AirTiles: Modular Devices to Create a Flexible Sensing Space

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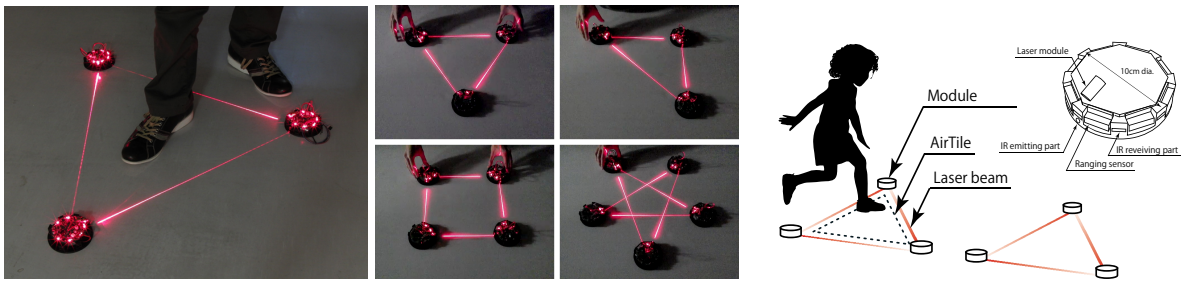

Figure 1: *AirTiles: Spacial measurement can be done by the created geometrical shapes according to the small and lightweight modules placed on the ground. Users can easily modify the shape which correspond to the sensing region.*

1 Introduction

There are a number of systems and devices for spacial measurement which can be used to measure bodily motion. However, these systems are usually large or fixed with the environment. In this study, we propose a novel modular device that allows users to create geometric shapes in the real world and also a flexible sensing space within the created shape. Users can freely put devices and rotate them so that a geometrical shape could appear on the floor. As the modular devices and the emitted laser beam represent the corners and sides of the shape, respectively, the device therefore does not interrupt figures or textures on the ground. The developed system provides an interactive visual/audio environment as if children could make a hand drawing on the ground or floor and play with the created shapes.

2 Overview

The developed module consists of a microprocessor, laser-emitting module, infrared-emitting/receiving components, small position sensitive detector, wireless meshed network component, LED, beep speaker and battery. All equipments are installed in a small case as illustrated in the right of Figure 1. The modules allow the user to create several geometrical shape on the ground (or wall) and realize the object sensing within the drawn shape. Each module is capable to emit a laser beam in one direction, and users can place these modules on the ground so as to create an enclosed region. The module's location and emitted laser beam correspond to the corner and side of the created shape.

As an example, triangle shape can be drawn by three modules: First, the user put first and second modules on the ground so that the emitted laser beam from first module could reach second module by rotating the first module. The user then put third module and rotate the second module in order to reach the emitted laser beam from the second module to the third module. Finally, by rotating the third module to reach the emitted laser beam to the first module. Each module emits both single laser beam and infrared beam to the same direction by receiving an infrared beam from the other module. Therefore, the relative angle between incoming and outgoing laser beams can be calculated at each module. Once an enclosed region is created, the modules automatically detect the created shape and start to measure in the region. The modules communicate with each other so as to detect comings and goings in the region by using position detection sensors installed in each module. Polygonal shapes such as rectangle and pentagon, and different shape like star can be created solely by changing the locations of modules, as illustrated in the center of Figure 1. The created enclosed region is called as *AirTile*.

3 Performance

We have conducted several experiments by using the developed modules. For example, we used more than two groups of modules (*AirTiles*) and designed a simple game for motion guidance. We asked users to create two *AirTile* on the desktop and then LEDs of one *AirTile* start to blink on and off. When the user put his hand in the *AirTile*, another *AirTile* starts to blink. On the other hand, these modules can be used as a bodily exercise tool. Side stepping is a simple exercise that the user should shift back and forth between predetermined two regions. In this case, the user first create two regions by *AirTile* and simply do the exercise. As *AirTiles* can be used as the data logger, exercise quantity and timing of footwork are recorded and analyzed after the exercise. Other potential applications include the human-behavior measurement, motion guidance, and therapeutic exercise.

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SIGGRAPH 2010, Los Angeles, California, July 25 – 29, 2010.
ISBN 978-1-4503-0210-4/10/0007