with little musical skills. It has no strings and the pitch is changed by the hand and finger positions of the left hand, GXtar [2] uses a real guitar as body and in addition, a FSR (Force Sensing Resistors) sensor and a 3Djoystick are attached to the body. It also has no strings and the pitch is controlled by finger position and finger pressure. AirGuitar02 [3] also controls the pitch through the finger positions on the strings. Le SuperPolm [4] is a MIDI violin instrument, but it also controls the pitch by finger positions. Additionally this instrument responds to body movements.

1.3 Advantage of the "Mountain Guitar"

Although there is some similarity to the previously described instruments, which also use pitch controllers on the left hand, "Mountain Guitar" is different as it links the control pitch to the height at which the instrument is held. Through this feature, everyone, even untrained users can play the "Mountain Guitar" very easily, as one can play it just by moving ones own body and there is no need to learn finger techniques on the strings. "Mountain Guitar" tries to feedback intuitive body action directly to the creation of the sound, and in addition one can also shake, knock and press this instrument.

2. The "Mountain Guitar" prototype

2.1 Sensors and system details

The current prototype is made of foam polyurethane and it includes the following sensors:

- Optical sensor (height recognition)
- Photocell sensors (picking recognition)
- Acceleration sensor (shake and shock recognition)
- FSR sensor (right palm pressure recognition)
- Push buttons (effect/mode select).

Every signal derived from the sensor is sent to a Max/MSP [5] application via an I/O interface, called GAINER [6]. In the Max/MSP application the signals are mapped to MIDI data and these are then sent to the VSTi [7], which produces the guitar

sounds. Figure 1 shows the whole organization and signal flow of "Mountain Guitar."

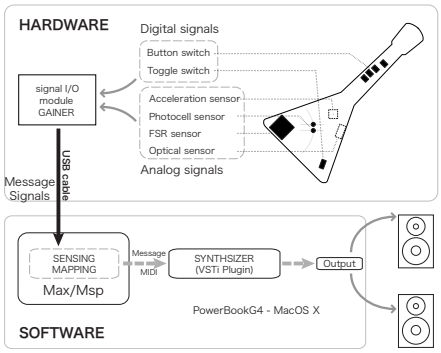

Fig. 1 "Mountain Guitar's" signal flow and organization.

2.2 Technical specifications

2.2.1 Mapping MIDI between heights

As stated earlier, "Mountain Guitar's" main function is to map MIDI signals to the height data derived from the height of the guitar held by the user. The analogue signals from the optical sensor are converted to one octave chord. The optical sensor's reaction is based on a quadratic function and we use a transformation table to convert the signals to linear functions. Figure 2 shows the relation between analog output voltage versus distance from the ground. Figure 3 shows the transformation table to convert analog input value to a linear function. One of the problems that needed to be resolved was that the optical sensor's signal tends to become noisier when the height of the instrument is changed too quickly. However, this problem could be resolved through using an average calculation algorithm and by assigning one octave (C～B) pitch to the transformed value.

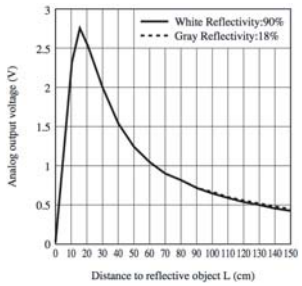

Fig. 2 Analog output vs. voltage value

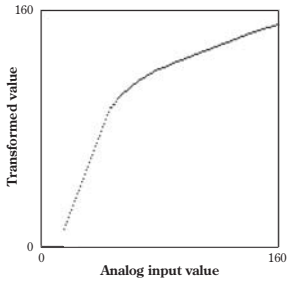

Fig. 3 Transformation table

2.2.2 Guitar playing technique simulation

"Mountain Guitar" is designed also to recognize information when receiving shock, tremble, tilt, and force pressure. These sensory information are also linked to special sounds. These are some of the implemented functions:

- Vibrato: When the user trembles the instrument's neck quickly, the acceleration sensor is activated, bringing the vibrato effect into the sound.
- Choking: When the user lifts or lowers the instrument's neck, the acceleration sensor works, creating choking effects onto the sound.
- Mute: When the user activates the pressure sensor with the right palm, the FSR sensor senses the force pressure and creates a mute effect to the overall sound.
- Picking: "Mountain Guitar" can also detect the picking speed and the picking up/down of the instrument through two photocell sensors. The picking speeds are reflected in the timbre, velocity, and decay of the guitar sound. The picking up/down of the instrument is reflected in the velocity of the sounds to simulate alternate picking play.
- Tapping: When the user taps onto the body of the instrument, the current sounds can also change according to the power of the tapping movement.

