Full-body Interactive “Board”game for Learning Vegetation Succession Based on Identification of People and 3D Position Measurement

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Abstract: We are developing a digital game, "Human SUGOROKU," in which enables game players as pieces to learn vegetation succession. In order to realize this game, it is necessary to robustly measure 3D position of people and identify them. In this paper, we proposed a method for 3D position measurement and identification of people by integrating ultrasonic sensors and Kinect sensors. The evaluation results show that proposed method is more robust than methods using ultrasonic sensor and Kinect sensor separately.

Keywords: Practical study, vegetation succession, ultrasonic sensor, Kinect sensor

Introduction

In recent years, global environmental problems are becoming serious. Under these circumstances, the environmental education with experience has been more required. Digital game,"Digital SUGOROKU of vegetation succession", that targeted the conservation woodlands as environmental issues have been developed.

Figure 1 shows the overview of this game. The game visualizes changes in forest ecosystems in large temporal scales by simulation. Practical study of learning environment has been advanced by using this game [1] [2]. The game is backgammon on the computer screen. An issue of Connection with virtual world and the real world had been left for the learner. Therefor we are developing a new system of the game, "Human SUGOROKU”, which enables people to learn vegetation succession more realistic.

In that system, people walk on board which was placed on the floor. That person, made applicable to the plant, can experience the change of pseudo physically planting ecosystem. Figure 2 shows the overview of the system “Human SUGOROKU”. The overall size of board is approximately 10m square and the size of a frame is assumed to be 1m square. The number of participants is six. Up to three people may enter in one square.
In order to realize this system, it is necessary the two technologies.

First, even if there are some people within one frame which is one meter square, they can be measured position and identified. Second, it is possible to measure positions of people in large space of 10m square. A method to measure the position has been proposed by using ultrasonic transmitter tags with unique identifiers [3] [4]. But ultrasonic sensors may become unstable due to the measurement of the directivity of the ultrasonic wave. The range which ultrasonic sensor can stably measure transmitter's position is limited. This is a problem because there is a need to measure position stable in a wide range. If we try to realize this system using only ultrasonic sensor, huge amount receivers are required. On the other hand, Microsoft's Kinect sensor can measure the position of the people by the visual information. Therefore the sensor can't measure if occlusion occurs due to the overlapping people. This is a problem because there are 6 people in the game. So we intended to develop a system to measure 3D position of people and identify them if they are in a narrow range by integrating Kinect sensor and ultrasonic sensor to compensate for the weaknesses.

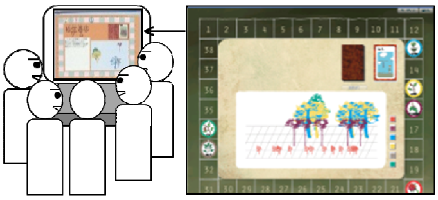


Fig.1 Digital SUGOROKU

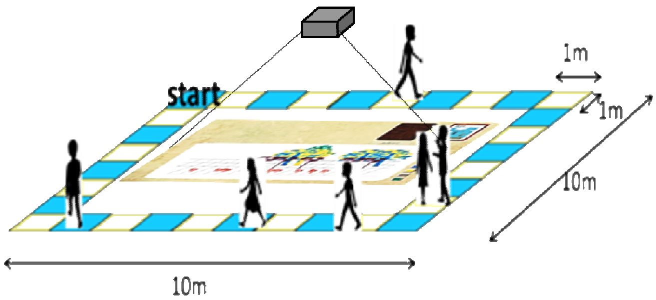


Fig.2 Human SUGOROKU

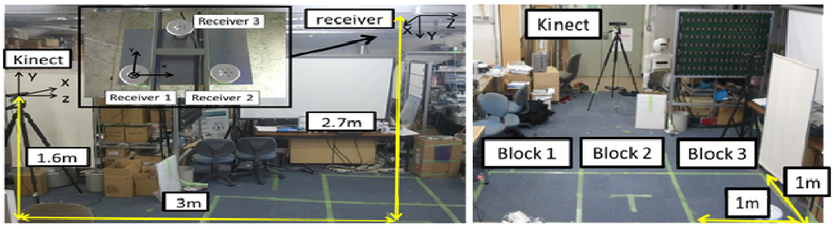
1. Experiment

By integrating the sensors, the weaknesses of each sensor are complemented. Then we investigated the stability of the measurement. In preliminary experiments, the position of a person was measured considering the weakness of each sensor. We compared the stability of the measurement by using each sensor separately and the measurement by integrating sensors. In main experiment, we investigated how much the system can measure position of two people.

