beacon: Embodied Sound Media Environment for Socio-Musical Interaction

Kenji Suzuki
Dept. of Intelligent Interaction Technologies
University of Tsukuba
kenji@ieee.org

Miho Kyoya
School of Art and Design
University of Tsukuba
mihokyoya@mac.com

Takahiro Kamatani
College of Media Arts, Science and Technology
University of Tsukuba
buhii314@gmail.com

Toshiaki Uchiyama
Dept. of Kansei, Behavioral and Brain Sciences
University of Tsukuba
uchi@kansei.tsukuba.ac.jp

ABSTRACT

This research aims to develop a novel instrument for socio-musical interaction where a number of participants can produce sounds by feet in collaboration with each other. The developed instrument, *beacon*, is regarded as *embodied sound media* product that will provide an interactive environment around it. The *beacon* produces laser beams lying on the ground and rotating. Audio sounds are then produced when the beams pass individual performer's foot. As the performers are able to control the pitch and sound length according to the foot location and angles facing the instrument, the performer's body motion and foot behavior can be translated into sound and music in an intuitive manner.

Keywords

Embodied sound media, Hyper-instrument, Laser beams

1. INTRODUCTION

Many sound installations with electroacoustic techniques have been presented so far. However, those systems usually require a large space or complicated instruments. There are very few compact interfaces for enjoying music with other performers or audience like conventional musical instruments. In this paper, we introduce a portable instrument called *beacon* for socio-musical interaction. A number of line laser modules are installed, and the laser beams are produced and rotated around the instrument. The beam performs like a moving string because sounds are generated every time the beam lying on the ground passes the performers' feet. A real-time motion capture technique and pattern recognition of users' feet are used in order to create a new style of musical interaction. Therefore, this instrument provides an *embodied sound media* environment [1] where everyone can readily enjoy it for playing the sounds without scores and also can interact with others through collaborative musical experiences. In the interactive environment around *beacon*, people can communicates with each other by means of sound, music and his/her own body motion like dancing or tapping. The promising applications include edutainment, recreation, fitness, rehabilitation, entertainment or sports and new artistic expression.

2. SYSTEM OVERVIEW

Hardware Configuration: The developed instrument consists of a loudspeaker, a small-size computer, 60 line laser modules, 2 laser range finders, dial and buttons interface, and battery. All equipments are installed in a cylinder shaped interface as illustrated in figure 2. This instrument is a kind of small lighthouse sending out line laser beams. The beams are used not only to mark the current location to produce the sound but also to assist musical interaction. In the current implementation, up to 4 laser beams with equiangularly-spaced directions are lying on the ground and rotating during musical performance. The rotation speed of laser beams can be set from 40bpm to 100bpm. At the bottom of the instrument, two laser range-finders are installed and used for the distance measurement to performers, in particular those foot positions and its angles every 100 ms at the height of 1 cm from the ground. The installed range-finder has 4[m] measuring range with 99% range accuracy, and also has a 240 degree angle of view for each. We used two range-finders in order to obtain omni-directional distance map every time.

Motion-to-sound Mapping: The performer is regarded as a *musical note*. *beacon* generates sounds when the beams passed individual performers as if the rotating laser beams could detect them. However, in reality, the performers around by *beacon* are detected at all times by the equipped omini-directional laser range-finder. A number of performers, therefore, can participate in a musical session, and individual per-

Figure 1: beacon - a new interface for socio-musical interaction.

formers is able to change the pitch in accordance with the distance from the center of the instrument to the foot. The sound lengths, on the other hand, are determined based on the foot angles. When the performer points his/her toes toward the *beacon*, shorter sounds are produced. The performer put the entire length of the foot facing beacon, longer sounds are played. The attack and decay of each note are predetermined, and the sound volume is fixed in this work. The timbre, tone colors and major/minor keys can be selected, even during the performance, by using buttons and a dial interface that are equipped at the top of instrument.

