To Design an Interactive Learning System for Child by Integrating Blocks with Kinect

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***Abstract*—In this study, an interactive block-building system named as e-Block system is developed for children to learn the concepts of geometric structures and space. First, the system displays a picture (e.g., car or house) of the target object intended for the child to assemble. The child then follows the instructions provided by the system and uses various blocks to build the object. After the child has completed the task, the system employs a pattern recognition algorithm to automatically compare the assembled object with the picture and determine whether the shape is identical. The experimental results show that the proposed system achieves high accuracy rate, and children in testing are enjoy this system and have more motivation to play with building blocks.**

Keywords—Interactive learning; Building block; Kinect; Pattern recognition

I. INTRODUCTION

Commercially available building blocks differ in form, shape, color, and usage. From a medical perspective, building blocks can be used to train children's ability to differentiate shapes, develop independent thinking, use their hands and fingers to grasp objects, and cultivate hand-eye coordination. Additionally, when children play with building blocks, they learn to describe the size, shape, and location of objects, thereby developing stronger language skills [1]-[2]. In recently years, several researchers integrated the Kinect as a learning tool to boost the motivation of learners [3]-[5]. Therefore, in this study, an interactive block-building system integrating with the Kinect is developed for children to learn the concepts of geometric structures and space when playing with assembling blocks.

II. INTERCATIVE BLOCK-BUILDING SYSTEM

In the interactive block-building system, a pattern recognition algorithm is proposed to recognize whether the shape of assembled object is identical. Four steps of the algorithm introduced as following.

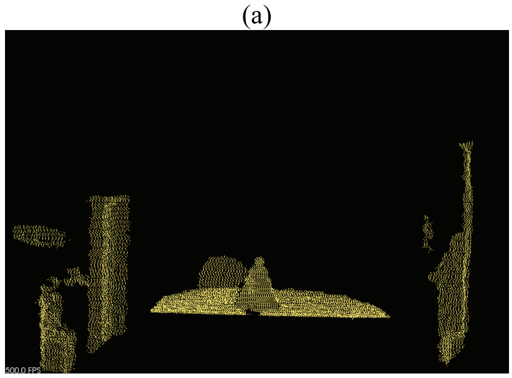
Step 1. Extracting Depth Information

In this study, the developed system employs the Kinect to extract the depth information for each input image. By converting the depth information, point cloud dataset with 3D format are then built for each input image.

Step 2. Coordinates Transformation

In the point cloud dataset, it contains the distance information between each pixel to the Kinect camera. To obtain the 3D coordinates of each pixel, we apply the Lin's [6] and PCD Viewer tool [7] to generate the point cloud dataset, as shown in Fig. 1.

(a)

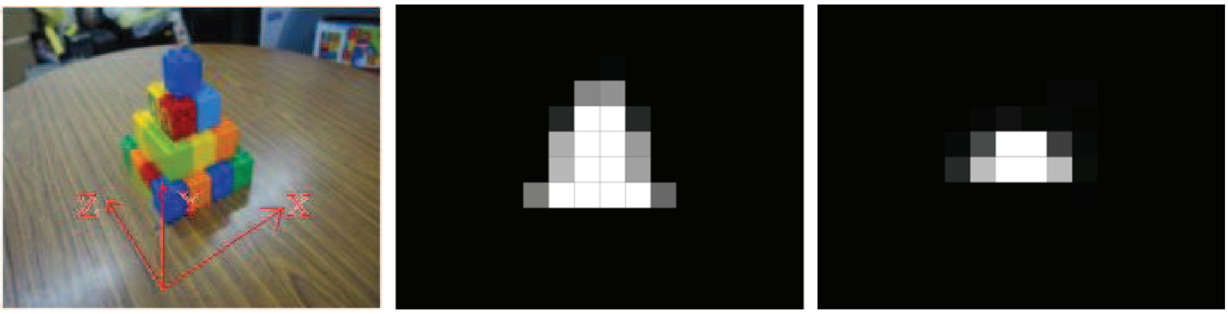


(b)

Fig. 1. (a) Original test image; (b) Point cloud data.

Step 3. Segmenting the Test Object

As shown in Fig. 1(b), the point cloud dataset contains the assembled object, desk, chair, cupboard and other furniture. In this step, the RANSAC algorithm [8] is applied to remove the point could data of the desk. Finally, only the point could dataset of assembled object is retained for recognition.



(a) (b) (c)

Fig. 2. (a) Original image of a pyramidal object. Projection intensity on (b) XY plane; (c) XZ plane.

