An AR-based Hands-on Study System on Fruits and Vegetables for Preschoolers

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Abstract: In this paper, an AR-based hands-on study system is proposed, which provides experiences preschoolers about cutting virtual fruits/vegetables. The system consists of a tablet PC with AR system, which displays overlapped images of virtual fruits and vegetables according to cubic AR markers. A preschooler can hold, rotate and cut the virtual foods by manipulate the markers in his/her both hands. Through the intuitive experience, he/she is expected to get interests in structure of the food. Comparing with handling the real foods, the system provides limited but simple, clean and safe environment. The proposed system is evaluated by observation of experiences by preschoolers. From questionnaires to preschool teachers, it is shown that the proposed system can increase the preschoolers' interests in foods, while some improvements and addition to the features are pointed out.

1. Introduction

"Away from the sciences" has been a major educational issue in Japan[1]. Most of the Japanese young generation are moving away from studying natural sciences and mathematics. The concern will impact on Japanese economy and industry in future as well as it will impact on Japanese level of intelligence, in comparison with situation in other countries/areas. Although fruitful impressions and interests through experience especially in childhood have been said to be keys for improving or easing "away from the sciences." For example, in the official educational guideline for Japanese preschool, importance on interaction with the nature is emphasized. However, such occasions become less in the urban area. Currently, there is no quick-impact complete solution about that. Therefore the combination of some partial but good solution should be discussed and applied if necessary.

From viewpoint of increasing preschoolers' experiences, laboratory with familiar nature products is effective. Cutting fruits and vegetables is simple but good experience for them to get interests in the foods. Contrary to reading picture books or viewing videos about food, they can interactively get information on three dimensional structures with haptic and olfactory senses through the cutting. However, the "real" cutting may cause injury accidents so that preschool teachers does not always agree with doing such laboratory.

Limited but similar experience can be made by virtual reality (VR) and/or augmented reality (AR) technologies. Namaly, AR is better than VR from viewpoint of providing haptic sense to users. Setozaki, et. al., developed an AR-based study system about astronomy for junior high school students[1]. Also Kosugi, et. al., proposed an AR study materials for preschoolers. Both systems lack either easy use or charm to preschoolers, while system achieves a certain level as study materials[2],

Therefore in this paper, we propose an AR-based hands-on study system, which provides experiences preschoolers about cutting virtual fruits/vegetables. The system consists of a tablet PC with AR system, which displays overlapped images of virtual fruits and vegetables according to cubic AR markers. A preschooler can hold, rotate and cut the virtual foods by manipulate the markers in his/her both hands. Through the simple but intuitive experience, he/she is expected to get interests in structure of the food. The proposed system is evaluated by observation of experiences by preschoolers. From questionnaires to preschool teachers, it is shown that the proposed system can increase the preschoolers' interests in foods, while some improvements and addition to the features are pointed out.

2. Proposed System

The proposed system is installed on Microsoft Surface3 with the "AR-ToolKit"[3]. Figure 1 shows transition diagram of the system. A preschooler is expected to view his/her workspace throught the tablet PC. Recognizing two markers he/she holds, the system overlapps an image of corresponding fruit or vegetable. He/she can see its cross-section surface when he/she separates one marker from the another. The threshold is set to 75mm for the determination of displaying the cut scene. The user or supporter can change fruit or vegetable by indicating on the menu window of the system. This system uses 4 markers. The 2 markers are object marker for displaying models. The marker is text marker for displaying description. The other marker is return marker for displaying menu.

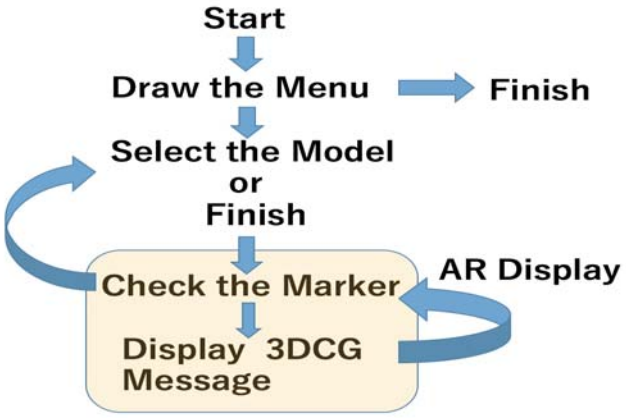

Figure 1. Transition diagram

3. Experiments and Evaluation

The flow of the proposed system is shown in the following.

