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A Marker-Based AR System on Image Shadowing for Tourists

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Abstract:
AR is an immensely high technology, but it still has defects that are stopping the community from implementing it on a large scale. Nevertheless, it can change the way we look at the world. Marker-based AR provides a very immersive experience and closely mimics the real world; with this, user engagement with the user becomes easy. At tourist attractions, in more cases, the human guides charge hefty amounts, and sometimes a manual is only available in some places. This work is about building a traveler-friendly application that can introduce AR- based experiences. Android Studio was used to build the program, and we used the ARCore library as the AR rendering engine for our app. In our app, when we project the phone at an image, a video (AR scene) related to the image will be played, replacing the image in our application. This is achieved by marker-based AR and image shadowing techniques. People will be able to use it in tourist areas, and it has the potential to be better than a human guide.

Keywords— ARCore, Marker-based Augmented reality, augmented scene, Mobile devices, Video anchor, Virtual object, and Video Observation

Introduction

We define augmented reality (AR) as a real-time direct or indirect view of an actual physical environment that has been improved or supplemented by the addition of artificially created virtual data. Augmented Reality applications operate in real-time and interact with real and virtual objects. Augmented reality differs from virtual reality (VR) in that in AR, part of the surrounding environment is "real" and adds layers of virtual objects to the natural environment. On the other hand, in VR, the surrounding environment is virtual and computer-generated. AR is closely related to real-world environments that augment it, so virtual environments cannot replace it. For example, with AR displays, which will look much like a regular pair of goggles, descriptive graphics will appear in your field of view, and we will adjust the audio to synchronize with the current scene. We will livelily render these improvements to reflect the corresponding moments in your head. For image recognition, there are several players in the market ex. Vuferia, Easy AR. We can choose with our budget as some of them are license based.

Research and development on this technology are still in their infancy at numerous universities and high-tech firms. Investment in AR has increased globally in recent years due to businesses' rising need to strengthen customer relationships through digital platforms.

Augmented reality uses an identifier called markers. AR tracking can be done in three ways: marker-based, marker- less based, and location-based. A Marker-primarily based totally AR is whilst the tracked item is called a black-white rectangular marker. Marker less augmented reality is when the tracked object can be anything else: picture, human body, head, eyes, hand, fingers, etc., and on top of that, you add virtual objects. For this study, we use marker-based AR. In this type of AR, each marker should be distinguishable and should be able to get detected by the system. The AR system assumes the real world as the 3-axis coordinate system, i.e., X, Y, and Z axis, and the camera is placed at the base origin of the coordinate system (0,0,0) as shown in Fig. 1. With the evolution of 5G, we can now transfer 3-dimensional data at faster speeds than ever.

With the development of Information technology, each educational institute has developed their own educational Information Management system which improves managing the data of students. There is a constant improvement of the educational policies which are changing fast with the new era of Big Data. The old management system had many points which had difficulties to handle the Data.

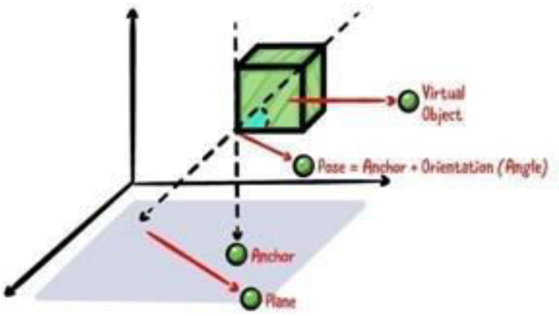

Fig. 1Real-world coordinate frame. Adapted from [12]

One of the most potent examples of a marker we use daily is the QR code. Social media platforms such as Snapchat employ the user's face as a marker to apply animation over the face. Snapchat algorithm identifies specific features of the face and produces the desired animations. The tech giant Google spent billions of dollars in research and the product development of a “Google glass” based on mixed reality. The popular game “Pokémon Go” is based on marker-based AR only. The strength of augmented reality (AR) systems lies in providing information to users that otherwise would not be available to handle their senses and help them solve tasks simultaneously.

