Build a prototype of new e-Learning contents by using the AR technology

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ABSTRACT

In the engineering education field, laboratory courses are very important for confirming theories studied. In general, these laboratory courses are more complex than classroom lectures. On the other hand, a lot of Japanese private universities become aggressive about downsizing. Therefore, this is very difficult as there are only a few teachers for more than one hundred students in a class. We have developed a new learning environment with Web based instruction manuals as e-Learning contents for these courses [1]. In our Web based instruction manual, description about experiment is doing by some illustration.

We see the next step, as students will easily understand how to operate these materials by watching the real things rather than seeing them illustrated. Therefore, we have tried to import pictures of experimental materials into this e-Leaning content. However, it was difficult to synchronize the instruction and the view of experiment materials. Therefore, we focused attention on the AR (augmented reality) Technology [2] to solve this issue. The AR Technology is a term for a live direct view of an actual-world environment that is augmented with a virtual image generated by a computer. It can enhance one's current perception of reality. By using it, we can make a new e-Learning content [3] that showing teachers through 3D computer graphics models with some instruction information attached.

Keywords: e-Learning contents, augmented reality, electronics laboratory courses, engineering education

1. INTRODUCTION

In the Engineering education field, laboratory courses are very important practical lessons for confirming the theory studied. T here are important for learners to improve their skills gradually from a rudimentary stage within a very limited classroom time.

A tough condition that there are only a few teachers for more th an one hundred students must be presumed in just one class. Si nce students do not have enough chance to prepare and review the experiments practically, a sort of virtual experimental envir onment is very useful in some cases. For these reasons, technol ogy that offers a virtual experimental environment that doesn't need real parts and tools has been widely researched.

However, although software faithfully reflects the theory, unexpected difficulties can occur in the design of actual systems, resulting in a shortage of training for students. Therefore, experiments using actual electrical parts and apparatus are indispensable training for practicing engineers. In a class for more than over hundred students with a few teachers or instructors, the experiment manual plays a key role. To guide experimenters properly, refined theories and directive procedure must be described appropriately in these manuals.

2. Individualized Experiment System

We have developed a new system based on individualized experiment environment and Web based learning system with instruction manual. Each student does experiment with personal laboratory booth while seeing a web page of our Web based instruction manual by using the Web-browser.

The Web based instruction manual is written by HTML and some Web technology. It is in page form, as shown Figure 2, and students can reads forward and backward page by clicking a thumbnail images in the left column. This manual acquires the access log to each page of students.

2.1 Individual Booth

The individual booth is installed some experiment equipment that an oscilloscope (A&D AD-8623A) and a power supply device, a soldering iron, etc. Also, in addition to these devices are also installed PC. Each student does experiment using the individual booth individually.

2.2 Web based Instruction Manual

The Web based instruction manual for experiments progress is composition by Web page of describing for theories about experiment and describing for experiments work. Student does experiment with individual booth while seeing a Web page of our Web based instruction manual. The Web based instruction manual can obtain the access log to each page of students.
This is expected to help improve for next class by feedback to teachers.

In Web based instruction manual, description about the experiment items is doing use some illustrations for instruct to students. However, in the individual experiment environment, some students, there is a vague understanding of experiment items operation. We have thought that these students will understand easily how to operate these items by watching rather the real items than seeing them illustration.

Therefore, we focused attention on AR (augmented reality) Technology to solve this issue.

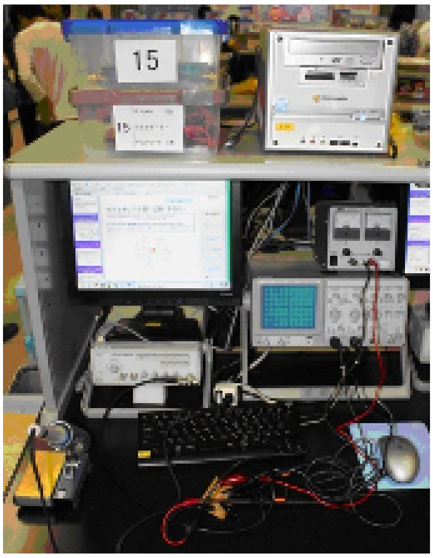

Figure 1. Overview of the personal laboratory booth

Figure 2. An example of a Web based manual (in Japanese)

3. AR (Augmented Reality) Technology

The Augmented Reality Technology can append to information such as virtual model made by a computer on information of actual-world environment. To implementation, it must consider superimposed position of virtual model fit with attitude and position of Web-cam. The sensor-based and the vision-based there are two methods to positioning. The method by sensor-based is using the some sensor to obtain the position of camera device. The method by vision-based is using the information contained in obtained picture by camera device to positioning. Currently, these applications to create by program library “ARToolKit” [4]. The library can build to AR applications using C and open source software. In addition, java developers can create AR application by use library “NyARToolKit”. This development is using “FLARToolKit” [5] that is one of the augmented reality program libraries.

A picture of actual-world environment and picture of augmented real by using AR technology as below shown in Figure 3.