2.2.3 Other functions

- Effect change: When the user pushes one of the push buttons, the guitar tones changes in turn, and create over drive, and clean chorus.
- Chord change: During pushing the other push buttons, the chord changes can change to minor, major7th, and minor7th.

3. CONCLUSIONS AND FUTURE WORK

Compared to other experimental guitar interfaces such as the ones described in literature [1]-[4], "Mountain Guitar" tries to control the pitch of the guitar sounds simply by the height at which the instrument is held. This enables untrained users to play guitar very easily and intuitively, by controlling the pitch of the sounds simply through moving one's own body. By keeping the usual guitar sounds and playing technique intact, but by controlling them through the users body movements, a new possibility of designing physical computing [8] musical instruments has been shown. In the future we plan to further implement other guitar playing techniques such as arpeggio, slide and harmonics, as well as to implement a session mode that allows communication with other "Mountain Guitar" players.

4. REFERENCES

[1] Matti Karjalainen, Teemu Mäki-Patola, Antti Huovilainen, and Pekka Jänis, "Virtual Air Guitar" In Proceedings of Audio Engineering Society, San Francisco, CA, USA

[2] Loic Kessous, Julien Castet, Daniel Arfib, " 'GXtar', an interface using guitar techniques" In Proceedings of the 2006 International Conference on New Interface for Musical Expression (NIME06), Paris, France

[3] http://www.langdoncrawford.com/nime/

[4] Suguru Goto, Takahiko Suzuki, "The Case Study of Application of Advanced Gesture Interface and Mapping Interface, - Virtual Musical Instrument " LeSuperPolm " and Gesture Controller "BodySuit" " In Proceedings of the 2004 Conference on New Interface for Musical Expression (NIME04), Hamamatsu, Japan

[5] Max/MSP, Cycling '74, http://www.cycling74.com

[6] Shigeru Kobayashi, Takanori Endo, Katsuhiko Harada, Shosei Oishi, "GAINER: A Reconfigurable I/O Module and Software Libraries for Education," NIME06 (New Interfaces for Musical Expression 2006), 2006.6-8, Paris, France.

[7] VSTi"Slayer2", http://www.refx.net/?page=Slayer2

[8] Dan O'Sullivan, Tommy Igoe, "Physical Computing: Sensing and Controlling the Physical World with Computers" Reading, 2004

Development of new visual musical Instrument "Phenakistoscope player"

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ABSTRACT
We describe about the development of new visual musical instrument system "Phenakistoscope player" and also present the multimedia performance work "Sight Sound -Phneakistoscope-" played on it.

Keywords
Turntable, D.J. ,Phenakistoscope, multimedia performance

1. INTRODUCTION
There are some researches about the turntable as a new musical instrument.[1],[2] In this system, the turntable has two functions. One is to rotate the phenakistoscope instead of vinyl disks. The other is to play the music. Usually the phenakistoscope creates moving images by looking through its slit. But in this system, there are not slits, so we develop the software that has roll of slits . We combine these two media together as a new type musical interface with moving image. Some phenakistoscope's sheets are made by OHP(Over Head Projector) sheets. So we mixed some images on the turntable in progress with music. Also the software plays the drum sound in response to the color detection of its sheets by digital camera .

2. BACKGROUND
The phenakistoscope was invented in the 19th century as an early animation equipment. It is a spinning disc mounted on a handle. Around the center of the disc, series of pictures are drawn corresponding to frames of the animation. There is a series of radial slits around its circumference. Users rotate the disc and look through the moving slits at the disc's pictures that is reflected in a mirror. The scanning of the slits across the reflected images keep them from simply blurring together, so that the user can see a rapid succession of images which looks like a motion picture. In those days,the phenakitoscope could be used by one person at a time. But in our "Phenakistoscope player" realized that the phenakistoscope for a lot of people by using a digital camera, a computer and a video projector. And it can play music with projected phenakistoscope's images.

