

Marker Based Augmented Reality

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Abstract— *The massive technological advancements around the world have created significant challenging competition among companies where each of the companies tries to attract the customers using different techniques. One of the recent techniques is Augmented Reality (AR). The AR is a new technology which is capable of presenting possibilities that are difficult for other technologies to offer and meet. Nowadays, numerous augmented reality applications have been used in the industry of different kinds and disseminated all over the world. AR will really alter the way individuals view the world. The AR is yet in its initial phases of research and development at different colleges and high-tech institutes. Throughout the last years, AR apps became transportable and generally available on various devices. Besides, AR begins to occupy its place in our audio-visual media and to be used in various fields in our life in tangible and exciting ways such as news, sports and is used in many domains in our life such as electronic commerce, promotion, design, and business. In addition, AR is used to facilitate the learning whereas it enables students to access location-specific information provided through various sources. Such growth and spread of AR applications pushes organizations to compete one another, and every one of them exerts its best to gain the customers. This paper provides a comprehensive study of AR including its history, architecture, applications, current challenges and future trends.*

Keywords: *Augmented Reality; Virtual Reality; Augmented Reality Browser; Mobile Augmented Reality*

1. INTRODUCTION

Augmented reality (AR) is a live, direct or indirect, view of a physical, real-world environment whose elements are augmented by computer-generated sensory input such as sound, video, graphics or GPS data [1]. Augmented Reality is a type of virtual reality that aims to duplicate the world's environment in a computer. Virtual reality (VR) is a virtual space in which players immerse themselves into that space and exceed the bounds of physical reality [2]. It adds information and meaning to a real object or place. Augmented reality is characterized by the incorporation of artificial or virtual elements into the physical world as shown by the live feed of the camera, in real-time. Common types of augmented reality include projection, recognition, location and outline [3].

Projection: It is the most common type of augmented reality, projection uses virtual imagery to augment what you see live. Some mobile devices can track movements and sounds with a camera and then respond. Virtual or projection keyboards,

which one can project onto to almost any flat surface and use, are examples of augmented reality devices that use interactive projection.

Recognition: Recognition is a type of augmented reality that uses the recognition of shapes, faces or other real world items to provide supplementary virtual information to the user in real-time. A handheld device such as a smart phone with the proper software could use recognition to read product bar codes and provide relevant information such as reviews and prices or to read faces and then provide links to a person's social networking profiles.

Location: Location uses GPS technology to instantaneously provide you with relevant directional information. For example, one can use a smart phone with GPS to determine his location, and then have onscreen arrows superimposed over a live image of what's in front of the user and point him in the direction of where you need to go. This technology can also be used to locate nearby public transportation stations.

Outline: Outline is a type of augmented reality that merges the outline of the human body or a part of the body with virtual materials, allowing the user to pick up and otherwise manipulate objects that do not exist in reality. One example of this can be found at some museums and science centers in the form of virtual volleyball. Although the player can stand and move on an actual court, the ball is projected on a wall behind him, and he can control it with an outline of himself, which is also projected on the wall. Using the concept of augmented reality our project focuses on creating a very useful windows based application. The idea is to allow the user to view the virtual object in the real world. The user could provide images of the object which would be the front, back, top, bottom, and left and right side pictures of the object. They will be placed onto a 3D cube which will make up the complete virtual object. Thus an extended environment will be created through the amalgamation of real world and generated object and it will appear as though the real-world object and virtual object coexist within the environment. In order to use this application, the user will first need to acquire a marker. A marker is a piece of paper with black and white markings. This is used to display the augmented object on your mobile phone's screen. Marker-based augmented reality uses a camera and a visual marker which determines the centre,

orientation, and range of its spherical coordinate system. Once the marker is present one can view augmented objects. Virtual object interaction is another added feature wherein the user can rotate or change the orientation of the object according to his requirements.

2. AUGMENTED REALITY

Augmented Reality (AR), also known as Mixed Reality, aims to combine virtual and real scene together to achieve that virtual ones are belong to the real world. Being characteristic of integration of virtual and real scene, many applications of Augmented Reality are emerging, such as in field of education, medical treatment and entertainment [4].



