An Augmented Reality System for Learning the Interior of the Human Body

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Abstract

Augmented Reality has been used for developing systems with learning purposes. In this paper, we present an Augmented Reality system for learning the interior of the human body. We have tested the system with children of the Summer School of the Technical University of Valencia. In this test we have analysed if the use of a Head-Mounted Display or a typical monitor influence in the experience of the children. Results do not offer statistical significant differences using both visualization systems and confirm that children enjoyed learning with the system and consider it as useful tool not only for learning the interior of the human body but also for learning other subjects.

1. Introduction

Many fields have used Augmented Reality (AR). For example: military; medicine; engineering design; robotic; telerobotic; manufacturing, maintenance and repair applications; consumer design; learning; entertainment; edutainment; psychological treatments, etc. [1][2]. In this paper we present an AR learning system and for this reason only several AR applications developed for learning purposes will be cited as examples. 1) Construct3D [3] is an AR system for constructing 3D geometries. It was designed for learning mathematics and geometry. It was tested with students comparing traditional learning with the AR system. 2) Mixed Reality Lab of Singapore (www.mixedrealitylab.org) has developed several AR systems for learning purposes such as: An AR system for learning the sun system; An AR system for learning how the plants germinate, etc. 3) Billinghurst et al. [4] presented the Magic Book. It seems like a normal book, but in the pages are markers, when the system recognizes a marker, an image is shown or a story starts. This type of books can be used for learning, storytelling, etc. 4) The Magic Story Cube [5] uses a cube as a tangible interface that is folded or unfolded and depending on the markers that are visible the story is different. The Magic Story Cube presented the story of the Noah's ark.

2. Augmented Reality system

2.1. Hardware

The system requires a camera to capture the real world in order to determine where the virtual elements will exactly have to be drawn. We have used a FireWire camera. To be exact a Dragonfly has been used. After processing the captured image, the system obtains the real camera position and orientation relative to physical markers, and determines where the virtual elements have to be drawn. A Head-Mounted Display (HMD) was used as visualization system. We have used the i-Visor HMD.

The camera has been attached to the HMD. In this way, the user sees what he/she would see if he/she did not wear any device. The image that appears on the HMD also appears on the computer screen.

2.2. Software

We programmed the system using ARToolKit. The version used was 2.65 with VRML support. ARToolKit is an open source vision tracking library that enables the easy development of a wide range of AR applications. It was developed at Washington University by Kato and Billinghurst (http://www.hitl.washington.edu/artoolkit). The required elements for the application are: a USB or FireWire camera, and a marker. Markers are white squares with a black border inside of which are symbols or letter/s. ARToolKit uses computer vision techniques to obtain the position and orientation of the camera with respect to a marker. Virtual elements are drawn over these markers.

The virtual elements that appear in the system are the picture of a male or a female and two possible organs: the intestine or the stomach.

2.3. Description of the system

The system consists of an AR system for learning anatomical structures in a human body. The user is able to "open" the abdomen of a virtual human body, using his/her own hands. He/She will see inside the human body, the areas where the stomach and the intestine are placed. Tangible interfaces have been used to interact with the system. The image of a human body and its interior organs will be shown over a squared structure in wood. This squared structure is covered with a white fabric. Two cuts have been made in the fabric in the zones where intestine (low part of the abdomen) and stomach (high part of the abdomen) are localized. These zones can be opened and closed by two white zips. Two colored papers (orange and blue) have been placed under these two zones. This will facilitate the system to identify the two different zones. The system requires the origin of the coordinate system in order to place all elements. This is achieved by placing a marker is one corner of the squared structure. In the system the hands are detected and shown over the merged image, see Figure 1.

