

# Augmented Reality Simulation to Visualize Global Warming and Its Consequences

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**Abstract** Augmented Reality (AR) technology is considered to be an important emerging technology used in education today. One potentially key use of AR in education is to teach socio-scientific issues (SSI), topics that inure students towards social conscience and critical thinking. This work uses multiple markers and virtual buttons that interact with each other, creating a life-like visual spectacle. Learning about issues such as global warming by using AR technology, students will have an increased sense of experiencing immersion, immediacy, and presence, thereby enhancing their learning as well as likely improving their ability to make better informed decisions about considerations of such issues. Another advantage of AR is that it is a low cost technology, making it advantageous for educators to adapt to their classrooms. Also in this work we compare the effectiveness of AR versus ordinary video by polling a group of students to assess the content understandability, effectiveness and interaction of both the delivery methods.

**Keywords** Augmented reality · Global warming · Multiple markers · Virtual buttons

## 1 Introduction

According to Johnson et al., among the different types of technologies that can be applied to education, AR is among the leading emergent technologies that will be utilized in the next five years [1]. The work conducted here demonstrates that AR can be a successful tool used for educational purposes. Socio-scientific issues

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(SSI) are important in education as they foster social conscience as well as encourage critical thinking. SSIs involve the purposeful use of scientific topics that entail students to hold in dialogue, discussion, and debate. They are usually divisive in nature but have the added constituent of requiring a degree of ethical reasoning or the assessment of moral concerns in the development of arriving at decisions concerning possible motion of those issues [2].

Global Warming is a crucial environmental threat and demands special attention. Students of today need to be well-informed because the proportion of GHGs (Greenhouse Gases) in the atmosphere increases significantly each year, thus the effects of Global warming will continue to increase, with potential to be seriously deleterious in the not-too-far future. Teaching by AR will allow the learners to have an almost direct virtual experience by seeing the process and the effects in a 3 dimensional lifelike view. Research shows that this type of experience increases learning by virtue of the immersion and immediacy of this method. Until now relatively little has been done in this field, which makes doing this type of work of particular importance [3].

Learning about issues of socio-science such as global warming by using AR technology, students will potentially improve their ability to make better informed decisions about considerations of such important current issues [4].

At present the concept of global warming is typically conveyed with the help of 2 dimensional medias such as animated videos and images. But often these media do not give the full impact of the adverse effect of global warming because of the limitations of 2 dimensional media. By teaching these concepts using the visual appeal of AR, the learners tend to be more attentive, thereby increasing their potential to retain the presented information.

Augmented reality (AR) combines both real world and digital data. At present, most AR research uses live video images, which the system processes digitally to add computer-generated graphics. In other words, the system *augments* the image with digital data [5]. Today Augmented Reality is used in many areas. Processor, display, sensors and input devices are the hardware components used for Augmented Reality. The objective of the project is to study the use of Augmented Reality in teaching and learning methodology. AR offers opportunities for more reliable learning and appeals to many learning styles, providing students an extra personalized and explorative learning experience [6].

The work includes the technology of Augmented Reality in explaining a global phenomenon. Here, using the technology of Augmented Reality, the satellite views of earth and sun are projected, rays emitted from the sun, detailed specification of the earth's technology of augmented reality in explaining a global phenomenon. Using Virtual Buttons the consequences are shown, so that learners could have the feel of actually experiencing the effect of global warming. Virtual buttons allows the user to interact directly.

Augmented Reality can be used with different game engines with the help of SDK. Unity 3D is the game engine used in the proposed system. We can do augmented reality applications using unity3D. Different SDKs used in Augmented Reality are Catchoom, Metaio, Obvious Engine, PointCloud, Sphero, SSTT,

Vuforia, Xloundia, NyARToolkit. The system needs external SDK to use Augmented Reality in Unity 3D. The proposed system used Vuforia SDK. The Vuforia SDK allows building vision-based augmented reality applications for the Android platform. The basics used in augmented reality are Marker Detection, Transform Mapping, and Rendering.