Sensing Spatial Movement: A rectangular-to-polar coordinate transformation is required in order to normalize the size and angles of performer's feet due to the characteristics of measurement. The figure 3 shows an example of sensing by the range-finder. An identical foot is measured as different size according to the distance from the instrument. The calculated adjusting parameters are obtained based on a calibration technique, and used for motion-to-sound mapping. We conducted two preliminary experiments to evaluate the sensing property. Subjects are asked to stand in front of the instruments with different distances and facing angles of the foot. The experimental results of 5 male/female individual subjects with different foot sizes are shown in the figure 4. The relationship between the distance d from the performer to instrument (X-axis) and the measured angular area θ (Y-axis) is approximated by $2\tan^{-1}(x/2d)$ with regard to x as the subject's averaged foot size. The ideal curve is calculated using geometric property, which is indicated by the bold line. This results verified that we could approximate the scaling effect by using the offset parameters k_d of the ideal curve described above.

We also obtained the relationship between the facing angle to the instrument and measured angular area with different distances. The measured data are collected with facing foot angles every 22.5 degrees. A clear difference can be seen according to the facing angles of foot at the distance of 500mm-1000mm. However, there are small differences over the distance of 1500mm. Based on this result, we use the foot angles for control of sound length within the area less then 1500mm radius from the instrument.

3. DISCUSSION AND CONCLUSIONS

We introduced a novel interface *beacon* for socio-musical interaction.This instrument allows performers not only to communicate with each other via music and motion, but also to improve the quality of sound production by training and devising various types of behavior. This novel instrument thus can be used for the physical exercise or recreation with fun. Moreover, by arranging small objects around the instrument, a variety of sound will be produced like a environmental music box. Sounds are generated when the laser beam passes the objects as well as human performers. This installation provides a new artistic expression for spatial designers. This round-shape interface does not have any directional characteristics and plays a key role of gathering people for affective communication.

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References

[1] K. Suzuki et al., *Proc. IEEE*, **92**(4), pp. 656-671, 2004.

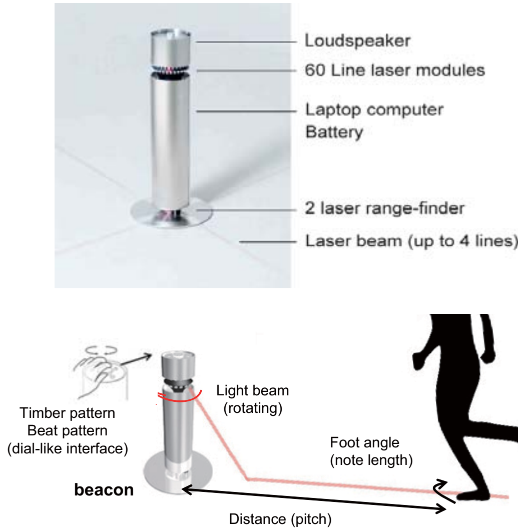

Figure 2: beacon - for socio-musical interaction

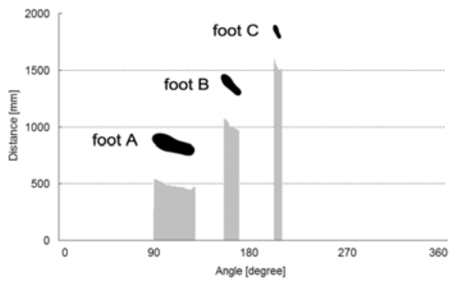

Figure 3: An example of measurement of feet

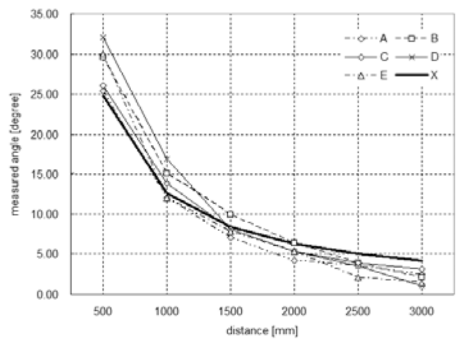

Figure 4: Foot sizes with different distances

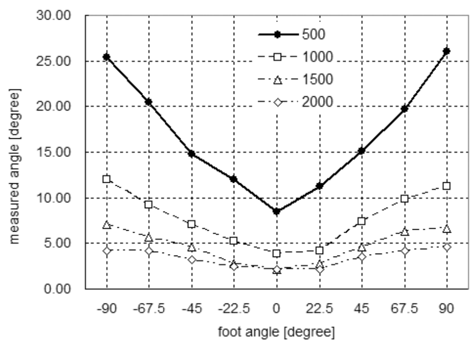

Figure 5: Foot angles with different distances