We use the current AR technology to create an experience to make history pictures or videos come to life through the mobile camera. The image in the background of the mobile camera will appear as a video playing. The image dimensions, pivot point, image surface, and distance from the camera to the camera are described.
The article follows with a literature review explaining the origin of AR, how it has evolved over the years and basics of how augmented reality works, and how a popular framework from Google called “AR Core” works. Literature reviews also mention the current technological limitations. Then what is the problem statement, and what are the hurdles we have in the current implementation? The methodology contains how we solve the problem for tourists and the design and implementation. Finally, the paper concludes the results and conclusions.

Literature Review

A. History

In 1968, augmented reality (AR) was initially exhibited by Ivan Sutherland, a Harvard professor, and computer scientist who created the first head-mounted display. Caudell and Mizell developed modern augmented reality in the 1990s. Louis Rosenberg created the first functional AR system in 1992 at USAF Armstrong's Research Lab. Azuma released a survey in 1997 that provided a definition of the area, listed numerous issues, and summarized previous developments [6]. Since then, AR has made significant growth and advancements. The International Workshop and Symposium on Augmented Reality, the International Symposium on Mixed Reality, and the workshop on designing augmented reality environments all started in the late 1990s [6]. A few well-funded groups, including the Arvika consortium in Germany and the Mixed Reality Systems Lab in Japan, focused on AR technology. But enough research has been done on AR over the last ten years to declare it a research field [6]. Augmented reality is created using a variety of technological breakthroughs, which can be used alone or in combination to create augmented reality. General hardware components, displays, sensors, and input devices such as GPS, gyroscopes, accelerometers, and software are included.

From being a science fiction idea, AR has evolved into a more realism that is based on science. The cost of developing AR has recently dropped sharply and is now readily available on mobile devices. In 2009, AR Toolkit brought augmented reality to the web [25]. Both Google and Apple have made significant investments in augmented reality, as reflected by the creation of AR Core (Google) and ARkit (Apple). These revolutionary technologies have enabled individual developers to

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control AR, which was unthinkable just a few years back. [26]. One example is the travel-focused smartphone app mTrip (https://www.mtrip.com/), which incorporates augmented reality with city guides [29]. Information, such as directions or ratings of attractions, is overlaid on display using the smartphone camera viewfinder and changes depending on what the phone is pointed at. Ryan Yung et al. concluded that despite the touted benefits of technology in the tourism industry, AR in the tourism context needs to be explored [29].

B. Current developments in tourism
Aspects of VR and AR have already been embraced by the travel industry. Both Tourism Australia (http://www.australia.com/) and Destination BC (http://bcexplorer.com/) in British Columbia, Canada, offer fully interactive VR experiences on their websites. supported by the regional office for tourism and information [30].

Fig. 2 Illustration of Samsung translation service

AR has encountered various divergent viewpoints in the field of cultural heritage. On the one hand, research has shown that AR makes it possible for museums to offer visitors richer information in a more dynamic and creative way [32]. In contrast, heritage site administrators resisted implementing the technology out of concern that it would lessen the sites' objective authenticity [33]. Examples include using augmented reality (AR) as a tool for information dissemination in museums [33] or as a travel guide [34 - 35]. The user experience requires more study. It is warranted to focus in particular on the topic of usability as a determinant of destination managers' intention to use and visitors' intention to visit or return. When visiting other countries, many people face difficulties reading the sign boards. Google and Samsung introduced a translation service to convert the local sign into the language understood by the tourist, as illustrated in Fig. 2.

C. How Augmented Reality works?
Augmented Reality starts with a camera-equipped device loaded with software. The software then uses computer vision technology analyses the video stream and recognizes a physical thing by detecting its shape or a marking, to recognize it when a user aims the device at an object. The key distinction is that instead of appearing on a 2D page on a screen like a web browser producing a web page, the AR information is delivered as a "3D experience" superimposed on the item. So, what the user sees is a combination of the real and the digital.

For the AR to render the object, a 3D model should be present. This model is created using computer-aided design, usually during product development or by using technology that digitizes physical objects. Then, with the help of AR software, it accurately places and scales up-to-date information on the object. The user can interact with it by sending signals like touch, voice, or gestures. As the user moves, the size and orientation of the AR display automatically adjusts to the shifting context, as illustrated in Fig. 3 and Fig. 4. In Fig.3, "E" represents the eye or mobile device, "P" means the surface and "X" is the 3D object which the AR system will generate. As a result, new graphical or textual information comes into view while other information passes out of sight.

