Augmenting Physical Animal 3D Models For Agribusiness Vocational Learning.

Zvetlana Bajada, Daren Scerri
Institute of Information & Communication Technology
Malta College or Arts, Science & Technology
Corradino Hill
Paola PLA 9032
zvetlana.bajada.a100022@mcast.edu.mt

***Abstract*—Lecturers of the Agribusiness Centre at MCAST strive to teach students using 3D life-like models. Since they are expensive only the lecturers can use them while they are delivering the lecture. This paper presents a prototype that will assist the lecturers and students of Agribusiness Centre at MCAST, to help them interact with the 3D life-like models using an Augmented Reality (AR) application. It will help the students by identifying the organs of the 3D life-like model by labelling them and in addition the student can watch a video related to the 3D model to understand more.**

***Index Terms*—Augmented reality, 3D object, Labels, Teaching, Learning**

I. Introduction

The Institute of Applied Sciences Centre of Agriculture, Aquatics and Animal Science offers Diploma and Degree courses in Animal Care, Animal Management and Veterinary Nursing [1]. Knowledge about animals is an important part of vocational education. Lecturers frequently encounter the difficulty in the teaching and learning which involves real scenarios e.g. large live animals. This is due to inaccessible environments and precautions that need to be taken with live animals. To address this challenge, the Agriculture Centre has invested in a number of 3D life like models to aid in the acquisition of knowledge about various animals and their anatomy. However, the models lack in themselves the content to be learnt. Although these models are highly useful, information related to them is still presented as paper posters or documents. The aim of this study is to explore the use of Augmented Reality (AR) technology to present better knowledge related to the 3D life-like models. This would enable lecturers to present and students to understand better the anatomy of the animal object [2].

Given the challenge with the Agribusiness centre explained above it is being assumed that AR can address this problem and improve accessibility through the use of mobile applications which accurately display augmented content like model labelling, placing objects, information, audio or video to facilitate learning through these expensive models.

1) How will Augmented reality facilitate the teaching and learning that involves real scenarios?
2) How will the result be presented in this application?
3) How can such a prototype be evaluated in term of accuracy and performance?

The aim of this project is to assist the agribusiness lecturers at MCAST by making it easier the proposed application will help them teaching the students by showing the 3D model label represented on the model organs using the mobile application. Therefore, students will be able to interact more with the 3D model by creating labels, delete and even play videos.

The goal of this research is to develop an AR application which displays accurately augmented content like placing labels on a 3D object. Finally, the achievement of accuracy and performance of the prototype is an asset.

The motivation of this research is the significant of this application that accuracy of the 3D labels on the 3D models will assist the lecturer and students at the institute of Applied Sciences at MCAST.

The purpose of this project is to assist teachers by giving them the ability to teach students using animals which are 3D objects. No matter the technological advancements, it is still hard for teachers to have interactable resources for them to use. Rather than using simple images of an animal's internals to explain their functions and locations, they could use a 3D object which entices users to interact more. Students could interact with the application and understand more using augmented reality technologies. The application will provide labels on the internal organs of the 'augmented animals', playing a video about the detected 3D object and displaying information about the 3D object.

II. Literature Review

Augmented Reality (AR) is a popular technology that manages to combine the real world and the virtual world together in order to create new experiences and environments. AR technology is also possible to experience on smartphones making it available to more users [3]. As of recent years, mobile devices have been upgraded with the inclusion of new features which can support Mobile Augmented Reality (MAR). MAR is a new experience for users and is being welcomed by many, and being spread throughout mobile app markets. MAR is one of the many developments being adapted from classic AR technologies [4].

Kesim and Ozarslan outline how AR Technology can also be experienced thanks to advancements with smartphones, making it more widely available to users, it has been used in used in various fields such as military; engineering design; manufacturing, maintenance and repair applications; consumer design; psychological treatments, etc. Displaying information by using virtual objects that a user cannot directly interact with or sense in real life, can enable a person to interact with the real world in different ways. We can edit the position, shape, and/or other visual features of virtual objects when desired thanks to specific techniques supported by augmented reality. Using our hands or a supported device's movement such as a shake or a tilt gives the ability to manipulate virtual objects. Augmented Reality can be utilized for learning, entertainment, or a combination of both by enhancing a person's level of interaction with the real world, by using augmented reality. Users can move around virtual images and view them from any specific points/angles, similar to a real object. Information conveyed by virtual objects can also help users do real-world tasks [5].

Lee and Choi are presenting an application which superimposes 3D Animal Models living in tideland in a sequence when the users make image targets in real time. They are attempting to improve the overall effectiveness of the proposed technique by implementing a Mobile Augmented Reality Application for smartphones using 3D animals, by selecting 10 animals living in tideland and creating 3D Animated Models of them. When implemented the application, 'Vuforia' SDK is being used so that the 3D tidal animals can be seen on a 2D plane through the use of a mobile device and its camera [6].

