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A comparative analysis of Augmented Reality frameworks aimed at diverse computing applications

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Paper S3.3

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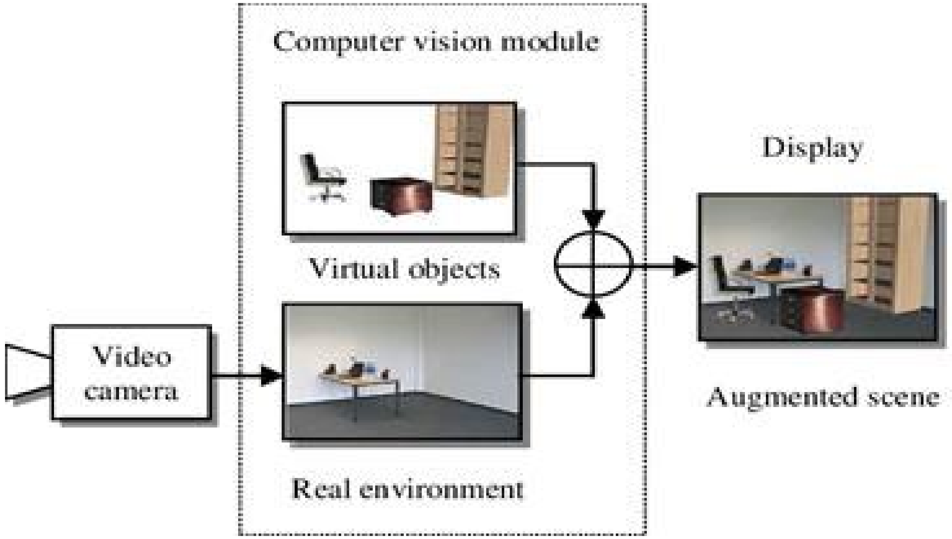
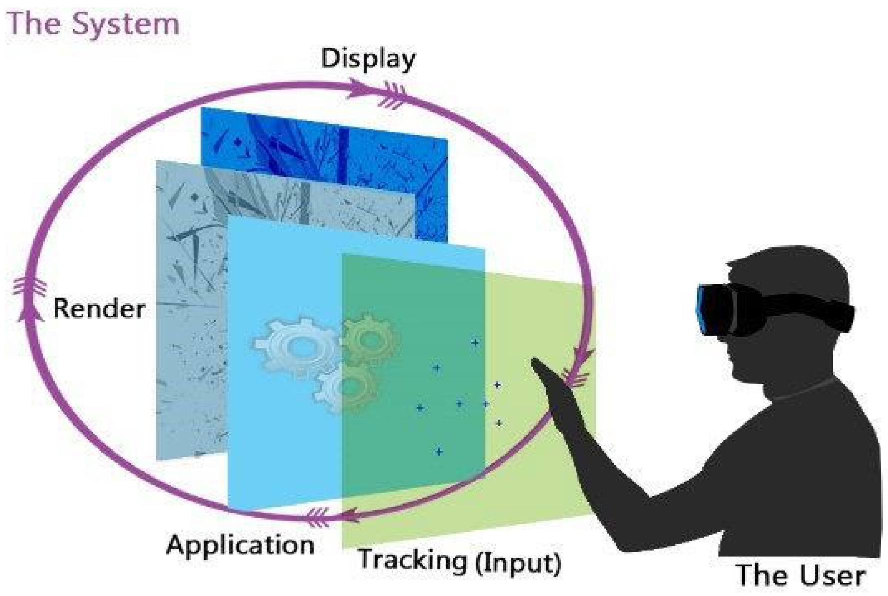
Outline

- Background/Introduction
- Problem Statement/Research Focus
- Literature Review
- Methodology
- Results and Discussion
- Conclusion
- References

Introduction

- Immersive technologies combine computer generated content with the real world
- Major types
  - Augmented Reality (AR)
  - Virtual Reality (VR)