Figure 3 shows the experimental environment. Receivers of the ultrasonic sensor were placed on the ceiling. The receivers were arranged such that an equilateral triangle of sides 300mm. Three frames placed on the floor under the receivers. The frames were allocated a number as figure 3 (b). The frames were 1 meter square. There is a center of the frame 2 on the z axis of the ultrasonic sensor. Border line is parallel to axis x and axis y. Coordinate system of the Kinect sensor was rotated 90 degrees counter-clockwise X axis of the ultrasonic sensor and moved in parallel.

Two people attached a transmitter on his head moved in the frames of three. They were sometimes hidden from the Kinect sensor due to overlapping. Figure 4 shows the experiment method. Ultrasonic sensors measured the position of the transmitter attached to the head. Kinect sensor measured the position of the head. Sampling rate is 25Hz and sampling number is 1500. Figure5, 6, and 7 shows the relationship between the sampling number and position of two people in x direction.

Because receivers cannot receive ultrasonic wave, there is the range which ultrasonic sensor does not measure position well. In addition, there is the range which Kinect sensor cannot measure position of the people due to overlapping. It is possible to robustly measure position of two people by integrating the sensors



(a) (b)

Fig.3 Experiment Environment

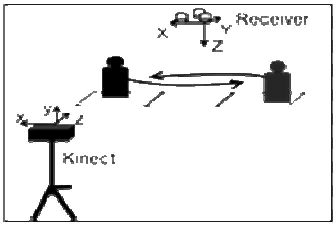


Fig.4 Experiment Method

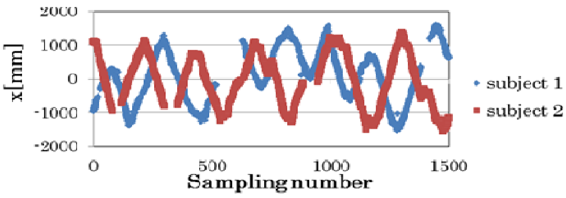


Fig.5 Measured by Ultrasonic Sensor

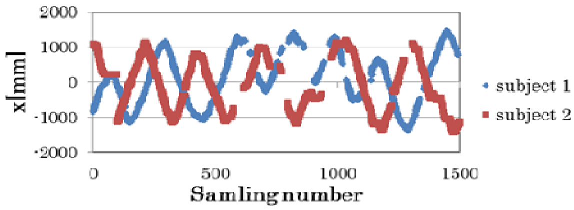


Fig.6 Measured by Kinect Sensor

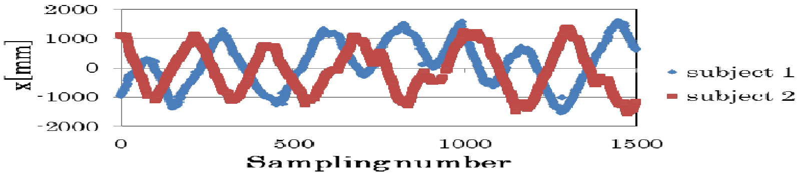


Fig.7 Measured by Integrating Ultrasonic Sensor and Kinect Sensor

2. Conclusion

This paper describes a method for 3D position measurement and identification of people by integrating ultrasonic sensors and Kinect sensors for developing “Human SUGOROKU”. Ultrasonic sensor can measure 3D position and identify tagged people. Kinect sensor can measure 3D positions of people and tracking them with OpenNI. By combining the Kinect sensor and ultrasonic sensors, we made it possible to measure positions of people and identify them. The experiment results show that the proposed method is more robust than methods using only ultrasonic sensor or only Kinect sensor.

The proposed method robustly measure position of people in three squares. In the future, in order to realize “Human SUGOROKU”, we will extend this system. We will develop a system which can measure the positions of people and identify them in a wide range of approximately 10 meters squares.

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