D. What is AR Core, and how does it work?
Google's framework for creating augmented reality experiences is called AR Core. Your phone can detect its surroundings, comprehend the outside world, and interact with information thanks to AR Core, which makes use of many APIs [10]. Augmented images interact with real-world images and use AR Core to create 3D experiences. Tango only works on devices with a depth sensor, while AR Core is available on most modern Android devices. [12]

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To combine virtual material with the real environment as seen through your phone's camera, AR Core relies on four main features:
1. Motion tracking
2. Environmental understanding
3. Light estimation

Understanding "depth" is important because the AR Core can produce depth pictures and maps that contain information about the separation of surfaces from a particular location.

Anchors and trackable can change as AR Core improves its understanding of its position and environment. When you need to vicinity a digital object, you want to outline an anchor to make sure that AR Core tracks the object's role over time, you need to define an anchor to ensure that AR Core tracks the object's position over time. Frequently, you create an anchor based on the pose returned by a hit test. AR Core makes use of hit checking out to take an (x, y) coordinate similar to the phone's screen. This lets customers choose or in any other case interact with gadgets withinside the environment. [10] The truth that poses can extrade manner that AR Core may also replace the placement of environmental gadgets like geometric planes and characteristic factors over time. Planes and factors are a selected kind of item known as trackable. As the name suggests, these are objects that AR Core will track over time. You can anchor virtual objects to a specific trackable to ensure that the relationship between your digital item and the trackable stays strong while the tool moves around. For example, suppose you place a virtual Android figurine on your desk. In that case, if AR Core later adjusts the pose of the geometric plane associated with the desk, the Android figure will still appear on top of the table. We reuse anchors, when possible, to reduce CPU costs and detach anchors you no longer need.

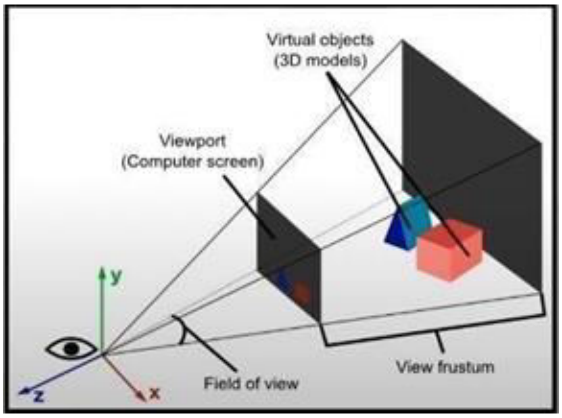

Fig. 3 A representation of how the eye to the device screen the AR works

Augmented Images: This feature allows you to build AR apps that respond to specific 2D images, such as product packaging or movie posters. For instance, they could point

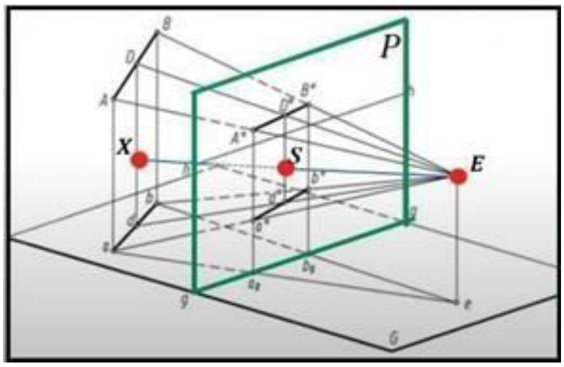

Fig.4 A diagram of augmented reality representation in the linear coordinate system.

their phone's digital digicam at a film poster and feature a individual come out and enact a scene. Once registered, ARCore will detect these images and the images' boundaries and return a corresponding pose. ARCore offers SDKs for a number of the maximum famous improvement environments. These SDKs provide native APIs for all essential AR features like motion tracking, environmental understanding, and light estimation.