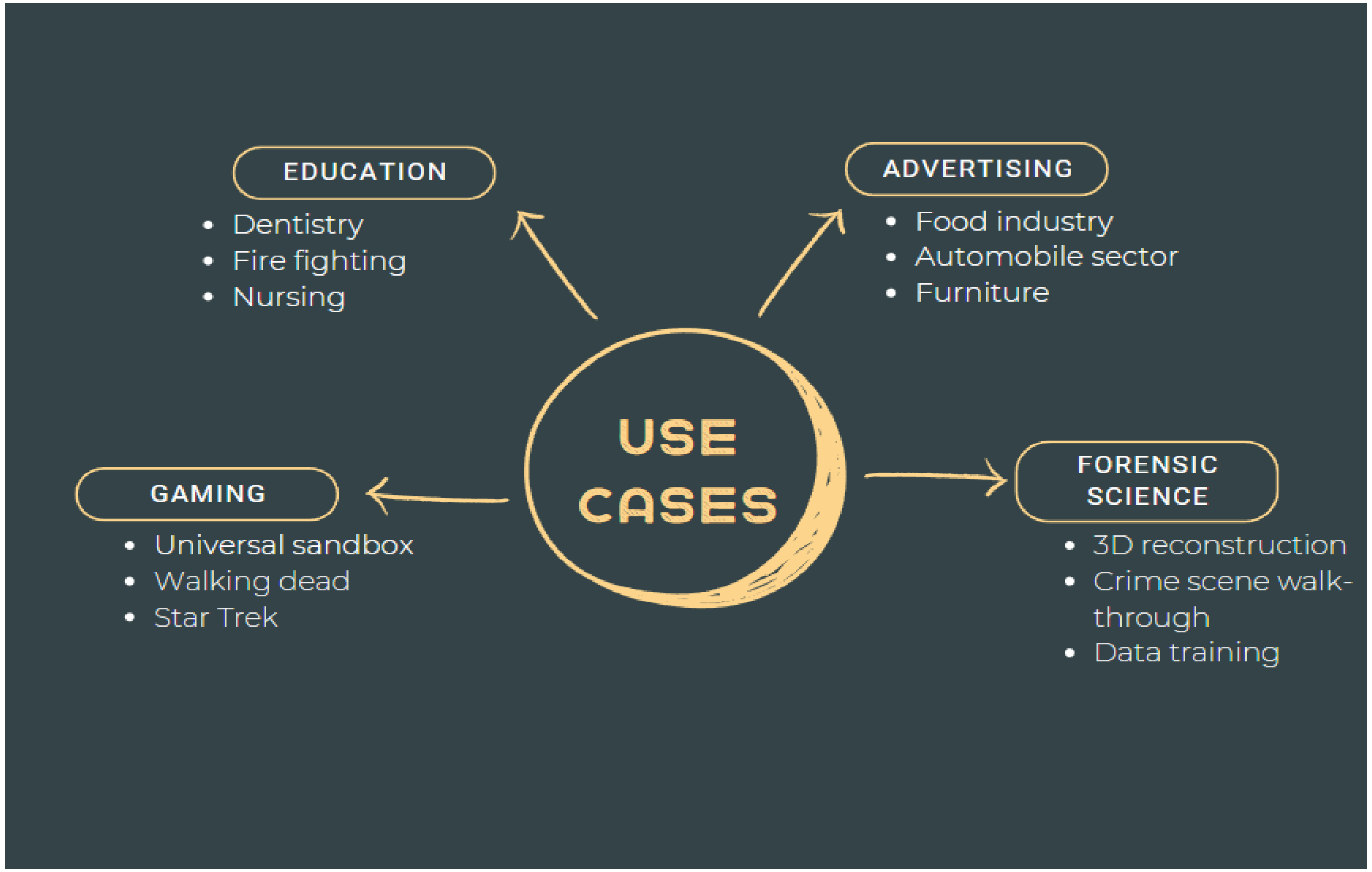




- Figure 1. Overview of Augmented Reality [1]
- Figure 2. Overview of Virtual Reality [2]

Introduction (con't)

- There are several use cases of the technology – e.g., marketing, **forensic science**
- Major vendors – **Android (Google) and iOS (Apple)**
- **AR Frameworks – ARCore and ARKit**