Marker based tracking is used in the proposed system. Knowledge and information on hard-copy book can be readily and interactively manipulated through images and 3D animation in the form of markers [7]. The marker is located mainly by using the device webcam. The content should be hidden behind the marker, unless the marker is shown to the web cam. In order to find a predetermined marker the webcam monitor the physical reality near the user. The positions, rotation, scale of the marker are interpreted by the webcam. Then the 3D model is being updated and changed to the screen. In Augmented Reality instead of using main camera, AR camera is used. Target image is tracked using the AR camera. Target image is nothing but the marker.

The use of an AR system provides several benefits over traditional teaching methods. One of the most important benefits is the stimulation of several sensory modalities: touch, sight and hearing. As a consequence, it makes students actively involved in the learning process. With traditional teaching techniques, students only receive information by one sense at a time [8].

The above Fig. 1 shows an example of a marker technology [9], which is used to load the real object. Marker technology is used in the system. The input given is the marker, which is cost effective and the expected output received is the real visualization of an object. Marker based AR system allows user to input predesigned markers, and create new scenes blending together the real world and computer generated 3D images [9].

**Fig. 1** Example of marker



## 1.1 *Augmented Reality Toolkit*

Augmented Reality Toolkit is a well-liked planar marker structure for Augmented Reality and Human Computer Interaction (HCI) systems due to its accessible source code. The first stage of the recognition procedure is finding the markers black borders that are finding connected groups of pixels below a certain gray value threshold [10].

## 2 **Related Work**

Zhu et al. [6] describes the various functionalities and use of augmented reality (AR) in the field of healthcare education is explored in this paper. Students and medical professionals require more situational experiences in medical care, particularly for the sake of patient protection there is an obvious need to additional learning the employ of AR in healthcare knowledge. It improves the learning effect by the acquisition of skills and knowledge, understanding of medical concepts, enhancing learning retention, given material in a suitable and appropriate manner. It seems that AR is very useful in the field of health care education.

Kaufmann [8] describes the impending and challenges of using collaborative Augmented Reality (AR) in learning contained by the better circumstance of immersive virtual learning environments. The paper takes an instance of a collaborative AR claim purposely intended for mathematics and geometry learning called Construct3D. The refuse in hardware costs, the use of mobile immersive virtual or augmented reality become practicable for educational institutions within this decade. The augmented reality or virtual reality features need to be carefully reflected in translating into educational efficiency.

Ivanova and Ivanov [11] describe the benefits of Augmented Reality (AR) for the educational sector and in particular for a computer graphics course using low-cost interactive marker augmented reality technology. The innovation of the solution is that it can propose students high interactive human-computer interface for model manipulation and thus observing the details in 3D space. Several of the students like AR technology, because there presentations are portable and easy to make, allowing them to observe the structures in more details and also to get a clear image. The AR technology can be applied in self-paced learning, where individual learners are able to manage their directions of exploration as well as in group-based learning where communication, ideas sharing and interaction among participants are the main methods for learning.

Cai et al. [12] discusses about the importance of AR tool in improving middle school students cognitive test performance on corresponding content, and has relatively larger influence of low-achieving students. AR tool is an innovative interactive technology used especially in subjects like chemistry. AR tool can act as remedial learning tool to express the contents in a middle school chemistry course

so that the students can memorize chemical structures and concepts. Students could control, combine and interact with the 3D model of micro particles by means of markers and perform a sequence of inquest based experiments.

Chang et al. [13] explored whether an online SSI unit improved by AR can get better students' accepting of the science content concerned. The reason of the study was to reveal a work in development of how to get benefit of mobile AR affordances to plan curricular actions that speak to significant science education goals. Results showed that learning was significantly improved using AR technology.

### 3 Solution Approach

This study demonstrates the effect of global warming with the help of Augmented Reality. Unity 3D is a novel portion of technology that strives to create life superior and easier for game developers. Unity is a game engine or a game authoring instrument that enables imaginative people to build games [14]. The system needs external SDK to use Augmented Reality in Unity 3D. Vuforia SDK is used in this study.

The proposed system gives awareness to people about the impact of global warming. Being a different technology most of the people will have keen interest to know about it. There are many different ways to classify the different augmented reality; they can be separated by function, hardware and software requirements [15].

