Advanced Science and Technology Letters
Vol.86 (Ubiquitous Science and Engineering 2015), pp.91-95
http://dx.doi.org/10.14257/astl.2015.86.19

A Study of Multiple Body Tracking System for Digital Signage of NUI Method

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Abstract. Recent developing trend of digital signage is being strengthened with interactive elements, such as sound, image, vibration, etc., for communication with participants to put simpleness and intuitiveness to user's interaction method by besides physical interfaces. The Microsoft Kinect sensor was originally developed as a game interface for its Xbox, but it is aggressively utilized for development of interactive digital signage with excellent motion tracking performance and high development easiness using Kinect SDK. However, there is a limit on sensing capability when it is interacted by multiple users in three-dimensional space because of the blind spot problem which is essential as a vision sensor. In this paper, we suggest a body tracking system for multiple users by using Kinect sensor and the motion sensor in addition. This method will solve the blind spot problem on the Kinect sensor and make practicable to correspond with multiple users in three-dimensional space.

Keywords: Signage, Body Tracking, Multi-Kinect, Unity3D, Skeleton Data, Motion Sensor

1 Introduction

Usual digital signage has been a digital media expressing contents, such as a variety of information, advertisement, etc. through the display panels like LCD, PDP, LED, etc. It is a recent trend to add interaction aggressively to it. This interaction signifies more direct interaction, beyond indirect one that only exchanged information with the system by GUI, keyboard, etc. Current digital signage is being formed to dance, play, and talk with participant as NUI(Natural User Interface) gets developed. It may be construed as an evolution as the independent formed attraction. It is a result following the development of NUI(Natural User Interface). Above all, the Microsoft Kinect sensor, which was originally developed as a game interface for its Xbox, is aggressively utilized for development of the attraction-like digital signage with excellent motion tracking performance and high development easiness using Kinect SDK. However, despite those many advantages include more direct interactive method compared the digital signage before NUI, the elements of the digital signage improved by Kinect is stuck in a form of the reactive kiosk which is a consistent one-to-one with the system. It is a blind spot problem what vision recognition method of

ISSN: 2287-1233 ASTL

Kinect inevitably has. In this paper, we will examine the object tracking method by multiple Kinects to solve this blind spot problem and to suggest an improved, robust tracking method as much as for practical use.

2 Object tracking method by multiple Kinects

Kinect's RGB-D camera operates to the flat space appearing in front of the sensor because it is fundamentally designed to extract the skeletal data of a game player(Kinect is a controller for Xbox game console). It senses the closest object preferentially. Recognition rate for the object rapidly declines when the object grows apart from the sensor, the boundary between the object and the background is unclear, or a part of body is occluded by any other object. To compensate this defect, we suggest arranging multiple Kinects as surrounding a certain area and have observation from various angles. On a research by Brian M. Williamson in year of 2012, they used four Kinects and combined the skeletal data from the object. On a research by Lee JinHo in year of 2014, they also used three Kinects to combine skeletal data, but unlike aforementioned one, they applied weight on each joint to trace more precisely.

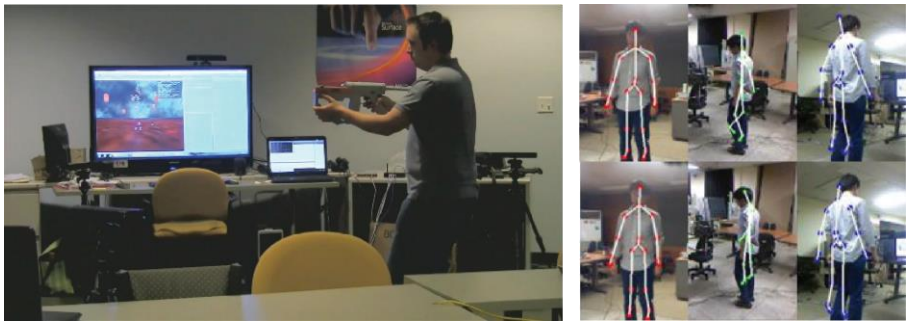

Fig 1. Multi-Kinect tracking for dismounted soldier training (Left), the improved body tracking method using multiple Kinects(Right)

Many researches proposed advanced body tracking method. However, all of them had considered about the tracking method for only one user, but multiple users. In case of one user, it is a feasible to correct the skeletal data occluded behind its own body by using another Kinect from different direction. Whereas, in case of multiple users, it might be happened that one user covers the scope of cognizance of the other user. Consequentially, this digital signage would still be on a level of reactive kiosk which is equivalent to the system one-on-one, even though you traced the subject in three-dimensional tracking space. A method should be devised with multiple Kinects to be consistent to three-dimensional tracking space and to distinguish multiple objects stably. In the system of this study, a motion sensor is utilized to correct the data. We will continuously trace approximate position and the possibility of disappearing to maintain the sufficient result by the motion sensor even on the error occurred at the blind spot.

3 Development of body tracking system for multiple users

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3.1 Environment composition for tracking multiple Kinects with the motion sensor

A solid tracking space is constructed by placing four Kinects on four corners at intervals of five -meter. We accoutered the motion sensor attached helmets to six tracking subjects because it is a maximum of six persons for tracking skeletal data by the standard of the Kinect V2. Each Kinect sensor is connected to separate PC to compose the network to collect all the data from Kinects and motion sensors to a single server. Each joint is applied weight by using the Kinect's Tracked, Inferred, NotTracked data then transmitted to the server by OSC(Open Sound Control). The server generates a virtual space in Unity3D with the data from four clients to fuse the data to one single skeleton after comparison of the skeletal data and the motion sensor data from each user. The fused data is sent back to the clients through OSC then each client invokes contents by using the joint data acquired from the server.