Authors of another research paper are proposing a multitude of techniques on how to place external labels on a 2D image [7]. As AR Cameras are always in motion, the labels float around the object they refer to. Desktop applications often only display external labels when the camera is not in motion. The specific technique is applied onto the label, as the 3D label is made up of a 3D annotation, a 3D pole and a singular anchor point - so that the label is essentially attached to the object and not "floating" around it. As this approach is aimed towards higher standards in terms of stability of the layout and general aesthetic, this paper introduces strategies for said layouts in 3D object spaces. Figure 1 shows the result of a balanced label distribution [7].

The authors proposes plant learning and a way for students to understand nature. With the help of mobile applications, the author finds a way to provide assistance in learning about plants. In previous research there was an application that was developed and designed based on mobile visual search.

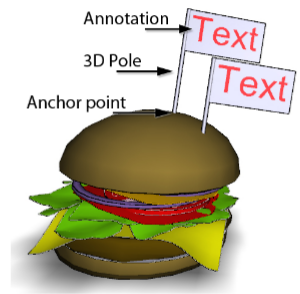

Fig. 1. labeled 3D object

The system using mobile intelligence could take pictures, audio, video and other information associated with plants. Though the system still required some modification. The researchers modified their system by implementing AR in it, using similar technologies like this paper is going to propose they were able to build a mobile application with Unity. By selecting the AR button from the mobile application it automatically requests usage from the phone's camera, and scans the plant. After the scan has finished - the information about the plant will be displayed on the screen so the student can interact with the 3D model of the plant by rotating it, zoom in and out, swiping left and right for information and rotating the model. This could increase the students interest and understanding about plants [2].

In this final research paper Mambu et al (2019) discusses AR to aid blind persons. In their daily lives they depend on other people, in a research which was based on 5,329 blind people, it showed that they had a hard time identifying objects on their own as well as describing the object. Therefore, the authors developed a mobile application for blind people so with a smartphone they can scan an object and the application will output a sound and give information about the object that the person is scanning. This application make use of 'Vuforia' that contains the data sets so that when the camera is pointed at an object, the camera can identify it via markers, of which are identified by that of a single image. In this research the total of identified objects are 40 objects that consist of jelly powder, noodles and wafers. The time required to identify the objects are seconds, with the help of google assistant they can open the application and then it will detect automatically objects that the user wants. If an object cannot be identified, then the application will keep on rendering until an object has been identified. The limitation of this application is that the user can't identify all objects but in the future the user themselves can add objects upon which the application could be converted and made available on different platforms [8].

The proposed application will use similar technologies that was mentioned above using Unity and 'Vuforia' to upload the chicken 3D scan. The application can provide features such as creating a label, watching videos, instructions etc. Also, the proposed application will have a unique feature that other research papers did not use, that is identifying multiple 3D objects while running the application and labels can be displayed on the 3D object.

III. Research Methodology

In the methodology will discuss step by step how the prototype was built. The purpose of this research is to provide a solution for the lecturers of Agribusiness at MCAST of how they can deliver a lecture using an AR mobile application instead of using posters.

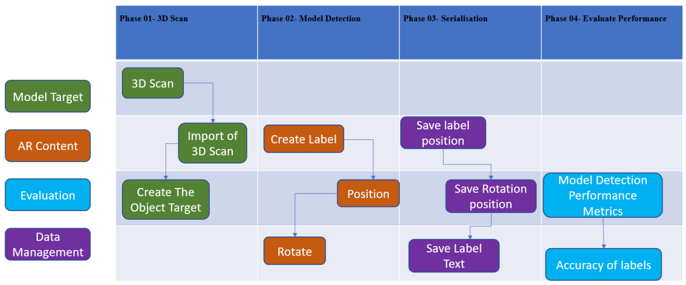

Fig. 2. Pipeline

A. 3D Scan

By using Vuforia scanner application, a £d life-like model of a chicken will be scanned to create a 3D point cloud. A 3D point cloud is a data set collection of data points that represents a 3D object, which are individual points plotted in 3D space.

Fig. 3. Chicken 3D Model

B. Model detection and Object Target

This data set that was mentioned above, will be imported in Vuforia as 3D object so it can be referenced in the Unity project. The data set will enable the AR camera from the application to detect the model target which in this case is the 3D chicken model. When the student detects the object target, he will be enabled to use several functionalities such as, creating a label, rotating the arrow attached to the label to the left or right, drag the label on the organs of the object target which is the chicken model and delete the label if the text is incorrect. After the student is satisfied with the text of the labels and their positions, he can save everything so when the application is loaded again everything will be in its place. A video will be available to the students to understand more about the 3D object (chicken). The video player has the features to skip through and even the sound to increase the volume and decrease it. Figure 4 shows the 3D life-like model labeled using this AR application.