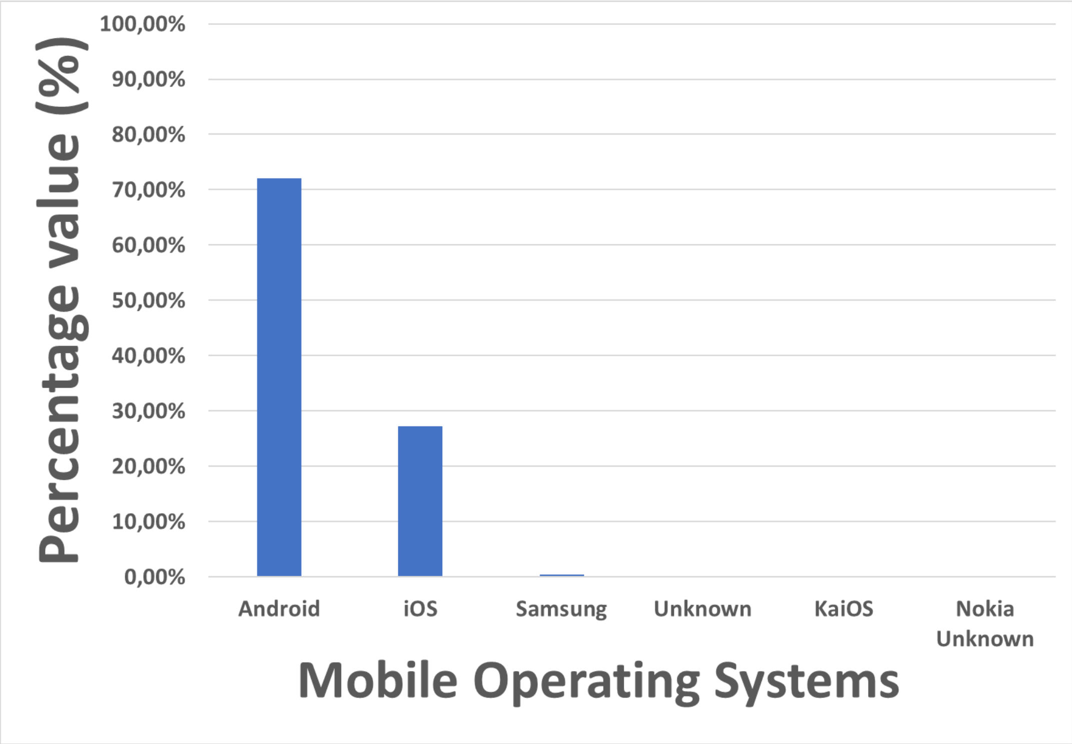
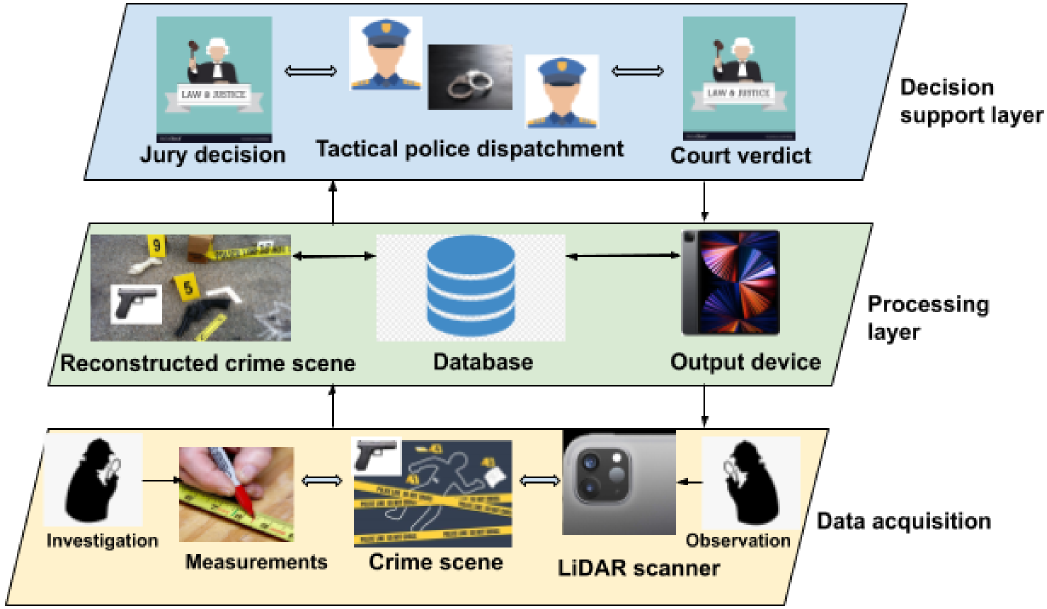