Vuforia is the software stage that enables the most excellent and most imaginative recognized augmented reality (AR) app experiences across the majority authentic world environments [16]. Vuforia uses image identification to sketch and record image marker [17]. The study shows the use of Augmented Reality in teaching and learning methodology. The proposed system shows the impacts of global warming. Marker technology is used to detect different objects. Unique markers are used to show every different object. For example, to show the picture of earth, a particular marker is used and to show an image of the sun, another marker is used. For each object each marker is used. For example, one marker is used to represent the earth model and another is used to represent the sun model.

In Augmented Reality, contents are hidden behind the marker image. The webcam connected to computer captures the "marker" reads the information/pattern encoded in it and sends this information to the computer. The information is being recognized and the marker is replaced with an image encoded in it. The movement of the marker is being tracked by the computer and adjusts the size of the image according to the movement.

When using this technology, it is easy for the people to know the causes of global warming, the reasons behind why the earth is getting heated up, the effects of global warming. This helps to bring realization in people that these are caused by their human activities and they will try to reduce these harmful activities which cause global warming.

The above Fig. 2 illustrates the augmented reality system. The system captures and detects the target image (marker) and renders the real object (3D objects, graphics) on the top of the target image and displays it. When the target image is exposed to the camera, the camera captures and detects the image. And then the image is being tracked and compared with the image stored in the database (Vuforia target manager tool). When the tracked image is detected in the database, it renders the real object corresponding to the target image.

The flow diagram shows in Fig. 3 demonstrate the cause of global warming with the help of Augmented Reality. Marker technology is used to detect different objects. The markers detect the sun and the earth model simultaneously. When the marker is shown to the webcam the real objects will be loaded.

The flow diagram shows in Fig. 4 demonstrate detailed explanation of the effect of global warming. Virtual Buttons are used to show the consequences of global warming. Using the marker containing two virtual buttons it shows the consequences of rays on the layers of the Earth.

When the marker is detected by the webcam, the particular area is detected. After detecting the area the real object is loaded. The same process is repeated for the other markers. So by explaining the consequences of global warming using Augmented Reality, its impact could be more pronounced. AR enables learners to

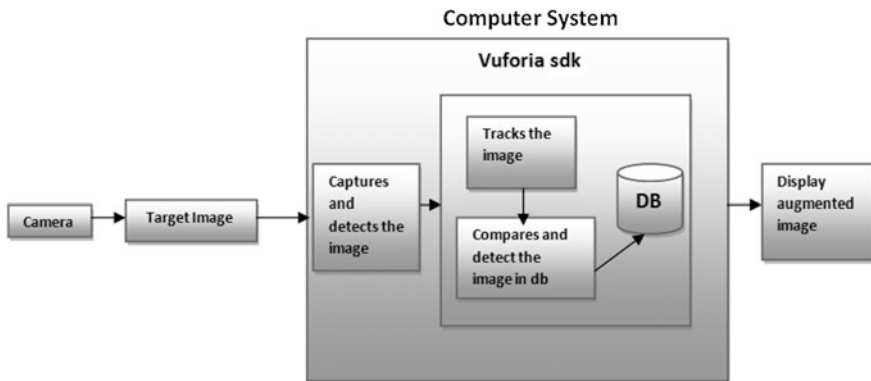


Fig. 2 Flow diagram for an augmented reality system

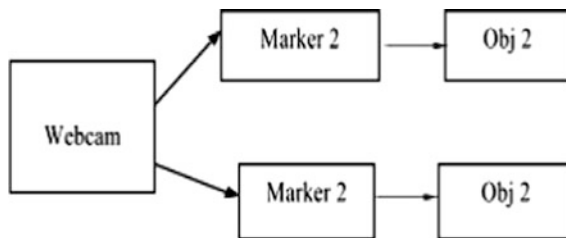
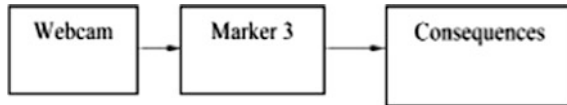


Fig. 3 Flow diagram to load the sun and earth model



**Fig. 4** Flow diagram to load the consequences of global warming

extend the attention span and make unseen more tangible. Thus the demonstration of global warming is made more effective and thought provoking.