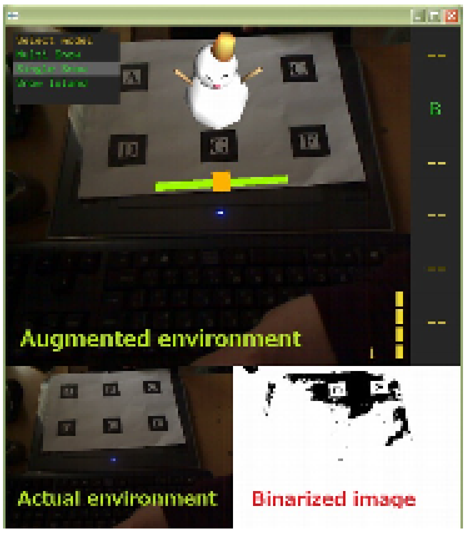

Figure 3. An example of a superimpose a 3D graphics model on a marker

4. New Web based instruction manual

We accomplish certain results by these innovations. However, we think there is still plenty room for improvement. We believe that it will lead to study by instruction with actual items for students.

Therefore, we tried to import the picture of experiment items into our Web based instruction manual (Figure 2). We record movies with Web-cam in a student booth (Figure 1) and then make a composition Web page. However, this approach could not synchronize the movie with the instruction. Therefore, we focused attention on augmented reality technology to solve this issue. The Augmented reality technology is a term for a live direct view of an actual-world environment that is augmented with virtual image generated by a computer. It can enhance one’s current perception of reality. By using FLARToolKit [5] that is one of the augmented reality program libraries [4], By using it, our Web based instruction manual will become tracking mark that uses simple black squares for positioning some instruction information (Figure 4) and then showing teacher by 3D computer graphics models with some instruction text. The size of the marker and accuracy of superimpose are proportional. However, experiments equipment does not have enough space for setting marker. Therefore, we measured the confidence of the marker.

Figure 4. An example of tracking marker

4.1 Measurement the confidence of the marker

We have measured confidence of the markers for determine whether how much space is needed. In this measurement, 13mm, 19mm, 25mm size markers, each 30cm, 45cm, 60cm taken from a distance and then obtained the confidence as shown in Figure 5. In addition, the measurement results are shown in Table 1.

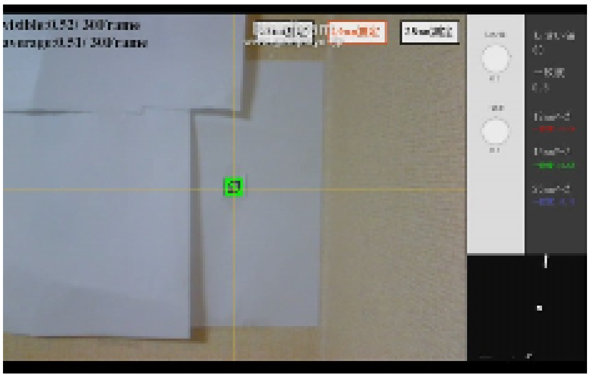

Figure 5. An example of measurement for confidence rates

Table 1. Measurement results between markers.

Distance	**30cm**	**45cm**	**60cm**
13mm marker	0.48(0.87)	0.14(0.00)	0.0(0.00)
19mm marker	0.67(0.97)	0.5(0.71)	0.29(0.00)
25mm marker	0.81(1.00)	0.62(1.00)	0.45(0.62)

These numbers are confidence of markers by measurement at three distances. Number in round brackets in this table is meaning of the steady fraction in one second. In fact, it is need over 0.5 to ensure efficacy. As a result, this system requires at least a 19mm blank square to set a marker.

4.2 Superimpose the instructions

The new learning content is doing instruct to the actual experiment items by superimposing some instruction images. It needs some resource information of instruction images paths and position of superimpose, region size of images, etc. for superimpose to movie of experiment items.

It is developed using the FLARToolKit and written by the Action Script 3.0. Therefore, it can embed as Flash movie into Web page of instruction manual as shown in Figure 6.

Figure 6. An example of a new Web based instruction manual (in Japanese)

This information is defined by XML format data. When student open this page, program reads this XML file and then automatically superimposes the instruction images to experiment items. Therefore, a teacher can add new instruction by simply adding element in XML.

An example of a definition is shown in Figure 7.

```
<annotation step="2" type="static">
  <path>Annotation/PowerOFF_into_top.png</path>
  <position>
    <x>-15</x>
    <y>-140</y>
    <z>0</z>
  </position>
  <size>
    <width>25</width>
    <height>30</height>
  </size>
</annotation>
```

Figure 7. An example of a definition

We have believed certain result that will improve further the laboratory courses by using our new e-Learning content.

5. CONCLUSION

In this paper, we proposed a new e-Learning content through the use of the augmented reality technology. Because this content is still being developed, we must strive hard toward perfection. And then we will try evaluation experiments for our university students. We think this approach can be used not only for instructional manual but also for any content, including some documentation. So, we will try to explore a new possibility, too.

6. REFERENCES

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