Figure 3. Overview of mobile operating systems [3]

Problem Statement/Research Focus

- **Limited research on accuracy measurements of AR applications**
- The two frameworks (**ARKit and ARCore**) may differ in output accuracy
- Impact on outcomes and decision in certain domains could be costly
    - E.g., forensic data collection (**decision support and jury's verdict**)



- **Figure 4. Crime data collection model**

- **AR measurements - Analyse and evaluate the prominent AR frameworks for immersive systems**

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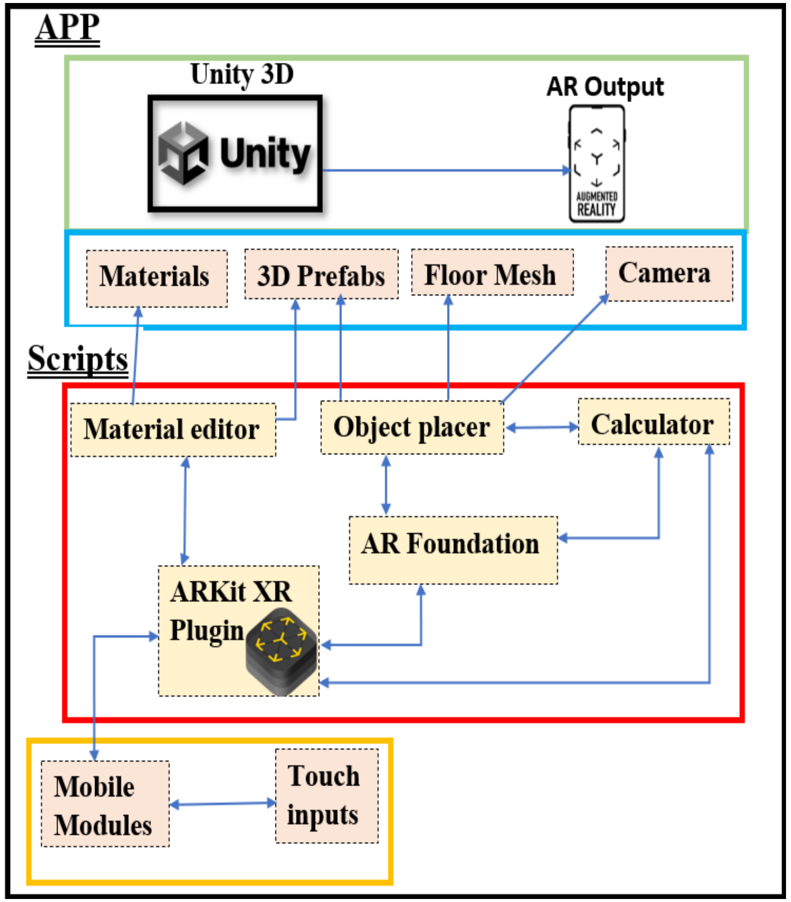
Literature Review