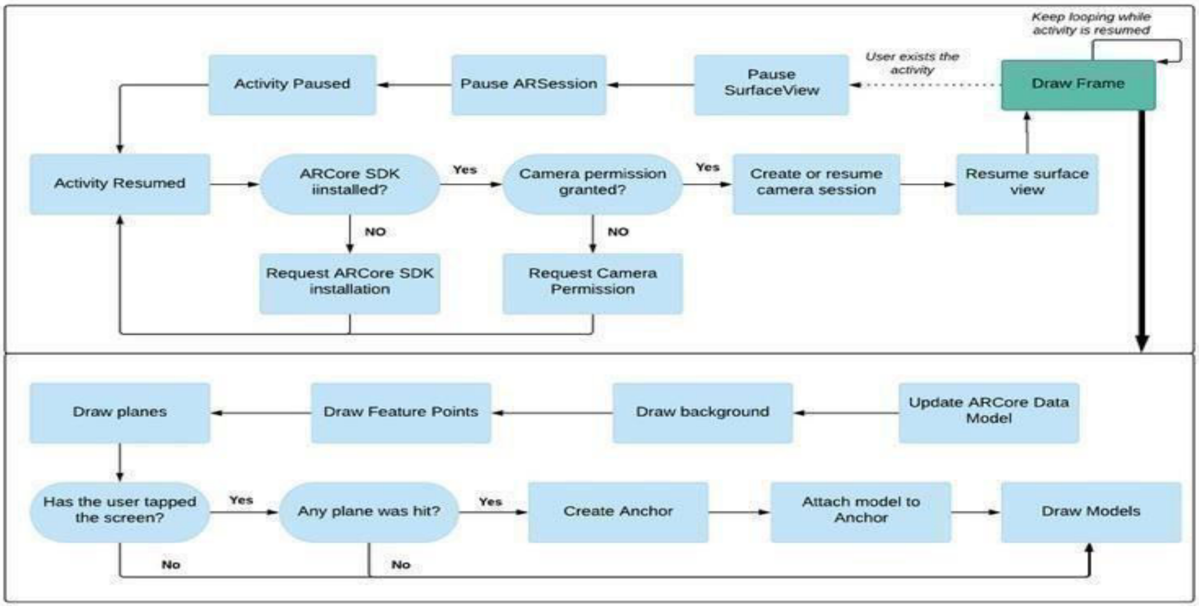

Fig. 5 ARCore Functionality Flow. Adapted from [28].

With these capabilities, you can build new AR experiences or enhance existing apps with AR features [10].

E. Technological Limitations

The field of view, focus depth, color depth, brightness, contrast, stereo view, and high resolution are only among the technological issues that AR must overcome. There are several drawbacks, some of which have already been mentioned, including portability and outdoor use, perspective lag, point tracking, depth perception, social acceptance, weariness, and eye strain [27]. The shape and size of the marker may affect its detection. The AR system could only provide its services to 10 diameters distances. Sometimes, the system may encounter glossy markers, which are very tough to detect.

Moreover, the system should constantly track the changes in the marker, which exerts pressure on the CPU and GPU. Each marker should be distinguishable. Although augmented reality has specialized uses, I fail to see it as beneficial for the average consumer, who is already too addicted to technology.

III. PROBLEM STATEMENT

Travellers have the problem of finding a guide who can give them complete information about a particular place. If they find a human guide, sometimes the human guide may demand more fee, and he/she will be available for a limited amount of time. Moreover, the information provided by the guide may not be authentic, and there will be various communication and translation problems when employing a human guide. So, keeping these problems encountered by tourists, we developed a mobile-based AR system to tackle these issues, and also the current implementation shows the potential of AR in a precise way.

IV. METHODOLOGY

On viewing the difficulties faced by the tourists, we concluded that a digital system is needed to aid tourists. A digital system will help people to get all the information about the place which they visited, and it will solve issues like translations and communication problems. Digital system could help in provide a cost-effective solution also and it could be distributed to a greater audience at same time.

While searching for an effective solution that could help tourists, we observed that Augmented Reality is the most effective technology and the best-suited answer for the problem. Not only AR provides information effectively, but it also enhances users' senses; For example, deaf and hard-of- hearing users could receive visual cues notifying them of missed audio signals, and blind users could receive