The first phase shows the earth model with single marker technology. The earth and the sun models were also loaded with multiple marker technology. The Target manager tool is used to create the target image. Target manager tool extracts the features of the target image and stored in the database. Target image is tracked using the webcam and then the virtual content or the object is loaded. Within seconds the sun emits the rays that results the color change of the earth. The consequences happened due to the result of human activities are also shown using the virtual buttons.

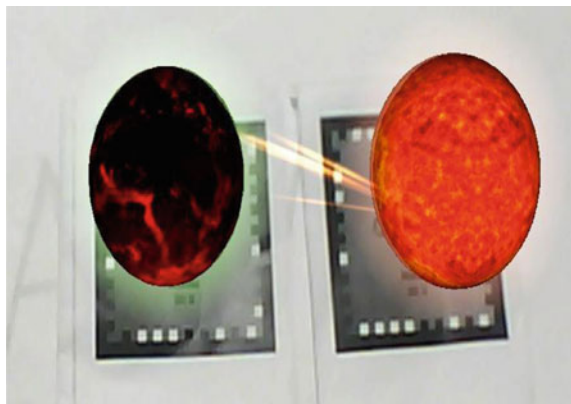
The above Fig. 5 shows the screenshot of earth’s heat up. Due to the rays from the sun the earth gets heated up. That results in Global Warming. Multiple marker technology is used to demonstrate the above process.

The above Fig. 6 shows that the human activities are the major cause of global warming. Here carbon dioxide is released to the atmosphere when humans chop down the trees.

## 4 Performance Analysis

The above Fig. 7 illustrates the statistical analyses of a comparative study of the AR system with ordinary video. The analyses redone on the basis of a survey conducted in a batch of students. The students were divided into two groups and were

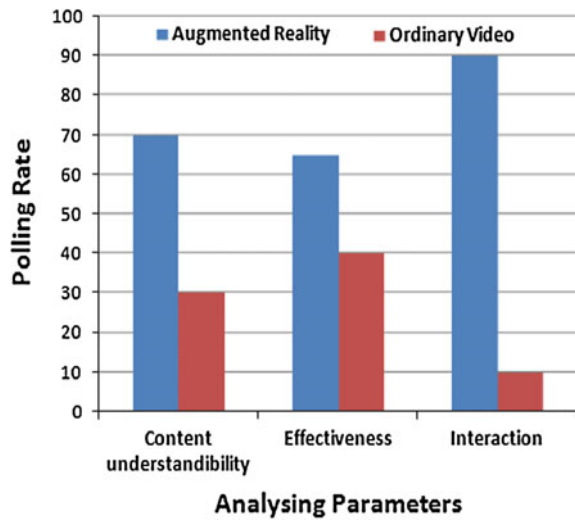
**Fig. 5** Screenshot showing the effect of global warming



**Fig. 6** Screenshot showing carbon dioxide emission from trees



**Fig. 7** Comparison of augmented reality and ordinary video



familiarized with both ordinary videos as well as the Augmented Reality. Polling was conducted to analysis the content understandability, effectiveness and interaction of both the delivery methods. Most of the student’s gave their approval for Augmented Reality. The study demonstrates that the proposed work gives an impact upon the user as how much effectively the technology of Augmented Reality can be used in the educational system. The proposed system is beneficial for educational purpose.



## 5 Conclusion

This study demonstrates the use of multiple marker Augmented Reality as an educational tool to teach an important socio-scientific issue: Global Warming. This emergent technology incorporates the use of multiple markers and virtual buttons that interact with each other giving a life-like sense of direct experience to the learner. The visual impact of the display creates an immersive experience that helps learners understand the deeper implications of SSIs which leads to more improved critical thinking and ability to discuss and debate suchlike issues.

We use AR technology to demonstrate the cause and adverse effect of global warming by showing how the radiation from the sun affects the earth. Multiple markers and virtual buttons are used in the work so that interactions and visual impact are more effective.

The study reveals that AR-based modeling is a more successful teaching tool than video based modeling by analyzing a survey conducted which showed increased interest and comprehension of content in AR technology over ordinary video.

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