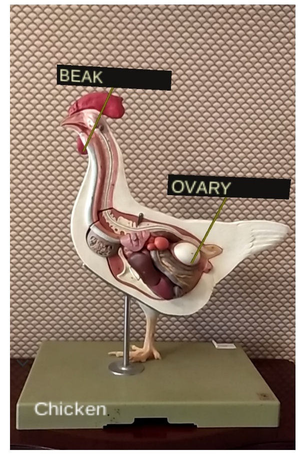

Fig. 4. Chicken 3D Model Labeled

C. Data Management

A script called game manager will handle the actions of save and load. It will save the text of the label and also its position in a separate array by referring to a class called save text which is serializable. By using serializable this can save the array data in a file and also update when referred.

D. Design Pattern

Unity uses compositions. Composition is when a class reference to one or more objects of other classes. The main benefit of this is to reuse code and to have a nice design in your code. When using composition, it makes encapsulation much stronger and easier to maintain the code. In this case the game manager refers to a class that is serializable which is save data. In this script since it is serializable it is referred in two different actions save and load. In the save method it is being serialised and in the load method it is being deserialized since the labels needs to be visible on the organs when the scene is loaded.

This application will be used by the students of Agribusiness at MCAST so they can use the functionalities of this mobile application to understand more the 3D life-like models that will be detected by their smartphone.

IV. Findings & Discussion of Results

These results show that outdoor-light is much better than indoor-light when detecting the 3D object using the mobile camera of a Xiaomi device. Xiaomi's camera is much better

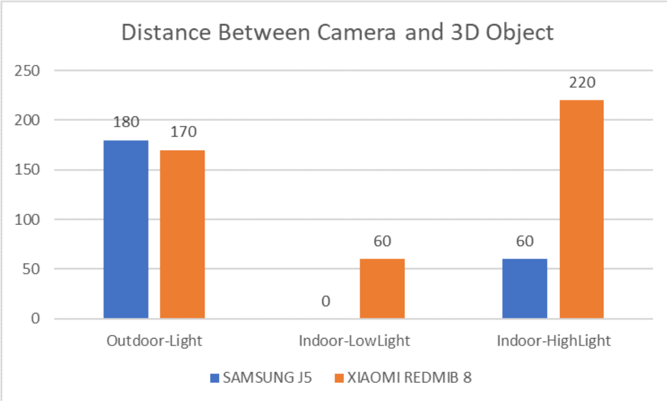

Fig. 5. Distance between Camera and 3D Object

when trying to detect the 3D object because it can detect the object from a distance of 170 cm in outdoor-light, 60 cm indoor-lowlight and 220cm indoor-highlight. Compared with a Samsung smartphone's camera it is not as good at detecting the 3D object in indoor-lowlight, but it is much better in outdoor-light.

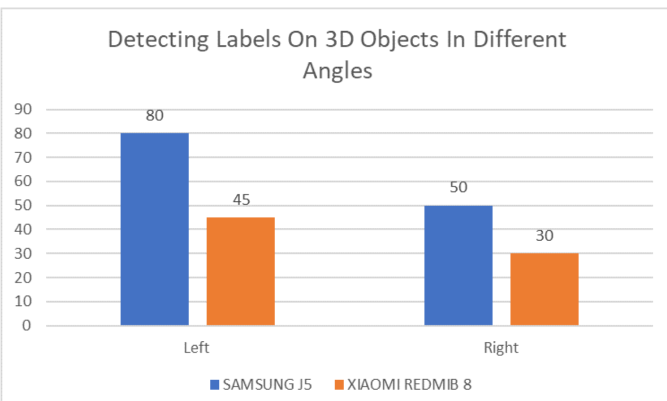

Fig. 6. Detecting Labels On 3D Object In Different Angles

This result is in regard to detecting the 3D object, creating labels and positioning them and moving the camera around the 3D object to see if the labels are still being detected from a different angle. This was tested in indoor-lighting, and the results showed that Samsung's devices keep on detecting the labels from the left side of the 3D object with an angle of 80 degrees and 50 degrees on the right.

It is recommended to use this application with outdoor lighting conditions to have good detection quality of the 3D models. To have a good angle of the labels it is recommended to use a Samsung smartphone to detect the 3D object with indoor lighting.

V. Conclusion

In this paper, an AR application to detect 3D life-like model is presented. This developed application shows how students can interact more with the 3D life-like model by creating labels and placing them on the respective organ. Also, it shows how it can assist the lecturers to present the material to their students.

For future work, it is recommended to follow this coming pipeline. By saving the arrow rotation and position, the student can see the label positioned on the organ of the 3D life-like model that was created within the application, and before it was closed. Creating a data structure to identify multiple model targets, means that the student can detect more than one 3D life-like model at any given time using this application. To achieve this data structure, importing new model targets and implementing serialisation of multiple models, this would result in having a better object-oriented programming. Another recommendation would be to allow the students to import new models from within the application itself so that multiple objects can be identified, and not only one.

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