

Personalization of Physical World Using Mixed Reality Concept: Augmented Reality and Virtual Reality

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Abstract: Augmented reality is gaining more popularity and have been considered as a vital technology. A combination of AR and VR is known as Mixed Reality (MR). This concept is more complicated than augmented reality and virtual reality since it integrates the several types of technologies which includes advanced optics, sensors, and computing power. This allows users to visualize the real world and virtual world at same time, a high range of communication between users and computational device for manipulation of the surrounding information. We use SLAM technology to derive some particular application on AR/VR. SLAM technology will allow user the capability to arrange augmented concepts in real time space which gives the best creating scenario of overlying virtual images. We give a brief idea about SLAM technology using which user can clarify the concepts of localization and mapping. Among various techniques to implement SLAM technology we discuss Visual SLAM technology, which is more interested in AR/VR/MR aspects.

Keywords: Mixed Reality, Augmented Reality, Virtual Reality, Computing power, SLAM

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I. Introduction

Augmented reality and virtual reality are gaining its feet in personalized reality which is about more than gaming, companies are finding enterprise potential in the technology. The major goal is to substitute keyboards and displays with new technique for collaborating the scene with communication and gestures. Mixed Reality concept and environment is termed by Milgram as virtual object and real world merged together into single display[1]. As Mixed Reality concept have proved for single user applications and very interactive in nature.

Advancements in Augmented Reality and Virtual Reality define new terms to interact with technology. The user having devices designed for gaming and entertainment is grown due to AR's and VR's organization potential has proved to be the real cause for excitement [13]. MR advances is more interactive nature and we relate in connecting with the new way of working. The ability to sense information from things around us, and the information gathered to act on our physical and visual feedback changes the ways in which we do our work and prioritize it. The Mixed Reality concept is intended to self-adaptable process which are extremely flexible with computing machine which act intelligently and autonomously by implementing concepts such as Internet of Things and cyber systems [2][11].

Previously, in AR application the image or the corresponding image descriptor had to be provided beforehand so that the application is exactly searched only for that frames (data) to compute the process. To do so marker based technique is used, where there is no need of accelerometer or compass and hence there is necessity for providing recognition libraries to compute the frames that are already provided.

Generally there are two types of AR: marker based AR and marker less AR. In marked based technique mainly image recognition is involved. So in AR applications the marker is usually an image, black and white image (2D image), QR code for an example. These images as a marker are easily tracked and recognized in camera frames. Markers also have several weaknesses like when two different markers are overlapped it doesn't

work. But in factual there is no relation of marker with actual real life objects. So marker based technique is a good start to learn or work with augmented reality. But to do more without prior knowledge time is to move on towards location based tracking which are based marker less AR technique.

Advancement in mobile hardware and software have motivated new approaches for augmented reality such as marker less technology. Marker less AR is based on recognition of objects which are not directly provided to the application in advance. Marker less AR technique allows developer to use all part of the physical environment as a medium by which it can impose virtual objects on it. The main aim of this technique is to perform tracking and recognition of surrounding environment without any marker. This strong approach of marker less AR which can be used to detect real life object and works even if the multiple objects as a target [3]. So marker less tracking simply keeps the objects in place by using combination of sensors and SLAM (Simultaneous Localization And Mapping) problem at run time. Though it won't require specially placed marker it allows more complex application to be developed using augmented reality concept.

Therefore, a SLAM based application system is developed in this study based on marker less AR Instant Tracking. This paper make general comparison between AR and VR which gives the general importance of reality concept. As a result, we are able to build the new relation between real and virtual objects by removing the barriers that change our skills to make conclusions quickly, learn and process crucial information, by visualizing possible scenarios before reacting, or share information and jobs between workspace and group of individuals.

II. Marker less AR Using SLAM

2.1 Intention of AR

Augmented reality is a technology that recognizes graphical computer vision and its algorithms to augment video, audio, graphics and other inputs based on sensor on the objects in real world using your device camera [4].

Augmented reality help enhance our perception of the physical world. User can apply his own imagination into the real world, education and learning new things can be made entertaining. User queries can be solved instantly. It camouflages information into our field of view and intensify it to take us into a new contemporary world. Travelers can explore new places more interactively.

