

AUGMENTED REALITY LEARNING MEDIA ON ANDROID SMARTPHONE: KnowItsLife

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Abstract

Nowadays, Smartphone is one of popular mobile phones used as a learning media. So, we have developed Augmented Reality learning media on Android smartphone: KnowItsLife which is a learning media about interspecific interactions for instances, Predation, Herbivory, and, Mutualism, etc. It not only works with a 3-dimentional pop-up book which includes an augmented reality (AR) card, but also uses the smartphone camera to detect AR card, lets users input several animals, and shows explanations of interspecific interactions. Its process can be divided into 3 parts, such as, AR card detection, object's position computing, and object displaying. After the development, we tested it with grade 8 students from Chulalongkorn University Demonstration Secondary School. The test result showed that it could make students more understand about interspecific interactions average up to 27.78 % and have fun while learning.

1. INTRODUCTION

Nowadays, many people use mobile phones. They do not only use for oral communication, but they also use for texting, taking a photo, listening to music, and being learning media. A mobile phone has many controlling functions depending on each type of mobile phone. Smartphone is a mobile phone which

Key words: augmented reality, AR card.

can be controlled by various functions such as using touch screen, device leaning, and others which are built from combining old functions such as using both touch screen and device leaning in racing car games. There are different sizes of Smartphone for different people. So, the aim of this project is to develop a learning media which has new controlling functions for every size of Smartphone.

Today, there are many operating systems for Smartphone and a very popular one is Android OS which is freeware. Thus, our learning media developed on Smartphone uses Android OS.

KnowItsLife, our developed is learning media using for learning under a topic of interspecific interaction in a field of ecology. KnowItLife uses Augmented Reality (AR), putting an object showed in the real world, with a 3-dimensional pop-up book including augmented reality card. Users use a camera function in the Smartphone to capture this book. When it is captured, a grass surface will appear on the book. KnowItsLife has a menu for choosing animals to be putting on the grass surface. Users can rotate the Smartphone and the book to change view, and zoom in and out by moving the Smartphone close to the book and far from the book. If animals on the screen have interactions in the real world, they will have interactions on the screen like they do in the real world and the explanation quote will appear on the screen. For an example, when a wolf and a rabbit are on the screen, the wolf will chase the rabbit and explanation quote of predation appears.

2. DESIGN, DEVELOP AND IMPLEMENT OF KNOWITSLIFE

KnowItsLife is a learning media with the 3D pop-up book including augmented reality card. We proposed 7 animals which you can choose to put them on the Smartphone screen. There are fleas, bees, birds, rabbits, wolves, cows, and giraffes. On the 3D pop-up book, there is a field of grass, flowers, and trees. And, interspecific interactions which can be happened are as follows:

- 1) Predation is an interaction between species which one species, the predator, kills and eats others, the prey, for an example, wolf and rabbit.
- 2) Herbivory is an interaction in which an organism eats parts of plants or alga, for examples, rabbit and grass, cow and grass, and giraffe and trees.
- 3) Parasitism is a symbiotic interaction which one species, the parasite, derives its nourishment from another species, its host, which is harmed in the process, for examples, flea and rabbit, flea and wolf, flea and cow, and flea and giraffe.
- 4) Mutualism is an interaction that each species benefits each other, for an example, bee and flower.

<p>IF an intensity of (x, y) is more than $T(x, y)$ THEN the intensity changes into 0 ELSE the intensity changes into a max value which is 255.</p>
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Figure 1: The device screen while capturing the AR card.

5) Commensalism is an interaction between species that benefits one of the species but is not harmed nor helped by it, for an example, bird and tree.

6) Facilitation is an interaction which species can have positive effects on the survival and reproduction of other species without necessarily living in the direct and intimate contact of a symbiosis, for an examples, cow and bird.

7) Competition is an interaction which occurs when each animal try to obtain a resource that limits their growth and survival, for example, a lot of wolves hunt one rabbit.

Processing of KnowItsLife for showing objects, animal and a grass field, can be divided into 3 parts; capturing AR card, calculating object position, and showing objects.

A. Capturing AR card

OpenCV[3] is an open source computer vision library which includes several hundreds of computer vision algorithms. It can receive images from the camera continuously, calculate the images, and show results in real time. Capturing AR card part used OpenCV functions. Its algorithm is as follows:

Step 1 Receiving an image: The device receives a gray-scale image from the camera, and the size of image is the same as the size of device's screen.

Step 2 Applying adaptive threshold: The program applies an adaptive threshold on it. For each coordinates (x, y) in the image, $T(x, y)$ is a weighted sum (cross-correlation with Gaussian window) of the 11×11 neighborhood of (x, y) minus 2. Then, an equation as in Figure 1 changes an intensity of (x, y) . After that, the image turn to be a black and white image.

Step 3 Finding contour of a rectangle: In this part, we need to find a border of the AR card from a balck and white image. Firstly, the program compresses horizontal, vertical, and diagonal segments and leaves only end points. For example, an up-right rectangular contour is encoded with 4 points. Then, it retrieves all of the contours and reconstructs a full hierarchy of nested contours. Next, the program compares between these contours to find one whose shape looks like a rectangle and is the biggest one. That means the AR card is the biggest rectangle in the image.

