Knowledge Based Augmented Reality

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Abstract

This paper surveys the field of Augmented Reality, in which 3-D virtual objects are integrated into a 3-D real environment in real time. It describes the educational and knowledge based applications that have been explored. Augmented Reality (AR) is the technology that enhances the user's view of the real world with computer generated information. Considered a cutting edge technology for computer user interface, AR opens many new applications in a broad range of domains, from entertainment to military training. One of the most challenged task in implementing AR system is registration. In order to align the virtual objects to the user's view of the world, AR systems need to accurately track the position and orientation of cameras. This paper surveys the step wise implementation of 2-D image into 3-D image using knowledge based AR application.

Keyword: augmented reality, degree of freedom, graphical user interface.

1. INTRODUCTION

Augmented Reality (AR) employs computer vision, image processing and computer graphics techniques to merge digital content into the real world. It enables real time interaction between the user, real objects and virtual objects. AR can, for example, be used to embed 3D graphics into a video frame in 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. In marker-based tracking, the system needs to detect the marker, identify it and then calculate the pose. Sensor tracking would require extra devices, which makes the system more complex and expensive. Thus, a developer may decide to use visual tracking because of the low costs or to keep the application and setup as simple and lightweight as possible. The technology behind AR is taking a real-world view and enhancing it with computer-generated imagery. We believe that one of the most powerful uses of virtual worlds will not be to replace the real world, but rather to augment the user's view of the real world with additional information.
along with transmission bandwidth and memory capacity and speed.

### a. Interactive Game Book

Augmented Reality applications are also being made to be used with mobile devices like the Sony PlayStation linking printed media to digital resources.

### b. Zoo Burst

Zoo burst is a digital storytelling tool that allows anyone to create a 3D pop-up book. The books are web based and work either through a Flash plug-in or through augmented reality and the use of a webcam. Books can have up to ten pages and use either your own images or open source vector images that can be sized, rotated and coloured. The company allows you to embed your book on social networking sites, blogs or other websites. Currently Zooburst is in beta trial.

### 2. SYSTEM ARCHITECTURE:

Fig. 2. shows a flowchart for a simple augmented reality system. The capturing module captures the image from the camera. The tracking module calculates the correct location and orientation for virtual overlay. The rendering module combines the original image and the virtual components using the calculated pose and then renders the augmented image on the display.

![Fig.1. System Architecture](image)

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 tracking module enables the system to add virtual components as part of the real scene. The fundamental difference compared to other image processing tools is that in augmented reality virtual objects are moved and rotated in 3D coordinates instead of 2D image coordinates[6].

### 3. TYPES OF MARKER

![Different Types of Markers](image)

Different types of Markers used by AR are shown in above figure. As shown above we can use multiple types markers to render 3D images.

### 4. BASIC PRINCIPLE OF ARTOOLKIT

ARToolKit applications allow virtual imagery to be superimposed over live video of the real world. Although this appears magical it is not. The secret is in the black squares used as tracking markers. The ARToolKit tracking works as follows:

1. The camera captures video of the real world and sends it to the computer.
2. Software on the computer searches through each video frame for any square shapes.
3. If a square is found, the software uses some mathematics to calculate the position of the camera relative to the black square.

4. Once the position of the camera is known a computer graphics model is drawn from that same position.

5. This model is drawn on top of the video of the real world and so appears stuck on the square marker.

6. The final output is shown back in the handheld display, so when the user looks through the display they see graphics overlaid on the real world.

The figure below summarizes these steps. ARToolKit is able to perform this camera tracking in real time, ensuring that the virtual objects always appear overlaid on the tracking markers.

5. AUGMENTED REALITY APPLICATION:

Augmented reality technology is beneficial in several application areas. It is well suited for on-site visualisation both indoors and outdoors, for visual guidance in assembly, maintenance and training. Augmented reality enables interactive games and new forms of advertising. Several location-based services use augmented reality browsers. In printed media, augmented reality connects 3D graphics and videos with printed publications. In addition, augmented reality has been tested in medical applications and for multi-sensory purposes.