AR promises to make all kinds of works faster and safer. It eases our queries in real world in real time. For mobile users who use mobile devices for daily activity, AR allows them to participate in a reality that is based on personal needs and desires. The possibilities of creating an augmented environment is simply boundless. Users can create literally any environment they would like and work in it as per their requirements.

2.2 Usability

Data Visualization is the most crucial factor to make people understand the significance of any particular data. These days Data Visualization tools are not limited up to Excel Sheets, Graphs, Pie Charts or any other sophisticated ways. The data presentation is more efficient using Augmented Reality. It actually acts like a bridge between the digital and real worlds.

Augmented reality has many applications and can be used almost everywhere. We designed an application where we summarize how beginners can use augmented reality using SLAM technology. We also designed 3 more applications of augmented reality based on Slam Technology where you can use it for home décor, navigation and education purposes.

When you want to buy new furniture for your home you are often confused whether it will fit with your home or not. So we designed an application to ease your confusion. Using our application for home décor you can augment desired furniture into places where you want them and check whether they are suited for your home [5]. Just point your smartphone containing our AR tool in the direction where you want the furniture to be. Using this you will be able to determine which color furniture you want with what size and what finishes it should have.

Augmented reality have a vast application in education. Education can be made fun with augmented reality. While studying, some topics can be very complex to understand. Our application for education purposes ease these topics for comfortable learning. 2D diagrams on books can be augmented into 3D imagery using our augmented reality application [6]. This also helps in understanding the structure of the object you are learning.

Maps and navigation have a broad scope for augmented reality. Exploring new places can be made easier and more interactive with AR technology. In navigation our application can give real time review of structures we are visiting. When we are visiting new cities while searching for a place to stay our application can help touring parties in finding a comfortable accommodation through reviews [7]. They can read reviews and facilities provided by these places in real time.

2.3 SLAM Technology

In our mobile based application we use Simultaneous Localization And Mapping (SLAM) technology. SLAM is a piece of software that refers to the problem of trying to simultaneously localize an unknown environment with respect to its surrounding keeping track of actual user location [8]. Slam can be implemented in many ways however, we will be discussing mostly about visual SLAM. Visual SLAM is very much suitable for tracking in unknown environment such as rooms or real world objects where the primary mode of sensing is camera.

Generally, marker based tracking are used in AR which is not SLAM, since it is known beforehand. Challenge in SLAM is to retrieve map structures and camera pose without their prior knowledge. The core technology in application is SLAM which uses sensor data to map environment in real time and identify its location [12]. In AR technology the object that is being rendered is required to be apt in real time environment as the user moves. In VR user would directly interact with objects in virtual environment without any external components.

Now in SLAM we need to localize and map such that mapping and locating 3D modelling object is done simultaneously. So localization is nothing but location given on a map and mapping refers to a map giving locations where all objects are simultaneously present.

III. Design and Implementation

3.1 How SLAM Works

Modern visual SLAM technology uses tracking method. Firstly a set of points are acquired using successive camera frames and are tracked, then these tracks are used to triangulate their 3D positions. Simultaneously the camera poses that have observed them are calculated using these point locations. Computing one without the other is impossible from a few points, so a sufficient number of points are required to solve for both structure and motion. This can also be done using a single camera, measurements of points are carefully combined to retrieve structure and pose with high accuracy. Basically SLAM acquires visual data from real and physical world in aspect of points to make it understandable for a machine [9].

SLAM technology also uses relocalization technique. Relocalization technique helps to handle poor tracking performance, which could lead to failure of the system. This allows to restart the tracker by determining which areas of the previously visited map resemble the current view of the camera.