Fig. 1: Real desk with virtual lamp and two virtual chairs.

Fig. 1 shows an example of what this might look like. It shows a real desk with a real phone. Inside this room there are also a virtual lamp and two virtual chairs. Note that the objects are combined in 3-D, so that the virtual lamp covers the real table, and the real table covers parts of the two virtual chairs. AR can be thought of as the "middle ground" between VE (completely synthetic) and telepresence (completely real).

Goals of Augmented Reality

- To challenge the impossible.
- To create virtual environment for a more rich user experience.
- To integrate it into daily lives to help the masses.
- To achieve feats which are limited in real world.
- To enhance imagination of youths.

2.1 Types of Augmented reality

There are two types of simple augmented reality: marker-based which uses cameras and visual cues, and marker less which use positional data such as a mobile's GPS and compass.

2.1.1 Marker based

Different types of Augmented Reality (AR) markers are images that can be detected by a camera and used with

software as the location for virtual assets placed in a scene. Most are black and white, though colours can be used as long as the contrast between them can be properly recognized by a camera. Simple augmented reality markers can consist of one or more basic shapes made up of black squares against a white background. More elaborate markers can be created using simple images that are still read properly by a camera, and these codes can even take the form of tattoos.

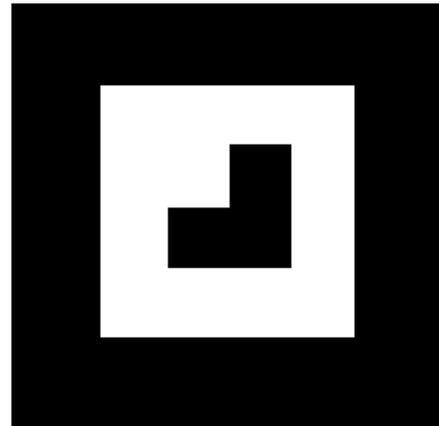


Fig. 2: A simple marker

A camera is used with AR software to detect augmented reality markers as the location for virtual objects. The result is that an image can be viewed, even live, on a screen and digital assets are placed into the scene at the location of the markers. Limitations on the types of augmented reality markers that can be used are based on the software that recognizes them. While they need to remain fairly simple for error correction, they can include a wide range of different images. The simplest types of augmented reality markers are black and white images that consist of two-dimensional (2D) barcodes.

2.1.2 Marker less

In marker-less augmented reality the image is gathered through internet and displayed on any specific location (can be gathered using GPS). The application doesn't require a marker to display the content. It is more interactive than marker based augmentation.



Fig. 3: Marker less AR

The only real difference from a consumer's perspective is that the surface the object is sculpted on doesn't have to have that.

3. MARKER DESIGN, DETECTION AND RECOGNITION

Markers are square and constituting of black thick border and black graphics within its white internal region. The advantage of using black and white colour is to separate marker from background in grabbed frame easily. Internal region of a marker marks identifier of it. In term of projective geometry, square markers in real world could not be square after projecting onto image plane, in other words, internal graphics in markers often display in distortion. When recognizing them, image unwrapping is necessary.[4] The procedure of unwrapping image is shown in Fig.4.

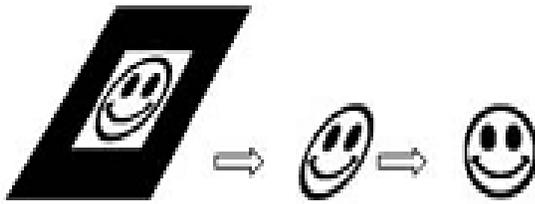


Fig. 4: Procedure of unwrapping marker image to find ID

The calculation of marker unwrapping could be described as follows: $(x_c, y_c), i=1,2,3,4$ as four corners of a marker are acquired after detecting grabbed frame. Positions of four corners are known in the real world as $(x_m, y_m), i=1,2,3,4$. Homography matrix H could be calculated in (1). By H points in internal region of marker could be unwrapped to formal one.[4]

$$\begin{bmatrix} hx_c \\ hy_c \\ 1 \end{bmatrix} = H \begin{bmatrix} x_m \\ y_m \\ 1 \end{bmatrix} = \begin{bmatrix} N_{11} & N_{12} & N_{13} \\ N_{21} & N_{22} & N_{23} \\ N_{31} & N_{32} & 1 \end{bmatrix} \begin{bmatrix} x_m \\ y_m \\ 1 \end{bmatrix} \quad (1)$$

After that, unwrapping image are used to match templates in matching method or decode in code-decoding method respectively.