3. IMPLEMENTATION

3.1. Hardware
The hardware(see Figure 1. ,Figure 2.) was consisted of a CDJ player CDX(CD player with turntable for D.J. player)[3], a firewire digital camera(iSight) , two computers(one for sound ,the other for image) and a video projector. The phenakistoscope's sheets spin on the CDJ player. We choose the CDJ player not but the analog vinyl player ,because it is difficult to draw phenakistoscope's pictures on vinyl disks. They are shoot by digital camera and sent to the image-computer via DV signal. Processed video images are projected by video projector. Also the image-computer analyze the moving image's color. The result of color analysys is converted to the MIDI messages and send to the sound-computer via MIDI interface. The soound-computer maps to adequate sound.

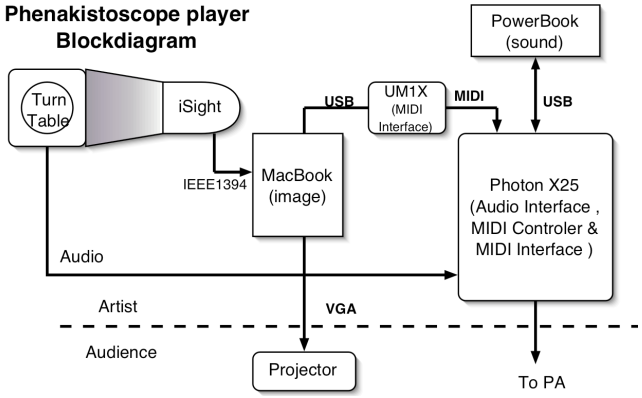

Figure 1. Blockdiagram of "Phenakistoscope player"

Figure 2. Equipments of "Phenakistoscope player"

3.2. Software

We developed two application softwares in this system. One is for image and the other is for sound, they are developed by MAX/MSP/Jitter. The image-software rolls as phenakistoscope's slits by adjusting the image sampling rate of the digital camera. The image sampling rate is suit for the spinning rate,images of phenakistoscope can show the animation. The image software has another function that analyzes the color of moving images captured by the digital camera. In this software, user defined eight rectangle areas and specific colors for it in the captured images. Each area is assigned the MIDI note number which responds to the specific color. When image's color corresponded with user defined color, MIDI note on messages sent to the sound-computer via MIDI interface. At the same time, the geometrically-designed short flash animation(about 200msec length) superimpose the phenakistoscope image. The sound-software executed on the sound-computer receives the MIDI messages from the image-computer and generates sound. This software has two characters, one is a system software and the other is a part of artistic works. So it changes depend on the works.

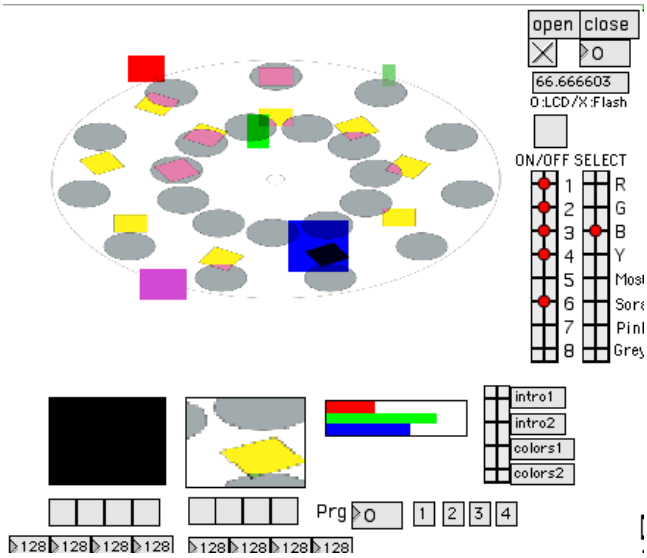

Figure 3. Screenshot of image procesing software's user interface.

