

A Study on Augmented Reality, its Applications and Challenges

Sunidhi Rachel Harrison¹
Priyank Singhal²

¹Teerthanker Mahaveer University, Moradabad

¹sunidhirachelharrison@gmail.com

²priyanksinghal1@gmail.com

Abstract—

This is a review paper on Augmented Reality which is an emerging technology. Augmented Reality enables a user to view additional information on top of real world view. In this paper, we will learn about the working of an AR system. It includes the application areas of this technology followed by some of the major challenges which are faced by AR. This paper will also throw light on the advantages and disadvantages of Augmented Reality technology. Finally the future scope of AR is discussed.

Keywords— Virtual Reality, Head Mounted Displays (HMD), Rendering systems, Markers, inertial and vision based trackers.

I. INTRODUCTION

Augmented reality (AR) is one of the most popular technologies prevalent in the current scenario. It is used to superimpose the real world view with a virtual view. In other words, augmented reality allows to capture real world information (which may or may not be real time), process it and supplements it with additional digital information which is added on top of it. It has proved to be of utmost benefit in various fields like education, training, manufacturing & assembly, tourism, location based information and much more [7].

II. WORKING OF AN AR SYSTEM

Augmented Reality works on tracking/capturing real world information and rendering additional data to augment it. This improves the comprehensibility factor by providing necessary details. For example: instructions can be provided while assembling different devices/systems which prove to be of great importance to understand how to assemble different parts. Moreover AR also tells the user which tools should be used and how those

tools are to be operated. Fig 1 shows the use of AR to display maintenance related instructions.



Fig 1. Instructions for servicing/maintenance

An augmented reality system requires some specific needs and AR hardware. AR hardware includes cameras to track/capture the real world entities, a processing unit to process the captured information and finally a rendering system to combine and display the results to the user[1].

Firstly, the environment to be augmented should be known to the AR system. This is done using various cameras which provide real world images. The number of cameras to be used depends on the need and varies from system to system. Then, the real world is matched with the virtual world by tracking the movement of objects in both the worlds. In an AR system there is a need to track objects continuously as they change in reality thus various kinds of trackers are used. These trackers include-infrared, ultrasound, inertial, vision-based,

mechanical and hybrid systems. Each of the tracker possess different operating conditions and is suitable for different kinds of tasks. Tracking is done with an aim to provide low jitter, high accuracy, low latency and robustness. After completing these steps, the collected information from the cameras and trackers is processed and the real world positions of objects are calculated. Now the AR system is able to display virtual images on real world images, thus providing useful information to the users[1]. Fig. 2 shows the above mentioned working process of augmented reality systems.

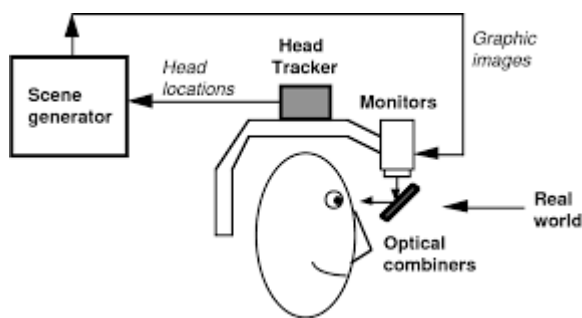


Fig 2. Working of an AR system

III. APPLICATIONS

Augmented Reality has numerous applications which range across multiple fields and domains. The major ones include -

- **Medical:** AR is extremely useful in medical science as it is used to gain knowledge about human anatomy and understand it more precisely using a 3D immersive format. This is used to train the surgeons to perform intricate surgeries and understand complicated conditions as well as explaining those conditions to the patients [6].
- **Military training:** AR is used in military for training and simulation purposes. The soldiers are trained in simulated environments using AR enabled devices like Heads Up Display (HUD) which enables the user to view things along his line of sight without having to look down [7].

- **Repair and Maintenance:** Different kinds of instructions can be provided using AR technology which helps in repair and maintenance tasks. A person wearing a head mounted device/AR enabled glasses (e.g. Google glass) can see the instructions on top of the real world view of the task. The whole process can be represented in a step by step manner. The mechanic can see what and how he is supposed to do to perform the repair [6].
- **Navigation:** AR is widely used for navigation purpose such as Google maps and Google earth. It is used to provide route information, distance, shortest route, traffic etc as per the need of the user. The mobile phone's camera can be used along with the GPS to see the selected route over the real view captured by the camera [6].



Fig 3. AR in navigation

- **Design and Modeling:** Augmented Reality helps the designers to visualize the products before and during its manufacturing/creation. It plays a great role in prototyping, ranging from architecture to interior design and much more [9][10].
- **Tourism Industry:** AR has given a boost to tourism industry. It makes it possible for a user to get a more realistic and wholesome experience of a place before actually visiting it. For example, a virtual walkthrough of various tourist places can be taken before actually deciding which place to visit [3].

