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# Hardware Performance Analysis of Mobile-Based Augmented Reality Systems

## ID: 318

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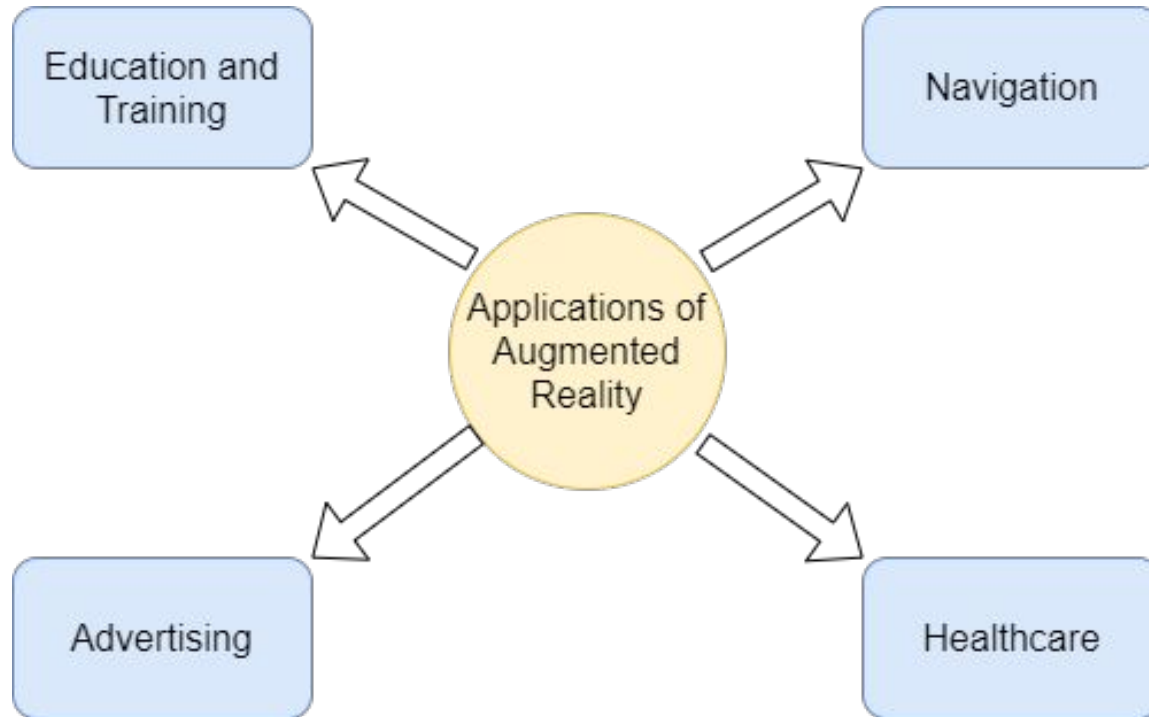
# Overview

- Introduction to Augmented Reality (AR)
- Applications of AR
- Hardware performance of AR technologies
- Experimental Results
- Conclusion

# Augmented Reality

- Augmented reality is the art and science of overlaying unreal objects, texts, or illustrations on top of the real-world view.
- The term “Augmented Reality” was coined by a Boeing researcher in 1990, and the first head-mounted three-dimensional display was designed by Ivan Sutherland in 1968.
- Mobile-based augmented reality is also being used quite extensively owing to its ease and greater reach.

# Applications of AR



# Education and Training

- Displaying 3D shapes, solar system, body organs, including heart and chest, are some of the use cases where AR visualization will be much easier and understandable.
- Collaborative AR is a good and comfortable method to simultaneously work in a single environment while being able to modify the background continuously. The modified environment is simultaneously visible in the devices of the other participants.

# Navigation

- Indoor navigation system is based on sparse 3D localization at selected points in confined spaces such as a building or a mall. This method is stable, and detection is fast due to the presence of marker-based features.
- Outdoor navigation is a relatively trickier task due to the high non-stationarity and difficulties in precise measurement acquisition. The inconsistency of global positioning system (GPS) is also discussed later in the presentation.

# Advertising

- There are several existing applications which are building on mobile-based augmented reality to offer a wide range of exciting advertising options.
- Products like spectacles, lipsticks, hairstyles can be virtually tried before actually buying them over online websites.
- Another class of try-on is cloth try-on, which is significantly trickier than face-based try-on.

# Healthcare

- An accurate 3D representation of internal organs is much more efficient in diagnosis compared to several 2D representations of the same 3D data.
- Using the obtained visualization, the surgeons can determine the region of interest during operation in an accurate manner.
- There are AR-based treatment for cockroach phobia. This system displays virtual elements on top of the real world, which helps people do away with the fear of cockroaches.



# Hardware Performance

- To assess the hardware performance of mobile-based AR systems, we conduct experiments on two important hardwares -
  - Global Positioning System (GPS)
  - Battery Performance
- Presentation includes experimental protocol, results and observations.