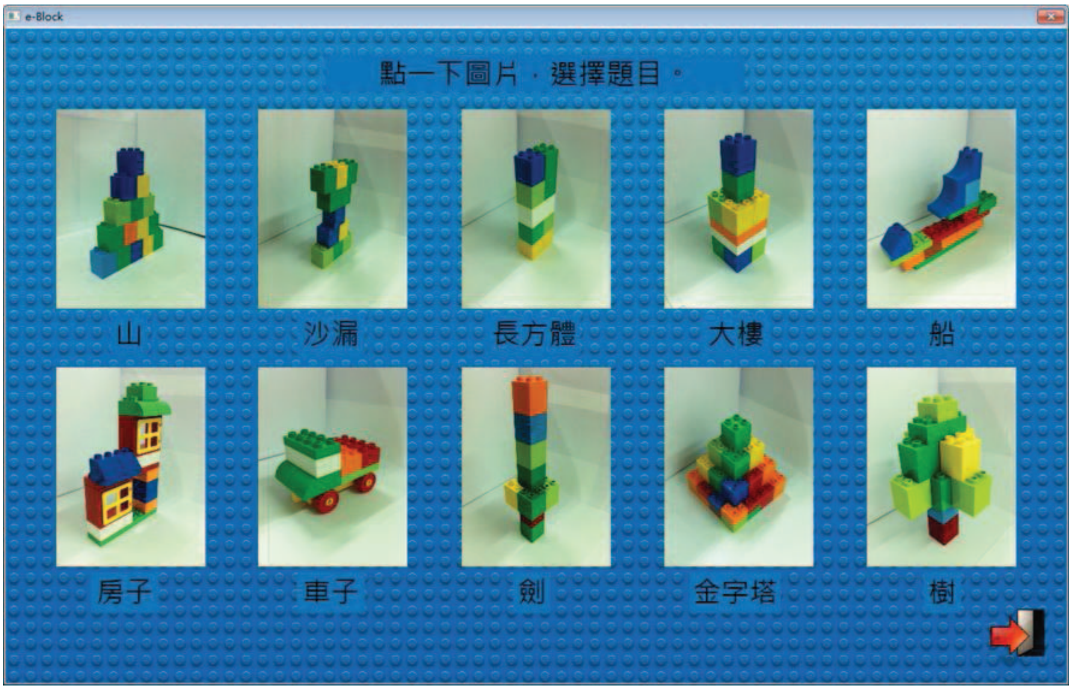


Fig. 3. Ten types of assembling objects used in the e-Block system.

Step 4. Feature Extraction and Object Recognition

In this study, a density projection algorithm is proposed to extract features of the assembled object. First each data pattern in point cloud dataset is projected to the XY, XZ, YZ planes, respectively. The distribution of each plane is then normalized as the size of 320×240. Fig. 2(a) is the original image of a pyramidal object. Figs. 2(b)-2(c) show the projection intensity of XY, and XZ planes Finally, the *k*-nearest neighbor is applied to recognize whether the assembled object is the same to the target object.

III. EXPERIMENTAL RESULTS

In this study, an interactive block-building system named as e-Block is developed. First, the e-Block system randomly displays a target object in the picture for a child to assemble. The displayed picture shows the target object from two viewpoints. After the child has assembled the object with blocks, the e-Block system compares the assembled object with the target object. If the assembled object is the same to the target object, a voice response of successful message is appeared and the spending time for assembling object is also provided. Otherwise, a fail message is responded.

In Fig. 3, ten types of assembled objects are used in the e-Block system, for example, the mountain, boat, house, car, pyramid, and tree. A total of 460 and 230 images acquired by the Kinect are used as training and testing patterns, respectively. The recognition accuracy is 95.21% for classifying ten types of assembled objects. In addition, the e-Block system is also tested by night children. By analyzing the survey, all of them agree that the e-Block is interesting and joyful. In addition, if a child can successful assemble the target object in this trail, he always spends fewer time to assemble the same object in next trail. This illustrates our system could help children to learn the concept of geometric structures and space when playing with assembling blocks.

IV. CONCLUSION

In this study, we integrate the Kinect, Lego blocks, and PC to develop an interactive block-building system. The developed e-Block system boosts the motivation of children to assemble blocks. This system only display the target object from two viewpoints, then the tested children need find out a possible solution to complete it. The process of playing e-Block system would help children to train their to differentiate shapes and develop independent thinking.

ACKNOWLEDMENT

We would like to thank Dr. Ya-Fen Huang for valuable comments. This work was supported by the National Science Council, Taiwan, R.O.C., under the Grant NSC 102-2221-E-032-041, NSC 102-2622-E -032-003-CC3, and NSC 102-221-P- 006-015-.

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