- **Classroom Education:** The field of education is not left untouched by this technology. Learning is enhanced by using AR which allows more real time examples, more realistic experience and easy step by step instructions. The students can learn about unknown things by simply capturing it on AR enabled device's camera and the AR software will display the related information[2].
- **Entertainment and Gaming:** AR is used in the field of games and entertainment to a vast extent. Majority of the games coming up these days use augmented reality to make the game or app more interactive and user friendly. Games like, Pokemon Go (Fig 4.) , Temple Treasure Hunt etc. are really popular.



Fig 3. Pokemon Go using augmented reality

IV. CHALLENGES

Augmented Reality face a lot of challenges despite its rapidly increasing popularity. Some of the major ones include the following-

- **Social issues (public acceptance and retention):** The overall public reception of AR is mild as compared to its popularity as an emerging technology. This is because the quality of the AR content produced is either a hit or a miss. The masses are not aware about the applications and benefits of this technology. Moreover, retention of users is a bigger challenge as most of the users download the apps, use them for a short period and then abandon them when their curiosity is satisfied.
- **Lack of augmented reality app designs & development standards:** There is a lack of standards and designs for this technology which is a difficulty in terms of compatibility with other systems and technologies.
- **Security and privacy issues:** There are no designated authorities to supervise augmented reality environments and systems. This results in lack of regulation thus many illegal or harmful acts can be easily accomplished by people having malicious intentions.
- **Possibility of physical harm:** There is a great probability of harming yourself or your surroundings due to lack of attention and awareness about this technology. The virtual elements added by this technology drive away attention from reality resulting in a potentially harmful situation.
- **Legal and ethical issues:** AR combines real and virtual world which may result in unfavourable situations. For example, AR allows you to navigate through places but this does not permit you to enter someone's private land or cross a busy road while looking at your cell phone. This may result in some mishap. There is a strong need on the part of users to be aware about the ethical and legal boundaries which should not be crossed while using this technology [5] [7].
- **Lack of use cases and poor quality of content:** In current scenario, AR apps are mostly limited to a single kind of functionality. Moreover, most AR systems are pretty much same with little or no difference. This is due to lack of expertise on this technology which is relatively new [2] [5].

V. ADVANTAGES

AR systems has a number of advantages some of which include the following-

- Augmented Reality is an extremely flexible technology. It can be used for a range of applications and as per need.
- Unlike Virtual Reality, AR system provides the best of both worlds feel to the user by combining information from real as well as virtual world [8].
- The additional information which is provided by the AR system is very beneficial.
- AR systems usually provide information which is not easily available or whose retrieval is quite a tedious task.
- A huge number of errors which occur during maintenance can be significantly reduced by using AR systems.
- AR simplifies difficult assembly tasks which involves many parts thus giving better guidance than manuals.
- AR can be used to remove restrictions of location and time which leads to faster knowledge transfer and a better understanding of various processes like maintenance.

VI. DISADVANTAGES

In spite of being an extremely beneficial, Augmented Reality systems pose certain problems that may hinder their actual implementation in real time applications.

- AR hardware is generally bulky with limited range of movement. For example a Head Mounted Display (HMD) usually weighs about 700 grams which makes it quite difficult for user to wear it for a long time. Moreover, HMDs are connected with cables which limit range of user displacement.
- AR hardware is not easily affordable because of its high cost.

- Low resolution devices and high latency of the systems and small field of view would result in bad user experience.
- Lack of any regulating authority.

VII. FUTURE SCOPE

Currently, the scope of Augmented Reality is limited to navigation, gaming and few other areas. However, in future this technology will expand rapidly throughout the world. More advanced AR apps will be created and made available to the masses. Moreover, the hardware required for AR will also become more affordable for common people thus making this technology more popular .

VIII. CONCLUSION

Augmented Reality is no more a fancy and has changed the way we interact with real world by augmenting important information to it. It is expanding rapidly in various domains ranging from business to technology and daily life tasks. The major application areas of AR include navigation, modelling and simulation, training and medical science. However, AR can be implemented in many more domains. There is still a lot more to be done in this field which makes it a good research area. It holds a great potential for compatibility with other technologies like IOT (for example, Augmented reality services enabled IOT based smart cities [4]), Human Computer Interaction, Virtual Reality and Artificial Intelligence etc.

Currently, there is a lack of standards, affordable hardware and public reception is not up to the mark. Better materials, faster algorithms, smaller hardware are demanded and the research community must take charge of this need and offer valid solutions. Thus in the coming years AR will be no less than a revolution which will transform the whole learning process.

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