4. PROBLEM STATEMENT

The proposed system aims to provide an environment that will help the users to place artificial 2D as well as 3D objects into real world through the use of AR Markers. The proposed system also allows the user to decide, where to place the object in real world. Once the object has been placed in the scene, it will be displayed accurately according to the perspective in the original scene, which is especially challenging in the case of 3D virtual objects. The proposed system solves the problem of viewpoint tracking and virtual object interaction. The main advantage of the proposed system is that, it is customer oriented and not product or service oriented thus allowing the users to augment a product of their wish.

5. PROPOSED SYSTEM ARCHITECTURE

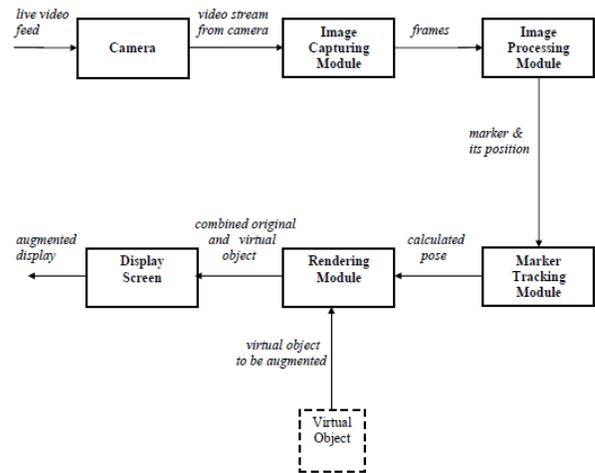


Fig. 5: Architecture Block diagram

The proposed system is a marker based system and its architecture as shown in Fig. 6 contains following modules.

1. Camera
2. Image Capturing Module
3. Image Processing Module
4. Rendering Module
5. Display Screen

1. Camera

A real-world live video is feed as an input from the laptop camera to the Camera module. Displaying this live feed from the laptop camera is the reality in augmented reality. This live video stream is given as an input to the Image Capturing Module.

2. Image Capturing Module

The input to Image Capturing Module is the live video feed from the camera of a mobile device. This module analyses the camera feed, by analyzing each frame in the video. This module generates binary images i.e. a digital image that has only two possible values for each pixel. Typically the two colours used for a binary image are black and white. These binary images are provided as an input to Image Processing Module.

3. Image Processing Module

Inputs to Image Processing Module are the binary images from Image Capturing Module. These binary images are processed using an image processing technique to detect the AR Marker. Detection of AR Marker is essential to determine the position, where to place the virtual object. Once the AR Marker is detected, its location is provided as an input to the Tracking Module.

4. Marker Tracking Module

The tracking module is “the heart” of the augmented reality system; it calculates the relative pose of the camera in real time. The term pose means the six degrees of freedom (DOF) position, i.e. the 3D location and 3D orientation of an object. The calculated pose is provided as an input to Rendering Module.

5. Rendering Module

There are 2 inputs to Rendering Module. First is the calculate pose from the Tracking Module and other is the Virtual Object to be augmented. The Rendering Module combines the original image and the virtual components using the calculated pose and renders the augmented image on the display screen of the mobile device.

