Augmented Reality and its Working

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Abstract: Imagine a world with a technology that creates the 3-dimensional images of a virtual object around you with which you can interact, see, hear, smell, and even touch it. Technologies such as computer graphics, virtual reality, and augmented reality together can be used to implement this in real world. Augmented reality (AR) is a technology that has taken the world by storm in the past few decades. Augmented reality actually superimposes virtual objects into the real environment with the real objects for enriching the viewer's experience. It is a technology that puts graphics, images, and other computer-generated augmentations upon a reality that already exists, in order to improve the experience of the user by enabling different interactions between the user and his environment. In this review paper, we basically present how AR actually works and what are the different technologies that are involved in its implementation.

Keywords: Augmented reality, Displays, Location based, Marker-based, Virtual reality.

1. Introduction

The basic idea of augmented reality is to overlay images, graphics, and audio and other intelligence enhancements over a real environment in real time. The system is to grow the user's idea of and interaction with the real world by augmenting the real world with 3D virtual objects that appear to exist in the same space as the real environment. Various technologies like virtual reality, augmented reality, sixth sense technology, computer graphics and different sensors work together, to create a world where virtual objects are superimposed upon the real-life environment. These technologies create the environment in such a way that a person can see it, hear it, smell it, touch it or in short, we can say that he or she can interact with it. AR or virtual reality (VR) technologies have grabbed the eyes of researchers for quite some time now. AR and virtual reality are often confused with one another, where as in reality, they overlap each other and somewhere work together. This paper surveys the augmented reality and various technologies that are used in it. We present the different technique that we have studied form our survey. The technologies are Displays, trackers or gesture recognition systems and 3D modelling systems.
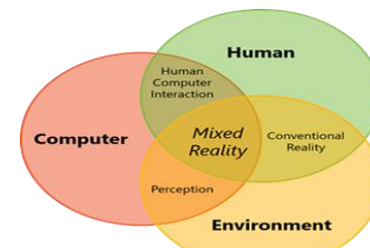

Fig. 1. Mixed reality

2. Augmented Reality

Augmented reality is the reality in which the virtual objects or images are mounted with the real-world objects. Augmented reality is a live view of a real-world environment whose elements are augmented by computer-generated sensory input such as sound, video, graphics or GPS data. It is a technology that supplements the computer-generated virtual objects with the real-world objects, it appears as if they co-exist in the same space as real world. A highly efficient AR device is made by combining the basic components used in AR technology. These include the different display units, tracking module, computer or other portable devices, different scanning algorithms, etc. Other than these, various devices like high resolution cameras, accelerometers, high speed multi-processors, different sensors like gyroscope, pressure sensors, and rotation sensors are also used to increase the reliability and performance of the AR device.

A. Augmented Technologies

AR Technology basically works on the three aspects or characteristics [1, 2, 3]:
1. Combination of real and virtual environment.
2. Real time interaction.
3. Register in 3 Dimension.

These three aspects are very important for AR technology. Combining these three will give a technology of AR with which we can actually see, talk, touch, smell, and taste. There are technologies that already exist to implement the augmented reality. There are many displays or techniques with AR can be viewed in real time, so it is not limited to one particular technology like head mounted display (HMD). As this technology includes the real time interaction, so it will require

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all of our senses such as sense of sight, hearing, touch and smell. The 3D registration means the virtual images or the objects are to be created or modelled into the 3-dimensional virtual object to give a real perception of the virtual object in the real world.

1) Combination of Real and Virtual Environment

This is often referred to as Display technology. Display technology has always been a limiting factor in the field of augmented reality. There are still many technologies that are yet to be discovered or developed, so in this section the focus is on the different existing display technologies used in augmented reality. The different types of visual displays that can be used are aural (sound) display, Haptic (touch) display are visual display. The other displays olfactory and gustatory display are yet to be developed or under implementation.

2) Interaction Based Technologies

Real Time Interaction with the AR system is done by Gesture Recognition or other tracking techniques. Gestures are the body motions that are used as the information. These motions are captured using some camera and saved in the database. The gesture recognition technique is used to recognize the motion and act upon it. Mathematical interpretation of the human motion using some computation device is called Gesture Recognition. There are no limits on the type of gestures or it does not have any specific meaning so it is a big challenge for the gesture recognition system to understand it, so it can be classified as discrete or continuous.

1. Continuous (Online) Gesture: In this type gestures are being captured while are being performed. For example, a zooming metaphor with the finger's movements.
2. Discrete (Off Line) Gesture: In this type the gestured are being capture after being performed. For example, gesture performed for screen or mobile.

3) 3D Registration

Before displaying any virtual objects of AR system in the real environment, the virtual object needs to be registered or modelled in 3 dimensions for better experience and view of the user. Creating the 3D virtual object is a greater challenge. There are various techniques used for modelling the virtual objects into 3D. For registration of any virtual object the system requires six Degree of Freedom (6DOF): three variables for position (x, y and z) and three angles (yaw, pitch, and roll). There three ways by which the 3D model or virtual objects can be created, first is automatic, second is semi-automatic and last is the manual. Various algorithms are involved in the creation of 3D model of virtual objects. Algorithm such as Z-Buffer, Ray tracing, and many more. Ray tracing is a rendering technique that calculates an image of a 3D real world scene by simulating the way rays of light travel. While the Z-buffer algorithm determines which part of the object is hidden and which is visible. There are many other technologies such as rendering, morphing, twining, etc. this technique is used in the animation of the 3-Dimensional objects that are created using the 3D registration. There is many software used in 3D

registration. The prototypes are generated by 3D registration in many fields such medical, mechanical, etc.