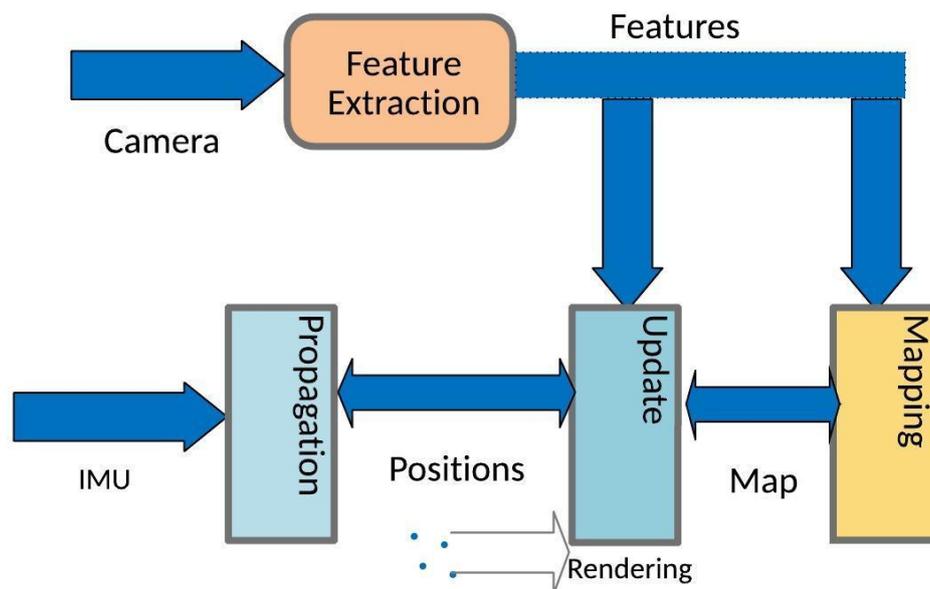


Fig 1 Working of general SLAM pipeline

Operation of SLAM is as follows:

- IMU consists of gyroscope that measure angular velocity, accelerometer to measure acceleration of movements in three axes.
- The propagation unit initializes the main task which integrate with IMU data and produces latest position. Though IMU consists of hardware which are usually biased and inaccurate thus we cannot fully rely on propagation data.

- The drift problem is solved using a camera which captures frames at a fixed rate, usually at 60 FPS.
- The camera captured frames can be delivered to the Feature Extraction Unit to extract useful corner features and develop a descriptor for each feature.
- The extracted features can then be delivered to the Mapping Unit to expand the map as the Agent continues to explore.
- The detected features are sent to the Update Unit which compare them to the map. If these features already exist in the map, the agent's current position can then be derived from the map points that are previously known.
- The drift received by the Propagation Unit can then be corrected by the Update Unit using this new position. Also, the map is updated by the Update Unit using the newly detected feature points.

3.2 Application Design

To make a marker less augmented reality application for mobile devices Instant Tracking engine is used. It allow us to detect actual surface so we can put 3D object without use of any marker. The Instant Tracking method works in two different stages: initialization stage and tracking. In initialization stage we initialize the current position with respect to surrounding and in tracking stage actual virtual object is placed while surrounding is continuously tracked. We have used Wikitude software for implementing our application. Wikitude is technology for mobile augmented reality [10].

For continuously tracking there is need of input parameter which is the height of device which is above the ground for scaling the virtual object. Another parameter taken in consideration is alignment of the ground plane, to represent alignment of plane the initialization indicator can adjust and follow the Instant Tracking.

Another scenario for augmented reality is tracking of the object(recognition). To track and recognize the subjected object in real environment, the tracking of object also follow the SLAM engine which is based on Instant Tracking. The object recognition provide us to detect object which are predefined by user. The object could be anything tools, books, household utensils etc. But the object should not have the dynamic object which are capable of changing the parts. The object tracking works in similar way as image tracking is done.

3.3 Scene Creation for Instant Tracking

- UI: The UI is partitioned into two for simplifying the Instant Tracking, which allow to change the interface. The first is initialization in Instant Tracking where the UI displays the height controller and there is button(initialize) for switching in Tracking mode. After switching the UI displays the button which shows the object shown in fig 3.