# Global Positioning System (GPS)

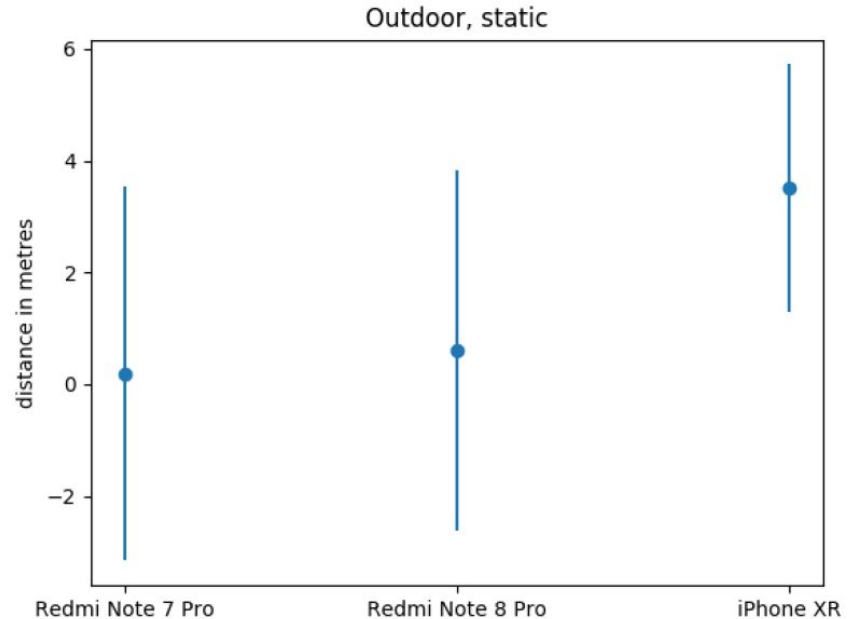
Global positioning system (GPS) is used to determine the location of the device. GPS sensor receives a signal from close to 30 satellites, and they act as a reference to determine the location of the device. GPS has several applications, including navigation, communication, and gaming.

# Experimental Protocol

- The three mobile devices used are Redmi Note 8 Pro, Redmi Note 7 Pro and an iPhone XR.
- Three different experiments are conducted. The details of the experiment are as follows
  - Static mobiles, acquisition at regular intervals, conducted outdoors
  - Static mobiles, acquisition at regular intervals, conducted indoors
  - Same position after a 1-minute random walk

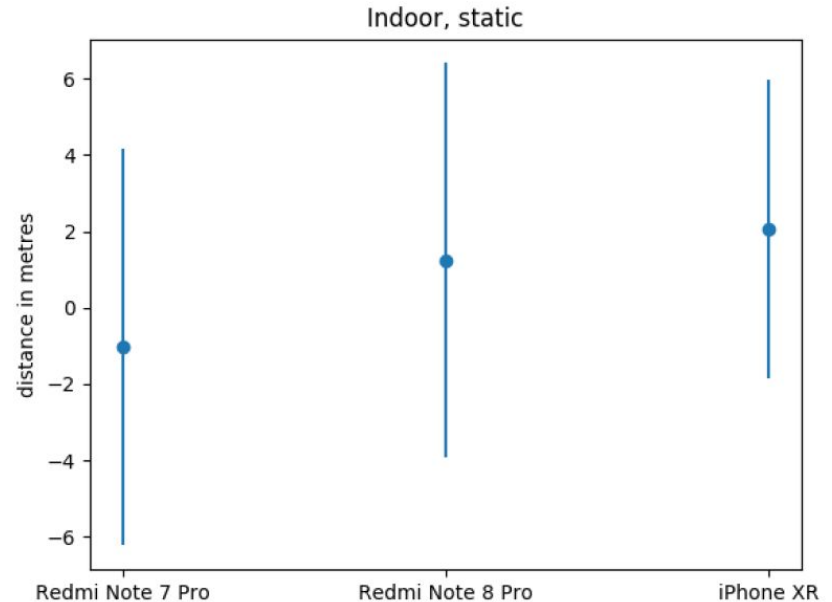
# Results and Observations

- Performance in outdoor environment is better than the performance indoors.
- The observed standard deviation is okay for most applications - but not good for some applications which requires accuracy.



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# Battery Performance

Another important hardware limitation in mobile-based augmented reality systems is the battery usage. AR systems require continuous rendering of 3D meshes, which in turn is computationally more expensive than either using a camera or rendering a mesh in a virtual space. Power consumption is not very significant when using the device for a short time. However, this analysis will be important when more and more AR-based applications will be available and all of them using the resources repeatedly.

# Experimental Protocol

- For this experiment as well, three mobile devices are used - Redmi Note 7 Pro, Redmi Note 8 Pro and iPhone XR.
- These experiments are conducted in three phases. All the devices are charged to the maximum in each phase. In the first phase, only the default camera application is kept open until the time the battery drops to 90%. After this, the designed mobile application was opened, which had a camera open using Vuforia package. On top of this, a static 3D model of approximately 100,000 vertices is displayed. In the final phase, the model is no longer static and is moving along some fixed trajectory. In both these phases, the 3D model was anchored via a marker fixed at a location.

# Results and Observations

- It can be inferred that the application consumes a significant amount of battery compared to the native camera.
- It is evident that even using a simple application with a large number of vertices can cause substantial power consumption.

TABLE I  
BATTERY PERFORMANCE ANALYSIS RESULTS

	Device 1	Device 2	Device 3
Phase 1	97 mins	88 mins	75 mins
Phase 2	73 mins	65 mins	57 mins
Phase 3	67 mins	62 mins	58 mins



# Conclusion

- In this work, various applications of augmented reality and the challenges associated with it are discussed. The challenges depend on the accuracy and speed that the application demands.
- In this work, an analysis of the performance of two of the essential hardware in mobile devices - the global positioning system (GPS) and the battery is presented. Both of these things are essential in mobile-based AR systems.



Thank You!