Step 1: Preschooler selects the model from menu.
The menu of this system to select model has buttons for intuitive operation at touchpanel.The system displays photo and name of food for intuitive selection.

Step 2: After preschooler selects model, the system loads mqo and jpeg files of the selected model.
The system calls batch file corresponding to the selected model. The batch file calls AR display with the selected model.

Step 3: The system acquires an image taken by a camera and outputs the image to display.
The system loads pattern file of 4 markers and initializaion processing is executed. The System sets threshold to select status of the model.

Step 4: The system searches the markers from an image taken by a camera.
The system searches patterns corresponding to pattern files from an image. The system calculates an angle of the patterns.

Step 5: Preschooler can manipulate (move and rotate) the markers. The system displays 3D virtual objects with description whenever the system recognizes the markers. object marker is used for displaying a model. When the system recognizes 2 object markers, the system calculates distance between the object markers. The system displays a combined fruit when the distance is shorter than the given threshhold, which is determined in consideration of error in the recognition of distance by ARToolKit. Otherwise when the distance is longer than the threshold, the system displays separated fruit. Considering usability and precision of the camera, we conclude that the threshold must be 50-100 mm. In the following experiments, we define the threshold as 75mm.

Step 6: If the system recognizes return marker, go to Step 1.

The proposed system is expected to have the following features:

- Intuitive understanding of food structure before/after cutting
- Easy, clean and safe environment for preschoolers
- It is possible to display description of food

On the other hand, the system does not provide smell and correct haptice sense of the foods. Therefore, the system is regarded as complementary study material.

Figures 2-1 shows a snapshot of a scene when a preschooler used the proposed system. Figure 2-2 shows markers used in the system. The “Draw Object” marker are used to draw the object. The “Draw Text” is used to display the description. The “Return to Menu” is used to return to menu. Figure from 2-3 to 2-7 shows a display of system. Figure 2-3 shows a menu to select models. Figure 2-4 shows that fruits combined to one. Further figure 2-5 shows that fruits split in half. In addition, figure 2-6 shows that Fruits combined to one with description. Further figure 2-7 shows that fruits split in half with description.