6. PROCEDURE:

The basic marker detection procedure consists of the following steps:

1. Image capturing
   Capturing of an video frame.

2. Preprocessing
   Line detection/line fitting
   Detection of the corners of the marker.


4. Identification and decoding of markers Template matching (template markers) Decoding (data markers).

5. Calculation of the marker poses
   Estimation of marker pose
   Iterative pose calculation for accurate pose.

7. MODULES:

7.1. Image Capturing:

- System should support Android handset
- System should allow user to open/close application
- System should allow user to start camera from application
• System should use power as minimum as possible
• System should not change telephony as primary priority of the handset
• System should not run as background process.
• System should support good GUI System should support multiple markers.

7.2. Marker Detection:

The first task of the marker detection process is to find the boundaries of the potential markers. Detection systems use two approaches: either they first threshold an image and search for markers from the binary image, or they detect edges from a greyscale image. 2.1. Marker-based tracking

Fig. 5. On the left, the original image; on the right, the image after adaptive Thresholding.

Marker detection systems using the threshold approach normally use an adaptive thresholding method.

After thresholding, the system has a binary image consisting of a background and objects. All objects are potential marker candidates at this stage.

We discuss these fast acceptance/rejection tests more. Finally, the edges of all potential markers are marked (Fig. 5) and their locations are undistorted for line fitting (Fig. 6). After line fitting, the system tests the potential markers again, checking whether they have exactly four straight lines and four corners.

Fig. 6: An example of edge detection using ALVAR. On the left: the edge contours detected on the threshold image (Fig. 4) are superimposed onto the original image with red. On the right: the remaining edges after applying the fourcorner test and size test.

Fig. 7: An example of line fitting using ALVAR. On the left, line fitting in undistorted coordinates; deduced corner point locations are marked with circles. On the right, detected lines over the original image.

Fig. 8: A cube augmented on top of a detected marker. The marker coordinate system (X, Y, Z) is rendered with (red, green, blue).

Even small errors in detected 2D locations of edges and corners significantly affect the calculated pose of the camera. Detection errors can be caused by a pixel quantisation error, incorrect threshold value, motion blur, noise, etc. These errors cause annoying jitter in an object’s pose even if the camera hardly moves.
For example, if the system detects a marker from a threshold image, it may use the greyscale image to find edges or corners with higher accuracy.

3. Rendering of 3D image: The rendering module draws the virtual image on top of the camera image. In basic computer graphics, the virtual scene is projected on an image plane using a virtual camera and this projection is then rendered. The trick in augmented reality is to use a virtual camera identical to the system’s real camera. This way the virtual objects in the scene are projected in the same way as real objects and the result is convincing. To be able to mimic the real camera, the system needs to know the optical characteristics of the camera. The process of identifying these characteristics is called camera calibration. Camera calibration can be part of the AR system or it can be a separate process. Many toolkits provide a calibration tool, e.g. ALVAR and ARToolKit have calibration functionality. A third party tool can also be used for calibration, e.g. Matlab and OpenCV have a calibration toolkit.

8. BASIC WORKING OF APPLICATION

1. In first picture we captures the image from the camera and sends it to the application.

2. Application detect markers and recognise patterns in the image.

3. Detected image is converted into binary image.

4. In fourth picture calculates the correct location and orientation for virtual overlay and calculates the relative pose of the camera in real time. The term pose means the 3D location and 3D orientation of an object.

5. In fifth picture combines the original image and the virtual components using the calculated pose and then renders the augmented image.

6. Finally rendered image is displayed on the screen

9. CONCLUSION

Using this application we are enhancing the user perception of and interaction with the real world through supplementing the real world with 3D virtual objects that appear to coexist in the same space as the real world. We believe that one of the most powerful uses of virtual worlds will not be to replace the real world, but rather to augment the user’s view of the real world with additional information. For example, graphics and text overlaid on the surrounding world could explain how to operate, maintain, or repair equipment, without requiring that the user refer to a separate paper or electronic manual. Due to the nature of AR, it is preferable to render using the camera and screen of a mobile device due to portability and ease of use.

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11. REFERENCES