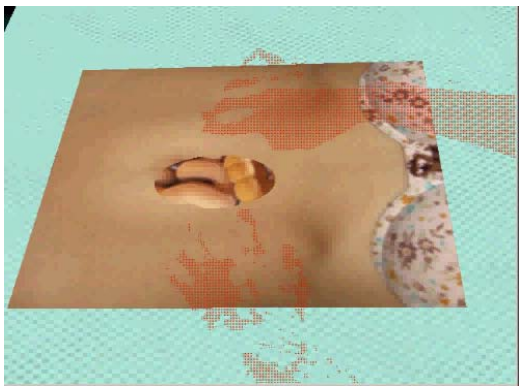

Figure 1. Female example of the AR Human Body system where the user's hands and the intestine are visible

The system woks as follow:

1) At first the system asks the child if he/she wants to see a body of a male or a female. Later, the system will show the desired body. Figure 1 shows an example of a female body.
2) The user is seeing the chosen body and the system tell him/her that he/she has to open the zip where the indicated organ is, for example, please, indicates where is the stomach.
3) The child opens the zip and the system recognizes if the child has chosen the right organ. If it is yes, the system shows: Congratulations!!. You have found the right organ!! and it shows the organ in the hole opened by the user. If not, the system shows: Sorry!. You have chosen a wrong organ. Please, try again. This step is repeated meanwhile the child does not found the right organ.
4) Steps two and three are repeated for the two organs included in this first version of the system

3. Study

The system was tested for understanding: the degree of presence perceived by the children; the degree of involvement of the children; the perceived usefulness of the system; the application usability degree; and the usability of the related interface.

Other aspects to check are to determine which visualization system they prefer and if the order of exposure influence in their perception. In order to check these aspects the following test was carried out. We checked if children prefer the HMD or if both visualization systems are perceived in a similar way. Moreover, we checked if children prefer the tangible interface or if both interaction systems (tangible interface and keyboard) are perceived in a similar way.

1) Children used a HMD as visualization system and used the tangible interface to interact with the system.
2) Children used a typical monitor as visualization system and used the computer keyboard to interact with the system. In this case the organs are selected pressing 1 for choosing the intestine, and 2 for choosing the stomach.

In the experiments, participants were counterbalanced, that is, half of the participants used first the 1) system and later the 2) and the other half used first the 2), and later the 1).

The test was carried out with children of the Summer School of the Technical University of Valencia.

The system was tested with children ranges from 8 to 10 years old. 40 children took part in the experiment. Figure 1 shows an example of the system running and Figure 2 shows a child that participated in the experiment using the system. The duration of the complete test was at about 20 minutes. After the exposure, children were asked to fill out a

questionnaire. The questions used a scale of 5 (1-Completely disagree, 5-Completely Agree).

This paper only describes some characteristics of the systems and includes one question asked as example and it is the following: *Q1: Would you like to know other parts of human body or other subjects using systems like the one you have just tried?*. This question reflects if the children think that the system is useful and it can be used for learning other subjects.

As it has already been said, we have checked if children prefer to use the HMD or the monitor in order to play with the system. For checking this, we took all the questions related with the HMD visualization system and with the Monitor. Results are presented in Table 1, second column where Student t test was applied to the scores given to Q1. We supposed that the order in which the experience were lived had an influence over the children preferences. For checking this, children tested the application in an alternate way: twenty people tried first the HMD Visualization System then the Monitor and twenty people tried it in the opposite way. Results using first the HMD and later the monitor are shown in Table 1, third column. Results using first the Monitor and later the HMD are shown in Table 1, fourth column. In both cases Student t tests were applied to the scores given to Q1.

The Student t tests have been performed with a confidence value of 95%.

From Table 1, it is possible to deduce that both visualization modes (HMD, monitor) have similar influence in children and the order does not affect their perception of the useful aspect of the system. We would like to highlight that scores given by participants were very high.

4. Conclusions

We have presented an AR system for learning the interior of the human body. This system can be improved adding new organs. We have tested the systems with children of the Summer School of the Technical University of Valencia and we have presented some results. From results it is possible to deduce that:

1) Children consider the system useful for learning the interior of the human body and also for other subjects.
2) They like the system do not matter if they were using the HMD or a monitor.
3) The order of exposure (HMD or monitor) did not affect the results.

These deductions lead us to considerer the use of this system for educational purposes.

Figure 2. Child using the AR Human Body system

Table 1. Results to Q1

	All users	HMD-Monitor	Monitor-HMD
HMD	4,50 ± 0,69	4.33± 0,89	4.5± 0,61
Monitor	4,56 ± 0,67	4,33± 0.96	4.67± 0,44

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