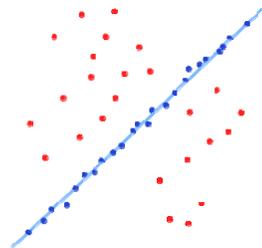
6. ALGORITHMIC PROCESS

The RANSAC algorithm is a learning technique to estimate parameters of a model by random sampling of observed data. Given a dataset whose data elements contain both inliers and outliers, RANSAC uses the voting scheme to find the optimal fitting result. Data elements in the dataset are used to vote for one or multiple models. The implementation of this voting scheme is based on two assumptions: that the noisy features will not vote consistently for any single model (few outliers) and there are enough features to agree on a good model (few missing data). The RANSAC algorithm is essentially composed of two steps that are iteratively repeated:

1. In the first step, a sample subset containing minimal data items is randomly selected from the input dataset. A fitting model and the corresponding model parameters are computed using only the elements of this sample subset. The cardinality of the sample subset is the smallest sufficient to determine the model parameters.
2. In the second step, the algorithm checks which elements of the entire dataset are consistent with the model instantiated by the estimated model parameters obtained from the first step. A data element will be considered as an outlier if it does not fit the fitting model instantiated by the set of estimated model parameters within some error threshold that defines the maximum deviation attributable to the effect of noise.



A data set with many outliers for which a line has to be fitted.



Fitted line with RANSAC; outliers have no influence on the result.

The set of inliers obtained for the fitting model is called consensus set. The RANSAC algorithm will iteratively repeat the above two steps until the obtained consensus set in certain iteration has enough inliers.

The input to the RANSAC algorithm is a set of observed data values, a way of fitting some kind of model to the observations, and some confidence parameters. RANSAC achieves its goal by repeating the following steps:

1. Select a random subset of the original data. Call this subset the hypothetical inliers.
2. A model is fitted to the set of hypothetical inliers.
3. All other data are then tested against the fitted model. Those points that fit the estimated model well, according to some model-specific loss function, are considered as part of the consensus set.
4. The estimated model is reasonably good if sufficiently many points have been classified as part of the consensus set.
5. Afterwards, the model may be improved by re-estimating it using all members of the consensus set.

This procedure is repeated a fixed number of times, each time producing either a model which is rejected because too few points are part of the consensus set, or a refined model together with a corresponding consensus set size. In the latter case, we keep the refined model if its consensus set is larger than the previously saved model.

7. PROJECT CONSTRAINTS

Augmented reality still has some challenges to overcome. Augmented Reality systems are expected to run in real-time so that a user will be able to move freely within the scene and see a properly rendered augmented image. The application will be built for mobile phones which usually have low screen dimensions and resolution. It also adds additional stress on the O.S because it requires high processing power to augment. Developers of the application are supposed to have a thorough knowledge of Windows O.S (Application developed in). Developers are also supposed to be familiar with Flash SDK and AR-Toolkit.

8. APPLICATION AREAS

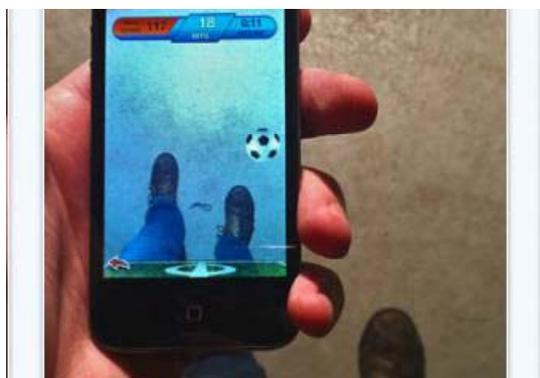
A picture is worth thousand words. The applications of this project are well understood from below snaps which shows virtual objects in real world environment.



Medical Science



Product Information



Gaming

9. ACKNOWLEDGEMENTS

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10. CONCLUSION AND FUTURE WORK

This paper proposes a marker based augmented reality application using windows operating system which will help to combine virtual objects with the real environment facilitating various applications as mentioned in this paper. The main advantage is use of low cost devices as compared to the costly head mounted display devices. Secondly with the

help of this project you need not buy product and then see how it will suit your environment. In future images of objects from various views can be fetched directly from vendor's websites; same could be modelled into a 3D objects and augmented. Also multiple objects will be augmented which is currently a major challenge.