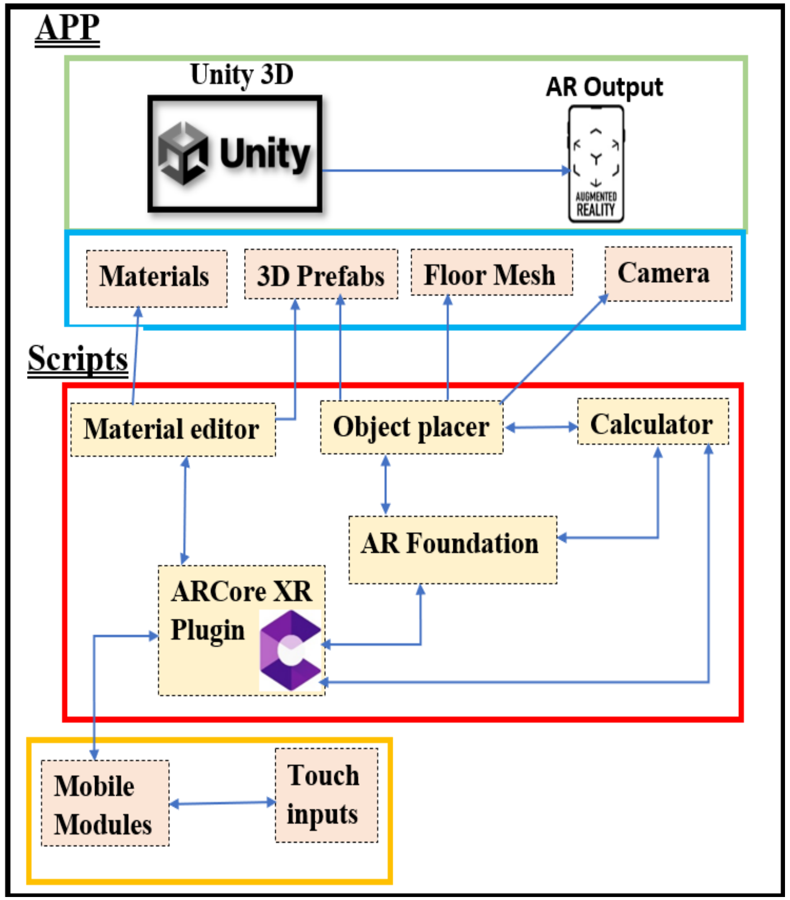
Reference	Year	Research focus	AR frameworks used	Parameters tested	Results
P. Nowacki et al. [4]	2020	Capabilities of ARCore and ARKit Platforms for AR/VR Applications	ARKit, ARCore	Mapping of planes on various surface types	ARCore is more accurate at surface detection, ARKit is faster at detecting planes, Smoother performance on ARKit and memory efficient.
Z. Oufqir et al., [5]	2020	ARKit and ARCore in augmented reality applications	ARKit, ARCore	Scanning of 3D objects, image detection, face detection	ARKit had better image tracking, 3D object tracking and environment probes than ARCore
R. Cervenak et al., [6]	2019	ARKit as indoor positioning system	ARKit	Accelerometer, gyroscope, and magnetometer sensors	N/A
J. Borduas et al., [7]	2020	Reliability of Mobile 3D Scanning Technologies for the Customization of Respiratory or Face Masks	ARKit, ARCore	Facial structure measurements	ARKit had the lowest error difference in 3D scanning as opposed to ARCore, ScandyPro and 3DSizeMe.
H. Fabrício et al., [8]	2017	A Comparative Analysis of Augmented Reality Frameworks Aimed at the Development of Educational Applications	Arkit, ARcore, Vuforia, Kudan, Wikitude SDK	Multi targets, Geo-location, Markerless AR	All AR frameworks were able to pass the tutorial test, only Vuforia was able to pass the text tracking test and the 3D object tracking test
This work	2022	A comparative analysis of augmented reality frameworks aimed at diverse computing applications	ARKit, ARCore	AR measurements with four distance criteria	ARKit proved to be more accurate than ARCore with an average accuracy of 99,36% as opposed to 89,42% scored by ARCore.