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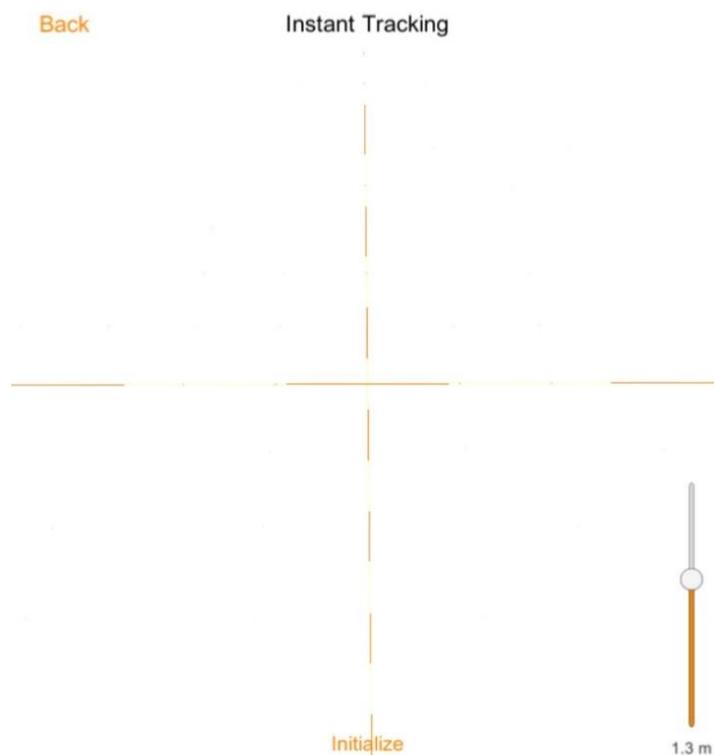


Fig 2 Initializing mode

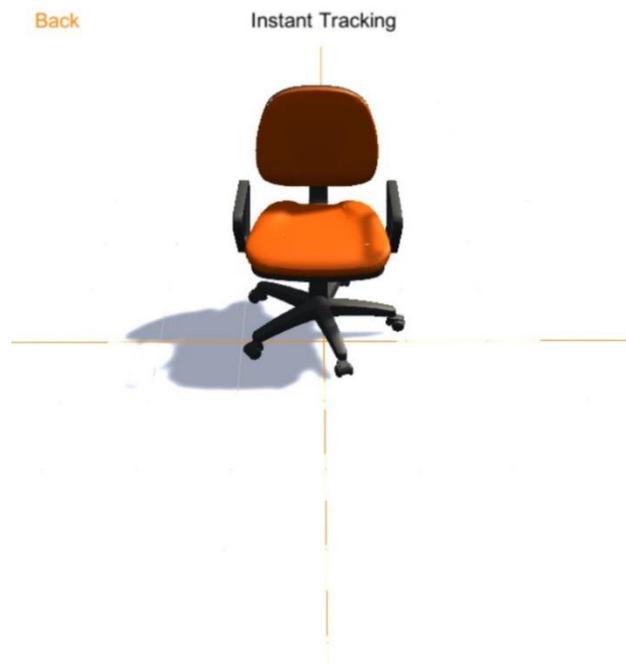


Fig 3 Tracking mode

- Controller: It coordinates with virtual object and touch input to scale and move the object. Forspacing in initialization and tracking grid render is provided
- Plane: For physics interaction the plane has collider in it which enables custom shader that allows shadows on it
- Instant Tracker: The actual tracking is done in this component

IV. Results

After development of our application the next stage is testing it. We first chose a plain surface to place the objects. Then we place virtual objects over it as shown in fig 4. The augmented objects are placed on the plain surface though it is smaller in size because we can optimize the size of objects according to our needs.

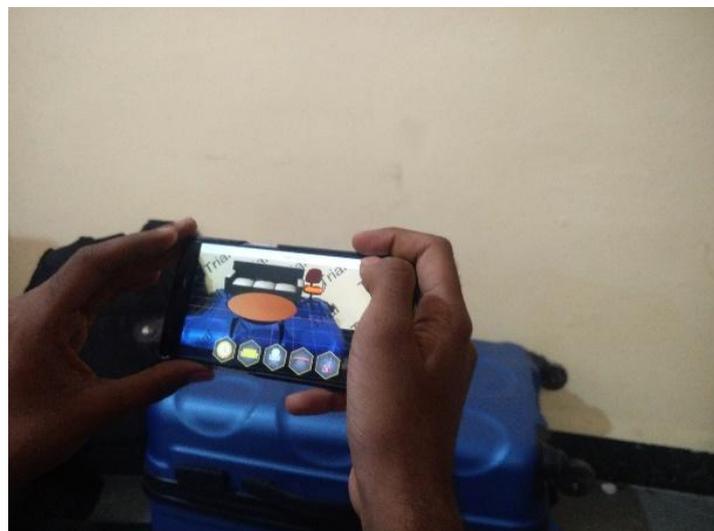


Fig 4 Application Testing

To run the developed application the device should have gyroscope and gps receiver and extra computational function to reach the goal for localization, typical desktop computer does not have any receiver and required functional component for localization function. Marker based AR is mostly supported by desktop computer and mobile devices, and marker less AR is supported by mobile devices only.