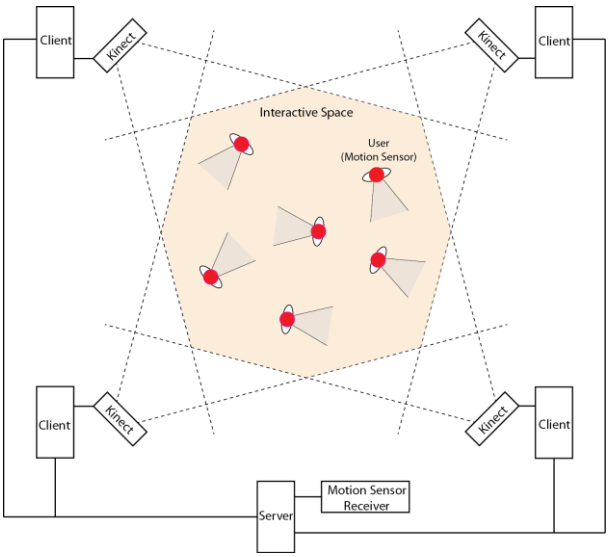

Fig 2. Body tracking system for multiple users

The client saves the values of ID, type, location, rotation, and weight for each joint of perceived subject on Kinect and transmits them to the server. In this process, the weight is given by basically supported data by the Kinect(Tracked, Inferred, NotTracked) and each one is consistent on 1.0, 0.1, 0. When a subject gets continuous recognition through the Kinect, received IDs from the motion sensor and the skeleton from the server are retransmitted to the server.

The motion sensor on the helmets transmits the values of ID, location, and rotation to the server by the motion sensor receiver. The motion sensors are authorized individual IDs which will be linked to the skeleton on the server. This ID takes a role to make a number of the skeletons united to one. Also, the ID is utilized for unrecognizable data by Kinect. In this situation, still unrecognized movement of the user is traced by the position data from the motion sensor.

The server progresses initialization to make a virtual space and a real space coincident by using the joint data of a user in the center of four installed Kinects. This initialization creates each spaces with the data extracted from Kinect by using angles of top, bottom, left, and right directions of a body from user's joint data then it makes the spatial data from four Kinects be consistent. According to the united data, it calculates the number of users in current space with location and angle for each skeleton and saves those skeletal data for the users to a skeletal data list. Multiple skeletal data saved after comparing with position and rotation data from the motion sensor combined to one skeleton. During this step, each skeletal data gets more weight applied to the Kinect places where the use is facing at.

3.2 Combining tracking data

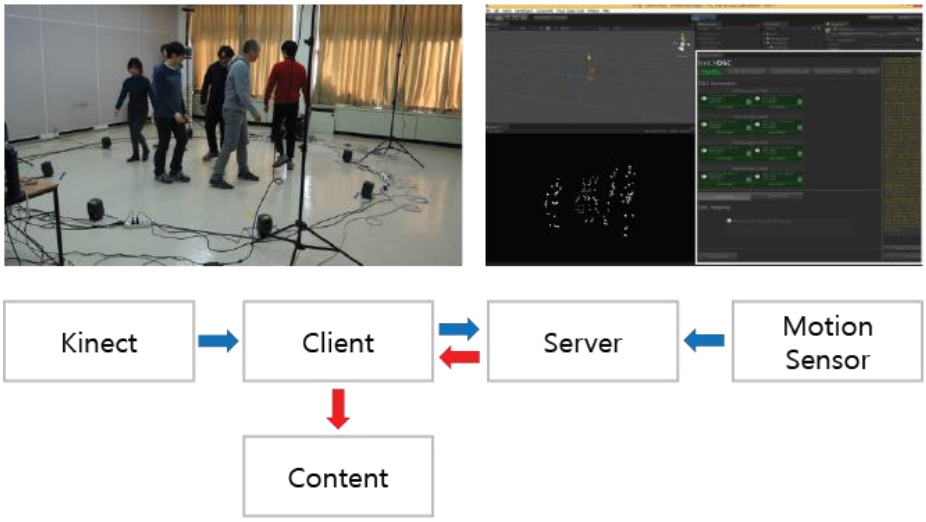

Fig. 3. Result (Top) and process(Bottom) of body tracking system for multiple users

We combined the data from the motion sensor and the client and authorized an ID to every piece of the skeleton to let the server merges each users' skeletal data with this authorized ID. By iteration of the method, we could obtain the data for multiple users

include the data of position, rotation, and any other gesture about specific actions, such as jumping or raising hands, on enhanced accuracy. However, the precision of the data for the joints of arms and legs got lowered because the number of unrecognizable joints by Kinect is on the rise as the number of the users in the interactive space increases. We could get better result by correcting with the motion sensor for the data of position and rotation which was seldom unrecognizable by Kinect. Our future research should be focus on how to enhance the method of cognition of the data for each joint of multiple users.

4 Conclusion

In this paper, we grasped the usual problem on body tracking research using multiple Kinects and suggested a body tracking method for multiple users by utilizing multiple Kinects and the motion sensor. In this method, we tracked the data of users by four Kinects then corrected the data of position and rotation by the data from the motion sensor. As a result, we achieved using the values of location and rotation acquired by the motion sensor to correct the data which was unrecognizable on four Kinects. Also, we gained more advanced data of position and rotation by the motion sensor when compared to the data by the Kinect. This system is expected to be applicable to diverse contents of the digital signage by many other kinds of advanced body tracking data.

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