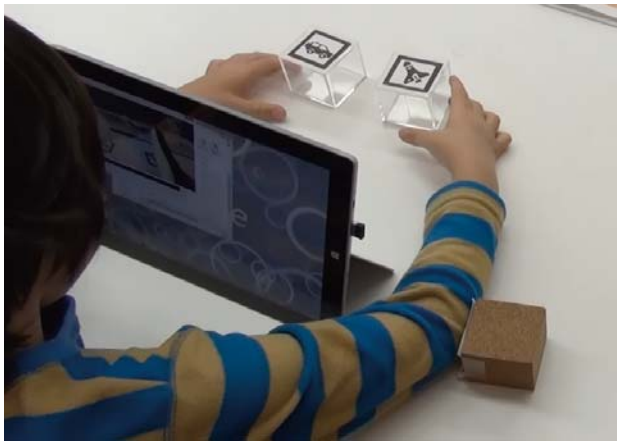

Figure 2-1: Snapshot of the system working manipulated by a preschooler

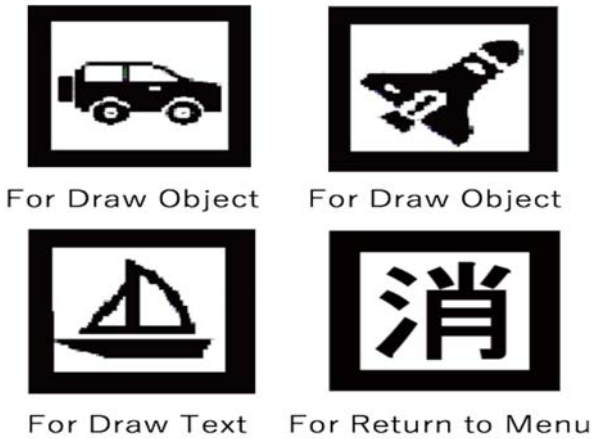

Figure 2-2: Markers for the proposed system

Figure 2-3: Display Menu

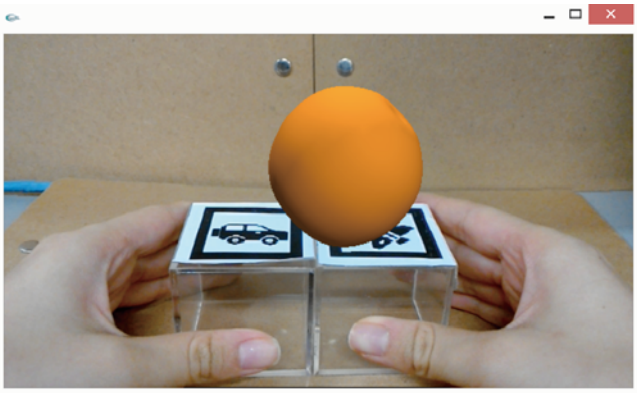

Figure 2-4: Combined Fruit

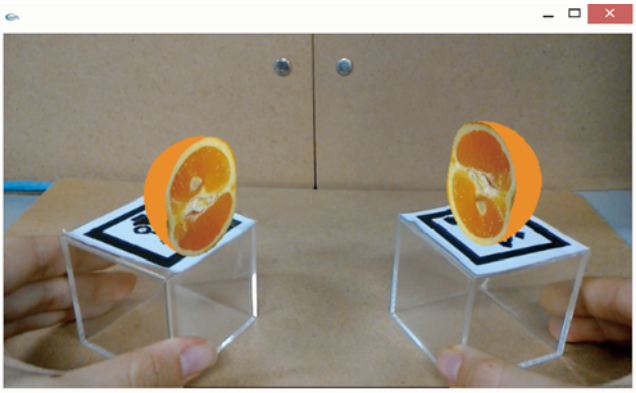

Figure 2-5: Separated Fruit

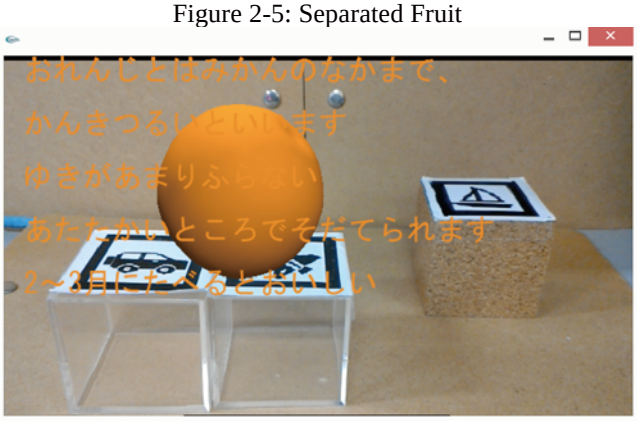

Figure 2-6: Combined Fruit with Description

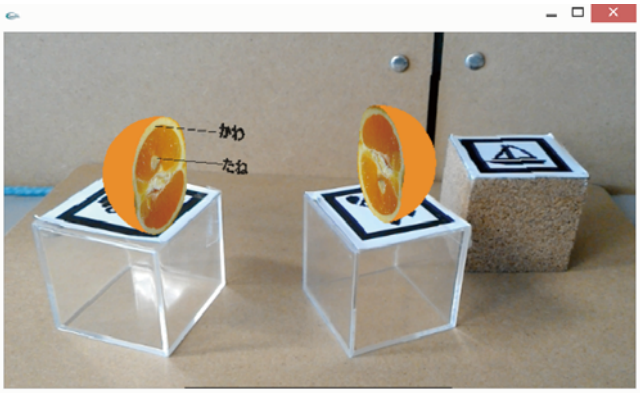

Figure 2-7: Separated Fruit with Description

For evaluation, 7 preschoolers at 5-6 years old experienced the system after pre-questionnaire. Their teachers answered questionnairies after they observed childrens' experiences.

Table 1 shows the result. In the table, the rating from a(best) to 4(worst).

