THE INTERACTIVE DANCING FLOOR: THE SMART FLOOR PLAYS MUSIC *

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In this paper, we propose the Interactive Dancing Floor that provides a user with more intuitive and natural interface by exploiting Tangible User Interface with multimedia. The proposed system detects the movement of user using a set of ON/OFF sensors. Then the media such as MIDI and CG are generated according to the user's location and walking pattern. Due to its intuitive interface and interactive media feedback, it gives users more immersive feeling. According to the experimental results, the proposed framework can be applied to various interactive applications such as game, entertainment, training, etc.

1. Introduction

Recently Tangible User Interface (TUI) has attracted considerable attention by paving a new way of interaction for those who are not familiar with a computer [1]. Comparing to Graphic User Interface (GUI) exploiting a mouse or keyboard, TUI does not requires for users to have through knowledge of each device. Instead, TUI allows users to intuitively interact with each device through the physical objects in the real world. In this scenario, the audio-visual feedback-added TUI will provide more intuitive and natural interaction for general users.

Over the last few years, various types of audio-feedback systems with natural and intuitive interface have been developed. For example, the U.T. Touch-Sensitive Dance Floor measures features such as pressure and velocity of a user with force sensing resistors and maps the features to the control parameters of MIDI to play music [2]. The magic Carpet plays music by tracking the movements of a user using Doppler radar and piezoelectric wires [3]. The Expressive Footwear plays music by tracking foot movements using embedded sensors in shoes [4]. Note however that the feedback of these systems is focused on only audio effect, which may not be sufficient to provide users immersive interaction.

In this paper, we propose the Interactive Dancing Floor (IDF) allowing users to control audio-visual objects by tracking the movement of the users on the floor. The proposed IDF consists of a micro controller and a set of simple ON/OFF sensors that tracks users' steps on the floor. The resulting information

* ITIP supported by Ministry of Information & Communication in S. Korea.

on steps is used to control CG objects on wall-size screen as well as foreground (FG) and background (BG) music. The shapes of CG objects are changed dynamically as the foot position and duration time change. In advanced mode, both FG and BG music are played according to the position of steps and duration time. In addition, the user can change musical instruments on the fly.

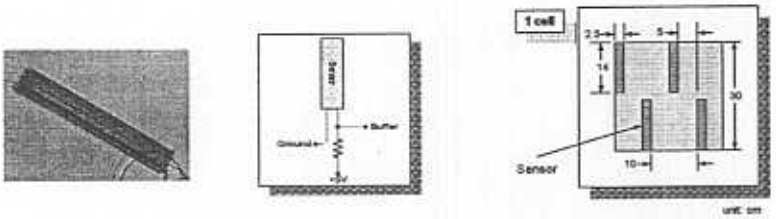
The proposed IDF exploits the advantages of TUI by adopting audio-visual feedback. The IDF amuses users by allowing to play music with a natural and intuitive interface. In addition, the visual feedback, controlling CG objects in a big screen according to the steps, gives the users immersive feeling. Without loss of generality, the IDF with intuitive and comfortable interface can be applied to various applications such as games, entertainment, education, training, etc.

2. Interactive Dancing Floor

Fig. 5 shows the implemented system. A user is stepping and watching bar-typed object on a big screen.

Figure 1. Implemented IDF system

In the IDF, we used a set of ON/OFF sensors shown in Fig. 2 instead of load cells, which detect weight of a user and are very sensitive in slight changes of weight. As shown in Fig. 2 (c), four sensors per tile have been arranged. This arrangement was chosen not only to find the position of the user but also to detect user's footstep with minimum number of sensors. The floor covers the area of 3m by 1m to ensure enough space for detecting user's step.



(a) Shape (b) Logic (c) One Cell of Smart Floor

Fig 2. ON/OFF Switch

As shown in Fig. 3, all 144 sensors are connected to a DAQ board where a 80C196KC micro-process is located. The output from 8 sensors is the input of one 8-bit buffer to store raw data from sensors temporally. A micro-process sends the received data from buffers to a host PC through RS-232C.

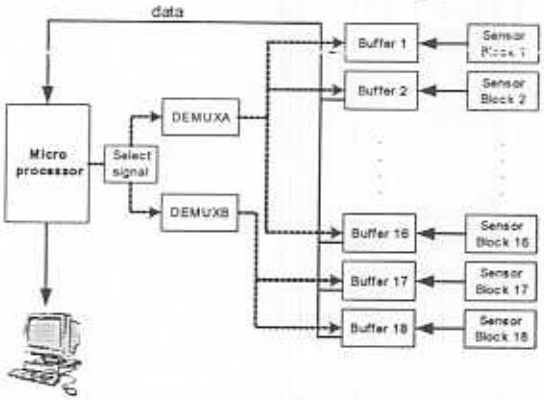


Figure 3. Information flow chart.

There are two playing modes. In easy mode, the velocity of a step determines the speed of the music. In this mode, users can play music without learning complicated MIDI interface. Instead, the IDF plays pre-recorded music, which is classified into 3 steps (fast, medium, slow speed) according to the values in Table 1. The music being played is switched to another music according to the dynamic threshold values in Table 2.

Table 1. Easy mode classification (t: msec, d: cm)

	stepping time	Step Width
Fast Music	$t < 600$	$d \approx 21$
Medium Music	$600<t<1500$	$d \approx 24$
Slow Music	$t > 1500$	$d \approx 30$

Table 2. Dynamic threshold of each classification (t: msec)

	Fast Music	Medium Music	Slow Music
Fast Music	-	$t > 720$	$t > 1800$
Medium Music	$T < 480$	-	$t > 1800$
Slow Music	$T < 480$	$t < 1200$	-

In advanced mode, with the BG music, user's each step can dynamically control monotone and CG objects as well as musical instrument. The switching between each BG music is made when user's movements (step width and holding time) is more than the updated threshold which is higher than the threshold values of the beginning state as shown in Fig. 3. The x, y position controls the FG music in sound of monotone. The top and bottom areas of the floor,

respectively, are allocated for choosing musical instruments and stopping music. In addition, the CG objects on the big screen are changed dynamically according to the user's movements.

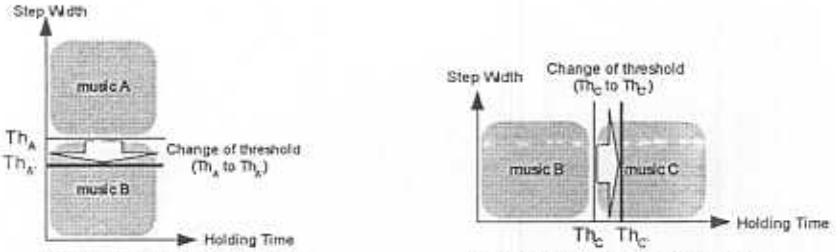


Figure 3. Example of dynamic threshold values.

3. Conclusion

The proposed Interactive Dancing Floor provides immersion by allowing users to control audio-visual objects by exploiting the emerging TUI framework. The system consists of microprocessor and a set of simple ON/OFF sensors to provide comfort, natural and intuitive TUI. The movement of the user on the floor is reflected onto the CG objects in a wall-size screen as well as to BG/FG music. Note however that the steps are only a part of the user's movement. Consequently, a remaining challenge is to take advantage of the upper body movement to control audio-visual objects. In addition, recognizing user's intention by analyzing user's whole body movement will be another challenge to improve the immersion effect of the system.

References

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