Step 4 Checking if the rectangle is the AR card: The program puts an image inside the rectangle into a new square-shaped image. Then, the program verifies it by analyzing if it has specific features. After that, the program calculates and gives an output which is a position of 4 corners and a direction of the AR card.

B. Calculating object position

The AR card can be divided into a 4x4 table and an area of the book can be divided into a 12x20 table which includes 4x4 table of the AR card in the center. The object can appear on corners of each cell of the table. When we get a 12x20 table, we can find the object's position. This part's algorithm is as follows:

Step 1 Finding a 3x5 neighborhood of the AR card: We draw a square tiling in perspective by using extended sides of the AR card and diagonal lines to find perspective points and calculating them. Then, we get a 3x5 table.

Step 2 Dividing each cell into a 4x4 table: Firstly, we divide each cell into a 2x2 table by finding an interception of two diagonal lines and drawing lines to divide it. Then, we divide each cell into a 2x2 table again. So, we get a 4x4 table for each initial cell. Finally, we get a 12x20 table.

C. Showing object

Before the program shows objects, it needs to find a size and a direction of objects. The size of the objects can be calculated from size of neighborhood cells which the object is on and original size of the object. For the direction, it can be calculated from the direction of the AR card and the direction of object. Finally, the program can show the objects with the right size and direction. See Figure 2.



Figure 2: The device screen while capturing the AR card.

Objects, which are 7 animals, have different actions for each object as follows:

- 1) Bee - moves to a flower
- 2) Flea - finds an animal, derives its nourishment until it is dead. Then, finds another animal
- 3) Bird - flies to a tree or living with a cow to get some food while the cow is stepping on the ground
- 4) Rabbit - hops, eats, and runs away from the wolves
- 5) Wolf - chases the rabbits
- 6) Cow - walks and eats grass
- 7) Giraffe - walks and eats leaves from a tree

Besides the objects which are animals, there are a menu and interspecific interactions' name and descriptions. When users touch on the screen, the menu which includes 7 animals appears on the right of the screen as in Figure 3. Touch the screen outside the menu area to make the menu disappear or touch a name of animal in the menu to make appear in the field.

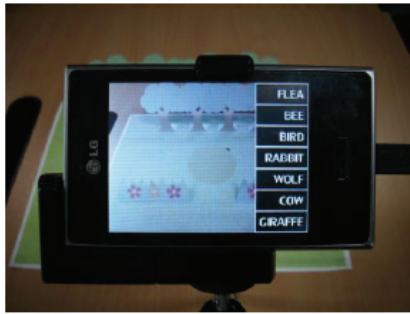


Figure 3: The screen showing the menu of animals

When an interspecific interaction happens, its name appears with a black semi-transparent background and all animal stop their action as in Figure 4.

On the right top of the screen, there is an "I" symbol. The description can be shown or hidden by touch this symbol as in Figure 5. To make the name and description disappear, just touch the area outside the symbol.

3. EVALUATION OF KNOWITSLIFE

We tested KnowItsLife on Smartphone with an Android operating system (version 2.3.3). Users of this test were 20 grade-8-students from Chulalongkorn University Demonstration Secondary School.



Figure 4: The screen showing a name of interspecific interaction



Figure 5: The screen showing a description of the interaction

Firstly, we divided students into 2 groups which consisted of 10 students. Then, we let the first group in laboratory and assigned them to do a pre-exam. After that, we taught them in interspecific interactions by using slide presentation. Next, we assigned them to do a post-exam and a survey about satisfaction to the recent teaching. Then, we let the first group out and let the second group in. We assigned them to do as the same as the first group, but we taught them about interspecific interaction only with KnowItsLife. Results of the pre-exam and post-exam, and difference between both exams of the both groups can be compared and shown as TABLE I and TABLE II, respectively.

According to TABLE I and TABLE II, we found that mean score of pre-exam from both groups are equal. From the result of the first group, mean score of post-exam is higher than one of pre-exam up to 46.30%. In the other hand, from the result of the second group, mean score of post-exam is higher than one of pre-exam up to 27.78%. It shows that slide presentation and KnowItsLife can make student understand about interspecific interaction better, but slide presentation did better than KnowItsLife.

According to the survey, we found that KnowItsLife let students participated in learning and made student have fun more than using slide presentations. Furthermore, KnowItsLife is appropriated to the lesson and is more interesting than only slide presentation.

To sum up, KnowItsLife should be used together with slide presentations to make students understand more and have fun at the same time.

4. CONCLUSION

KnowItsLife can make users understand the interspecific interactions better up to 27.78% and have fun while learning. However, users are not satisfied with accuracy and its speed of processing because images from Smartphone's camera have a lot of pixels. It makes our Smartphone cannot work fast enough to satisfy users. Moreover, in AR card detection process, it will verify an image which is received from Smartphone's camera thoroughly. Light and shadow which on the AR card can affect to detecting process and can make a result inaccurate.

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