B. Augmented Reality Types

When we want broad, background detail about some place like a nearby hotel or petrol pump or any local street map, we can use devices like GPS or some other such navigation system to find our location. This is the simplest form of tracking. It's easy to use tracking data from Wi-Fi hotspots as well. But accurate and exact locations and positions are needed by the AR devices. They use any of the two tracking methods: location based, or marker based.

1) Marker Less or Location-Based Tracking

This tracking method works by using scanning algorithms and feature detection systems. Say, we want to find the information about some object, we can simply point our phone at it and have some kind of feature-detection or pattern identification systems try to recognize it. Specific scanning algorithms are used to identify it. It creates or projects a virtual grid on the image caught by our camera. The GPS already locates the approximate location of our phone or the device we are using. And to pinpoint the exact location, the automatic scan finds several anchor points and binds a virtual model to it. The marker less technology has many advantages including that the real-life object can serve as a marker by itself and there is no overhead of making or creating markers on the objects. We don't have to make distinctive optical identifiers. The physical objects have the digital images projected directly upon them. This is known as projection mapping and can be used to quite remarkable effects.

Fig. 2. Location based tracking

2) Marker Based Tracking

In this method, a particular target is looked for by the device. Usually these are small, two-dimensional barcodes known as data-matrix codes or it's a 2D image printed on something like a poster. The target is recognized via the camera by the augmented reality application device, the image is processed, the barcode is turned into a web address, and an appropriate web page is called up by the browser with further information. All kinds of other markers or fiducial markers, as these "added reference points" are called, can be read by the AR systems by designing them suitably. The benefit of using this tracking method is that it's more convenient to use as the markers or targets can be recognized easily by the camera. Also, a more stable, accurate, tied to a particular point, image is obtained using the markers. Due to its simplicity of implementation, it is

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the more popular option currently.

Fig. 3. Marker based tracking

3. The future of augmented reality

Though augmented reality exists from a long period of time but it is an evolving technology. There are many areas in this field that still are undiscovered or requires large amount of work to be done. This technology has its limitations which are likely to be overcome at some point in the future. But it is important to have knowledge about them. These include limitations regarding accuracy of GPS and other tracking and positioning methods, information overload and privacy concerns. There is a danger of someone obtaining sensitive or private information about other people without their consent.

The currently existing augmented reality system requires the expert or skilled user to calibrate and operate it. To make it common for all type of user expert and non-expert, the system needs to have more robustness that will avoid calibration and setup requirements. It requires research on new auto calibration or calibration free algorithms. To replace the currently existing techniques researchers must continue their research on developing new and better technologies in augmented reality. Display technology is the limiting technology in AR, so it needs to be developed the most. Holographic displays can be advanced in AR for using it as the display.

In future the real time interaction with the virtual world need to be evolved. There should be advancements in the input and output devices used in the real time interaction with the augmented realty. Now the interaction system only uses the eyes and our hand movements in the interaction process by gesture recognition but in future person can not only see but he or she can touch or smell it.

Augmented reality's insights into the coming future

A. AR's Close Relationship with Artificial Intelligence (AI)

Artificial Intelligence is important for Augmented Reality operations.AR enables the naming and recognition of objects from a visual point of view of the viewer. A mixture of augmented reality and artificial intelligence creates many of the social media apps that we are using today.

B. AR In Terms of Teaching and Training

Both the training and teaching technologies belong to the field of education. By using augmented reality technology, any information or data can be passed to a learner in real-time. These systems give a better sense of vision and pull out the objects and hazards which ultimately result in best-practice.

Augmented Reality has proved its worth by decreasing the amount of risk and the cost rates in association with training.

C. AR's Connections with Virtual Reality

Augmented Reality results in connecting people, socializing them with the help of virtual reality. Both virtual and augmented realities together worked in developing the" conference calls" where users can see one and other and at the same time, they can interact with each other.

D. AR Is Overtaking the Automobile Industry

Autonomous cars may take a few more years' time to come into reality. Meanwhile, many automobile companies are making use of augmented reality and artificial intelligence technologies to mark their presence in the market.

4. Conclusion

We reviewed the area of augmented reality and the different technologies used to implement it. The review contributes the information about the AR components such as the display, tracking and orientation, software systems and different algorithms used. It also contributes the information about the technologies such as the Display, Trackers or gesture recognition and the 3D registration. Augmented reality is likely to worm its way into our daily lives more and more in the 21st century. Thanks to technologies such as augmented reality, the way we work with computing devices and think about the partition between digital and analogue realism is expected to transform vitally. If multiple objects are augmented then it is a major challenge which may be solved in future. The review concludes that there is a lot more to research upon and implement in this technology and it has a long way to go.

Acknowledgement

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