Table 1. Evaluation by teachers

	1	2	3	4
1.Were Preschoolers able to select the model	6(3)	1(1)	0	0
2.Were Preschoolers able to transform the model	4(3)	2(0)	1(1)	0
3.Were Preschoolers able to display the description	1(1)	2(0)	3(2)	1(1)
4.Were Preschoolers able to recognize the marker	5(3)	2(1)	0	0
5.Were Preschoolers able to call to the Menu	4(1)	3(3)	0	0
6.Were Preschoolers able to understand the Operation System	2(2)	5(2)	0	0
7.Were Preschoolers able to intuitivey operate the system	4(3)	3(1)	0	0

From item 1 in Table 1, it is shown that to select the model with touchpanel by preschoolers is highly achived.

According from item 2 in Table 1, it is shown that the prescoolers transform the model with intuitive operation by markers is highly achived.

Although the low evaluation about item 3, it is shown that the system do not display the description by operation of the preschoolers. Because this system uses 2 markers to display models and shuold be put on a marker to display description of food. Space recognized by a camera is lost. Therfore the system makes preschooler coordinate the markers. However coordinating the markers is difficult by the preschooler. Therefore more available space and better recognition should be given by the system. To solve this problem the markers are released the distance from camera or are shrinked. However small marker may increase the risk of accidental ingestion. Therfore the way of releasing the markers the distance from camera is the best. To increase the distance between camera and marker, it is necessary to use a small tablet or to put on a table the tablet and putting on the markers under the table.

Also from item 3 and 5, it is shown that there is difference by a way of using the markers. The system shows menu after the system recognizes marker at once. In contrast, the system does not show description after the system recognizes marker at once. To solve this problem,

that the system continues displaying description may gives better impression to the users.

From item 4 in Table 1, it is shown that recognizing marker by the preschoolers is highly achived. The users move usually tablet three-dimensionally to recognize marker in AR system. In contrast, the users move the markers two-dimensionally on the table to recognize marker in this system.

From item 5, 6, 7 in Table 1, it is shown that intuitive manipulation for the preschoolers is highly achieved.

Table 2. Evaluation by teachers

	1	2	3	4
8.After preschoolers use system, be interested in food better	2(2)	2(1)	2(0)	1(1)
9.After preschoolers use system, be interested in nature better	2(1)	1(1)	0	4(2)

Table 3. Correlation

	1	2	3	4	5	6	7	8	9
8	0.68	0.73	0.44	-0.48	0.04	0.79	0.60	1.00	0.46

Table 4. High ecaluate rate

	High evaluate rate		
	Over one a day	Over one a week and under one a day	Over one a month and under one a month
1.Rate of 1 evaluation to (1)	100.0%	100.0%	50.0%
2.Rate of high evaluation to (9)	100.0%	0.0%	0.0%

From item 8 in Table 2, it is shown that intuitive system for preschoolers is highly evaluated. Considering correlation between items, item 6 shows importance for the users to get more interests in the food. Also item 1, 2 shows importance for the users to get more interests in the food. It is important that preschoolers operate the system and display cross section of the foods with hands-on.

Although the low result about item 9, it is shown that preschoolers can not display description. Item 9 improves by improving the way of displaying description and description. Also the high result about item 9 in preschoolers utilizing smartphone or tablet over one a day. Therefore this system is useful about the preschoolers. However this system is not useful about other preschoolers. This comes to a settlement by increaseing operation with marker instead of touchpanel.

Distance between the preschooler and tablet is about 15cm. Arms of preschoolers is short. Therefore tablet needs shrinking to acquire more distance.

4. Conclusion

In this paper, an AR-based hands-on study system is proposed, which provides experiences preschoolers about cutting virtual fruits/vegetables. The system consists of a tablet PC with AR system, which displays overlapped images of virtual fruits and vegetables according to cubic AR markers. A preschooler can hold, rotate and cut the virtual foods by manipulate the markers in his/her both hands. Through the intuitive experience, he/she is expected to get interests in structure of the food. Comparing with handling the real foods, the system provides limited but simple, clean and safe environment. The proposed system is evaluated by observation of experiences by preschoolers. From questionnaires to preschool teachers, it is shown that the proposed system can increase the preschoolers' interests in foods, while some improvements and addition to the features, especially suitable presentation of text information, are pointed out.

5. Acknowledgment

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