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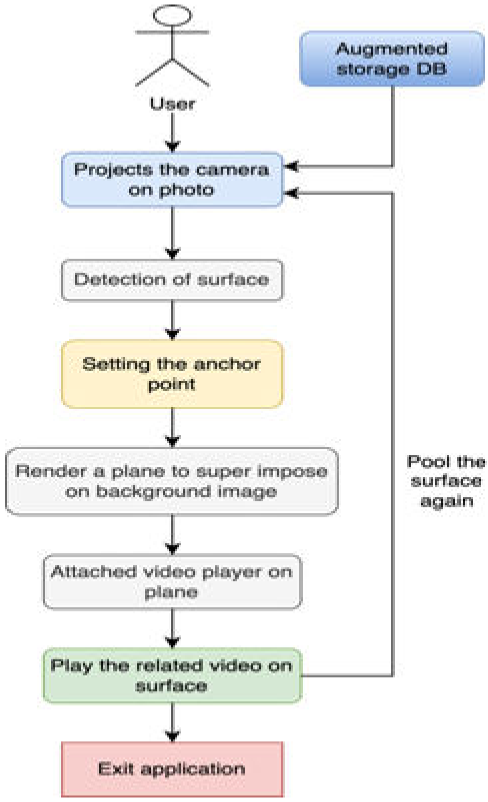
audio alerts notifying them of unusual visual events.

Augmented reality combines a realistic view seen by the user with a virtual scene designed by a computer using augmented reality. However, there are complex issues facing augmented reality, such as privacy, ethics, and user issues. But building a mobile-based AR system is based on various difficulties because AR systems require a powerful CPU and considerable amounts of RAM to process camera images. Furthermore, AR is still in its infancy stage.

With Augmented Reality coming to Android OS, the whole Android ecosystem has a new dimension to play around with. We employed the AR Core SDK provided by google after doing a survey on various AR SDKs available. ARCore has the best community support and compatibility with various operating systems. Our AR device includes 3 easy steps: recognition, tracking, and mixing. Any image, object, face, body, or space is recognized on which a virtual object will be superimposed. During tracking, real-time localization in the space of the image, object face, body, or area is performed. Finally, media in the form of video, 3D, 2D, text, etc., are superimposed over it. We started collecting the AR objects and their corresponding pictures. After the collection of data, an android application based on AR Core was built. We designed the flow diagrams, functionality and working of the application are explained below.

A. Design and Implementation
The augmented reality system consists of a smartphone with a high-resolution camera (more than 10 megapixels) and some internal storage. It has the AR Core SDK and the Scene Form library installed. There is a database where the AR objects will communicate with the AR system via HTTP. The camera sends each frame to the application as feed. The application, which AR Core supports, renders AR objects and provides them to the video player. As illustrated in Figure 6, the application is at the heart of the AR system.

B. Functionality
The AR system detects or identifies a marker when the user projects the mobile device near it. After identifying the marker, the AR system uses its surface detection algorithms to



locate the surface and set 2D plane coordinates as the surface to insert the object and also examine the marker's area and dimensions. It is the image in our case. Following this step, the system generates a three-dimensional anchor point, which serves as the base of the AR object. The object is then rendered and visualized in the vicinity of the anchor point. As shown in Fig. 7, the system overlays the AR object, and the object turns it into a task.

Furthermore, the AR system will pool the next frame and check for changes; if a change is identified, the entire process is rerun. The metadata of markers is loaded into RAM during

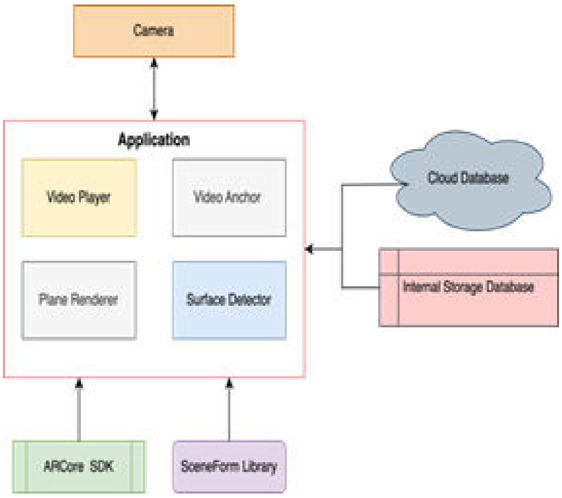


Fig. 7 Architecture Diagram of the application and internals

the application's initialization, and if there is an update, the application will pool the cloud database at regular intervals.