REFERENCES

- [1] P. Milgram and F. Kishino, "A Taxonomy of Mixed Reality Visual Displays," *IEICE Trans. Information Systems*, vol. E77-D, no. 12, 1994, pp. 1321-1329.
- [2] C.R.Huang, C.S.Chen, and P.C.Chung, "Contrast context this to graman efficient discriminating local descriptor for object recognition and image matching," *Pattern Recog.*, vol. 41, no. 10, pp. 3071-3077, Oct. 2008.
- [3] A. Swaminathan, Y. Mao, and M. Wu, "Robust and secure image hash- ing," *IEEE Trans. Inf. Forensics Security*, vol. 1, no. 2, pp. 215-230, Jun. 2006.
- [4] R. O. Duda and P. E. Hart, *Pattern Classification and Scene Analysis*. New York, NY, USA: Wiley, 1973.
- [5] Ronald T. Azuma, *A Survey of Augmented Reality*, In *Presence: Teleoperators and Virtual Environments 6*, 4 (August 1997), 355-385
- [6] Si Jung Jun Kim, *A User Study Trends in Augmented Reality and Virtual Reality Research*, 2012 International Symposium on Ubiquitous Virtual Reality
- [7] S. Wang, H. You, and K. Fu, "BFSIFT: A novel method to find feature matches for SAR image registration," *IEEE Geosci. Remote Sens. Lett.*, vol. 9, no. 4, pp. 649-653, Jul. 2012.
- [8] Rencheng Sun , YiSui , RanLi , Fengjing Shao, *The Design of a New Marker in Augmented Reality*, 2011 International Conference on Economics and Finance Research , IPEDR vol.4 (2011) © (2011)IACSIT Press, Singapore

Augmented Reality (AR) employs computer vision, image processing and computer graphics techniques to merge digital content into the real world. It enables realtime interaction between the user, real objects and virtual objects. AR can, for example, be used to embed 3D graphics into a video in such a way as if the virtual elements were part of the real environment. One of the challenges of AR is to align virtual data with the environment. A marker-based approach solves the problem using visual markers, e.g. 2D barcodes, detectable with computer vision methods. We discuss how different marker types and marker identification and detection methods affect the performance of the AR application and how to select the most suitable approach for a given application. Augmented Reality Tutorial No. 1: Marker-Based Primitive Object Augmentation. Edgaras Art. 36 Comments. March 21, 2015. Tutorial. Marker based Augmented Reality. This is one of the first and easiest to accomplish Marker based Augmented Reality tutorial in just a few minutes. Black square marker tracking have lots of drawbacks, therefore, in future tutorials we use markerless solutions. It's getting more interesting in www.ourtechart.com. Download # Processing. Download # Newest nyar4psg 2.0.0 library for Augmented Reality (*.rar file). Download # Hiro Marker (*.pdf file). NOTE: Extract library and put nyar4psg folder to Processing libraries location as you can see in example here: `C:\Users\EdgarasArt\Documents\Processing\libraries`. Augmented reality that relies on markers is the most widespread approach to the immersive technology implementation. Marker-based AR or image recognition uses a mobile device camera to detect a predefined marker that then triggers a certain computer-generated content. Markers can be AR-codes, physical objects, or printed images as it appears in the Absolut Vodka Augmented Reality app. To enable the AR app to recognize a real-world object as a trigger, a certain marker should be embedded into this object. Since AR-codes are much easier to recognize for both cameras and users, this type of marker is greatly used by augmented reality programmers. Marker-based augmented reality experiences require a static image also referred to as a trigger photo that a person can scan using their mobile device via an augmented reality app. The mobile scan will trigger the additional content (video, animation, 3D or other) prepared in advance to appear on top of the marker. Marker recognition can be local or cloud-based, it means that marker databases can be stored on device and recognition also happens on device. The databases can also be stored on a cloud and recognition happens on a server, phone is only sending point clouds to server. Device-based recognition can happen immediately, but if cloud recognition is used, then it will take a while longer for the content to be downloaded from the server. The Augmented Reality Markup Language (ARML) is a data standard to describe and interact with augmented reality (AR) scenes. It has been developed within the Open Geospatial Consortium (OGC) by a dedicated ARML 2.0 Standards Working Group. ARML consists of both an XML grammar to describe the location and appearance of virtual objects in the scene, as well as ECMAScript bindings to allow dynamic access to the properties of the virtual objects, as well as event handling, and is currently published in...