On the basis of our research Augmented Reality is the future of technology and is explored vastly for various applications. Gaming, medical, education, training, business are among the major fields that can benefit with augmented reality. Currently augmented reality is explored mostly in gaming. Gaming has been the stepping stone for various new technology and augmented reality is no different. Nowadays, gaming has been made so interactive that gamers do not want to step out of it. Augmented reality has been a revelation in gaming. Augmented reality is also been adopted by business, education and healthcare fields on a large scale. Performing operations and diagnosing major or minor injuries has been much easier than before. While business has been made interactive and interesting than ever before. Understanding the flow graph of business was never as easy as it has been after the introduction of augmented reality. As far as education is concerned various major institutes have adopted augmented reality methods to educate students. Education is more fun than before. Following chart show the distribution or adoption of augmented reality in various fields based on our research.

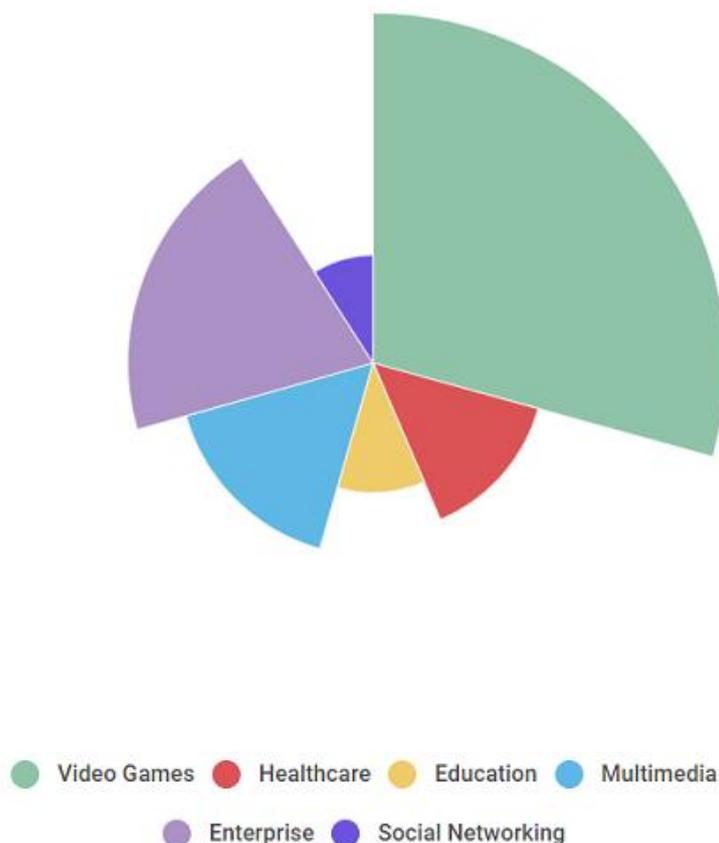


Fig 5 Total mobile AR market

V. Conclusion

Based on the research, we have applied SLAM technology techniques associated with the reality concept environment. In order of advancements in this field some of the works include overlaying virtual images, computing power and power consumption. While performing AR practices different factors that affect its working are lighting and visibility effects, aggressive or changing environments, or sound interference. Also real world noise may affect crucial and important components of AR system like localization and registration, restricting accurate and correct user data. Exposure to augmented reality leads to a new field of interest for users due to its immersive nature.

In this paper, we have discussed and successfully developed augmented reality application for home décor, education and navigation purposes. We have determined a better way for configuring our home to our needs using the home décor augmented reality application. Education is quite interactive using augmented reality and exploring new places is much easier using the augmented reality application for education and navigation respectively.

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