C. Working

The AR application works as follows: It first creates the necessary environment. After that, it initializes the images and the database required for serving the videos and loads the libraries required for the application. There are specific image size and quality standards to fill up this augmented database. "ARCOREIMG" is a tool that also provides a helpful "quality score"; anything 75 and over is desirable for a decent reference image. The Sceneform Android Studio plugin makes it simple to import and preview 3D models for rendering. Grab a model from the internet and head to Poly to get started. A Sceneform Binary Asset (SFB) is produced and added to the app's Gradle file.

Fig. 8 A sample picture acts as a marker for the AR system to detect it.

After that, we must check if the device supports OpenGL (as ARCore is heavily dependent) and then load the ARCore models required to detect surfaces.

Now, we can start tracking the reference image in the real world to determine if the device is identifying the image. This is carried out during the AR Core tracking sessions on Update Frame. ARCore does the heavy lifting here and checks the images from the database against the camera; all we need to do is fit a match and display our model. Once the image is identified, a VideoAnchor Node is set, and the PlayerNode is initialized. To host the scene, the ARCore renders the plane shadowed on the image, and then the video player plays the appropriate setting on the plane. Surface detection and Plane Renderer control whether renderable cast shadows on them to aid this process smoothly. VideoAnchor Node has some scale types like FitXY, CenterCrop, and CenterInside.

The application continuously processes the video frames from the same feed and changes the planes and scenes accordingly.

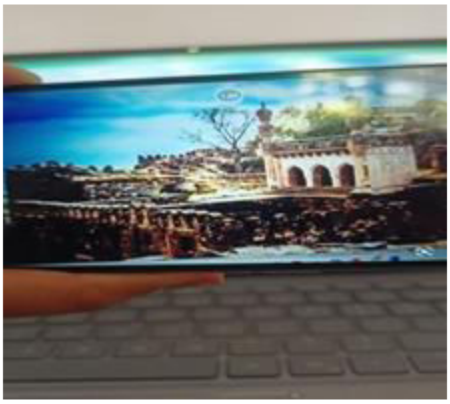


Fig. 9 In the AR system, a video will be played. Itcould be illustrated in the picture.

Results And Discussion

Here, we have implemented an AR experience that could be used on a smartphone by simply downloading an application from the internet. The application will provide an experience that will augment the image in the scene. This will assist tourists wherever they travel. We can deploy our app in tourist places where people can install the app, project their phone to a scene, and get an augmented video of the history of that place, which would be extremely helpful in tourist places where there is no guide. Compared to mTrip[29] which provides direction and ratings, our application goes further and provides real-time guidance and history. And our application uses the ARCore which is a proven technology. Tourism Australia and Destination DB of British Columbia, Canada have AR experiences on their websites, but we provide a mobile application that is very handy. Our implementation is also a better information dissemination tool. The accuracy of detection is based depends on the light conditions and the camera of the mobile largely. The accuracy of the picture detection version is 96.2% and the required processing time using the One plus 9R Mobile (8GB RAM, 2.42 GHz octa-core Processor) is 0.2 seconds to detect the images and produce an AR scene.

The AR application has two main components: tracking components and recognition components. As augmented reality has no bounds for development, its implementation provides accurate results tested on different lighting conditions and surfaces. The libraries used are open-source and widely used across the industry. This experimentation demonstrates the power of augmented reality, which could help people communicate more effectively.

Conclusion

Finding a guide who can provide them with comprehensive information on a specific tourist location is a challenge for people. To address these issues tourists face, we developed a mobile-based augmented reality system that can serve as a complete digital guide for people. Furthermore, mobile- based augmented reality applications will add value to a wide range of application domains by improving user experience and the well-being of the sophisticated next- generation society. AR technology has no boundaries and can be used in various settings.

We observed that users of this product should be aware of AR technology and understand what the application is conveying. According to our experience, handing the application to 15-20 people took 1-2 hours to familiarize them with the application and the AR technology. In addition, we discovered that 70% of them need to be made aware of augmented reality. When it comes to AR systems, these systems require a powerful CPU and a large amount of memory. Furthermore, current implementations need an understanding of the environment, which would allow the phone to detect the size and location of various surfaces such as the ground, a coffee table, or walls. Light estimation is also critical for implementation because it greatly impacts detection. We could improve the current implementation by creating custom models for each use case and introducing better scene and surface detection libraries, which would improve the overall application.

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