4. WORK. -"Sight Sound -Phenakistoscope-"

"Sight Sound -Phenakistoscope-" is a multimedia performance work. This work was performed at Inter College Computer Music Concert 2005, IAMAS, JAPAN, NIME06, IRCAM, FRANCE and Apple store Shinsaibashi, JAPAN. The performance is consist of 3 parts. Beginning of the each part we used a paper sheet, after that layered the OHP sheets on it. In the performance we uses from 15 to 20 phenakistoscope sheets(paper and OHP film). (see Figure 4.) We put sheets on a platter, control speed,change the rotate direction and scratch it, similar to the DJ play. The CD for the CDJ player is originally composed for this work. There are no melody and no rhythm in this composition. And the sound is so simple(only one or two sound source), changed slowly(almost sustain sound). Because simple sound is easy to understand about the relationship between the DJ performance, phenakistoscope animation and sound. The sound-computer makes rhythm track responded to the phenakistoscope's animation. In addition, we play ad-lib performance with software synthesizer on the MIDI keyboard.

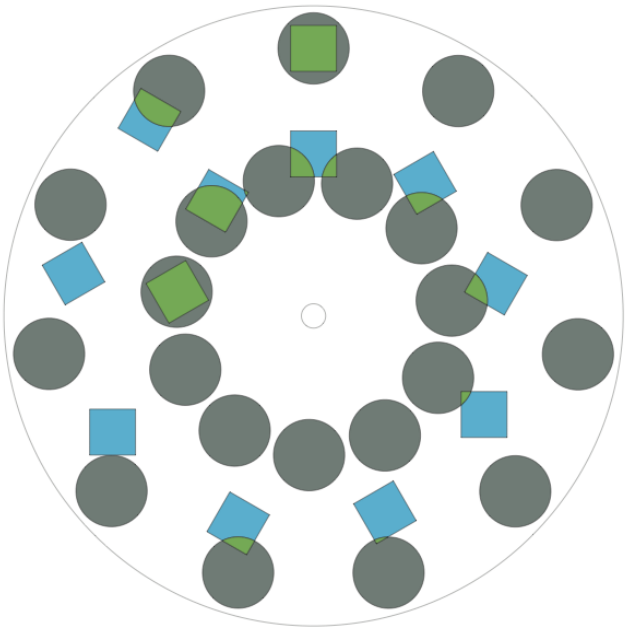

Figure 4. Phenakistoscope sheet

5. CONCLUSION

We describe about the new multimedia performance instrument "Phenakistoscope player" and its perfomance work "Sight Sound -Phenakistoscope-". This instrument combines old animation medium phenakistoscope and digital technology. And simultaneous performance of animation and sound realized by this instrument. There is something to improve. This system is so nervous about light environment because of analyzing the color of sheets. So we need to develop the software for color compensation to realize quick preparation. In this paper we introduce "Phenakistoscope player" as an instrument for performance, but this is effective for media installation work and workshop about animation and sound. We will try to develop another usage of this system.

6. REFERENCES

[1] Takuro Mizuta Lippit *Turntable Music in the Digital Era: Designing Alternative Tools for New Turntable Expression* Proceedings of the 2006 International Conference on New Interfaces for Musical Expression (NIME06), Paris, France,71-74

[2] Spencer Kiser spin Cycle *a Color-Tracking Turntable Sequencer* Proceedings of the 2006 International Conference on New Interfaces for Musical Expression (NIME06), Paris, France,75-76

[3] http://www.numark.com/products/product_view.php?v=overview&n=101

Coment about demo

In the demo session, I would like to show the "Phenakistoscope player" system. The duration of one demo is less than 5minutes.

We want to demo of this papers system.
Data projector (XVGA resolution) for PC.

Stereo loudspeakers and amplifier.

Fixed lighting environment.

Larger than 1.5m * 0.6m desk to put on the Note PC ,TurnTable and Projector. And 2m * 2m space and white wall or screen for projection.

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2. A simple example of representative audiovisual material in a loop.

4. A description of where and what can touch and try with the technology you are planning on demonstrating at the conference including audio and/or video output.

If you have any questions, please E-mail me(shirano@nn.iij4u.or.jp)

Best regards,

From Saburo HIRANO