Test Setup

Android application



iOS application



Device camera configurations

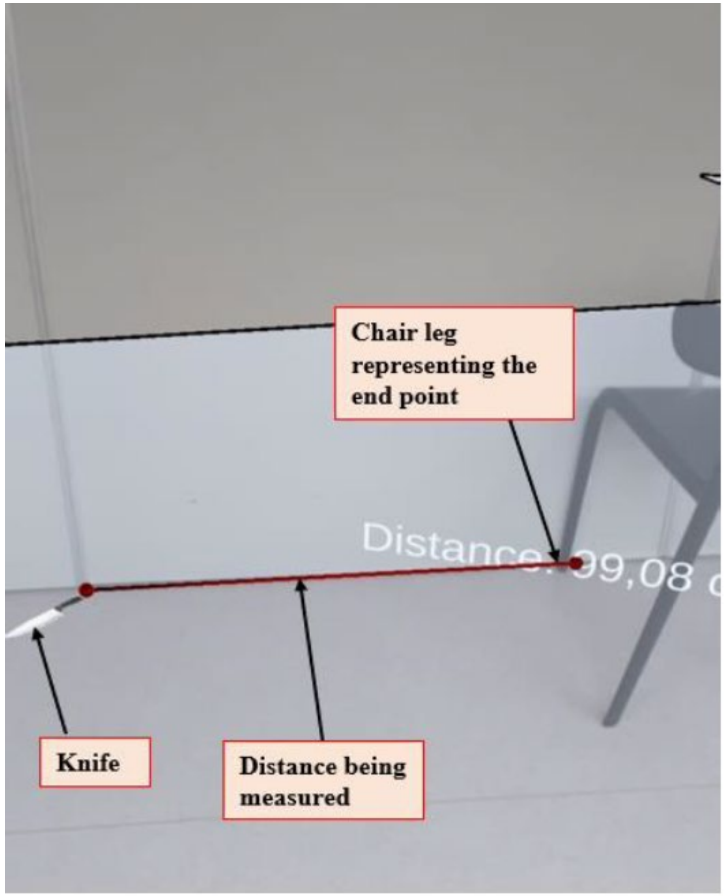
Device	Camera specifications
Samsung S8	12 MP, f/1.7, 26mm (wide), 1/2.55", 1.4µm, dual pixel PDAF, OIS
Samsung S10	12 MP, f/1.5-2.4, 26mm (wide), 1/2.55", 1.4µm, Dual Pixel PDAF, OIS 12 MP, f/2.4, 52mm (telephoto), 1/3.6", 1.0µm, AF, OIS, 2x optical zoom 16 MP, f/2.2, 12mm (ultrawide), 1/3.1", 1.0µm, Super Steady video
Samsung S20	12 MP, f/1.8, 26mm (wide), 1/1.76", 1.8µm, Dual Pixel PDAF, OIS 64 MP, f/2.0, 29mm (telephoto), 1/1.72", 0.8µm, PDAF, OIS, 1.1x optical zoom, 3x hybrid zoom 12 MP, f/2.2, 13mm, 120° (ultrawide), 1/2.55" 1.4µm, Super Steady video
Samsung A20	13 MP, f/1.9, 28mm (wide), AF 5 MP, f/2.2, 12mm (ultrawide)
Samsung A32	64 MP, f/1.8, 26mm (wide), PDAF 8 MP, f/2.2, 123°, (ultrawide), 1/4.0", 1.12µm 5 MP, f/2.4, (macro) 5 MP, f/2.4, (depth)
Apple iPad Pro 5th Gen	12 MP, f/1.8, (wide), 1/3", 1.22µm, dual pixel PDAF 10 MP, f/2.4, 125° (ultrawide) TOF 3D LiDAR scanner (depth)

Data Collection and Evaluation Metric

Four distance criteria used

- 10 cm, 45 cm , 75 cm & 100 cm
- Each at 1 meter and 2 meter proximity
- 6 mobile devices (ARCore & ARKit)
- **Tape measure used as control**

Hypothesized crime scene



Average accuracy

- Equation applied: $D = \frac{1}{N} \sum_{j=1}^{N} X_j$
- D = arithmetic mean/ average
- N = number of values
- X_j = data set values

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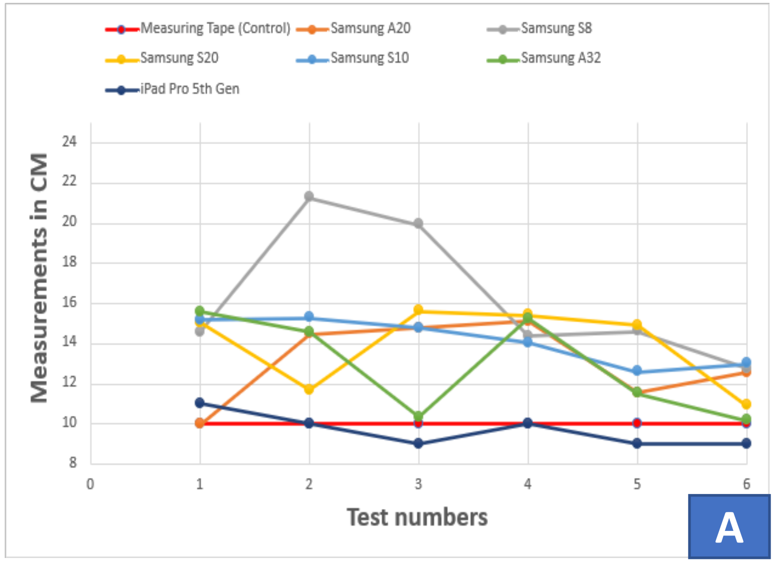
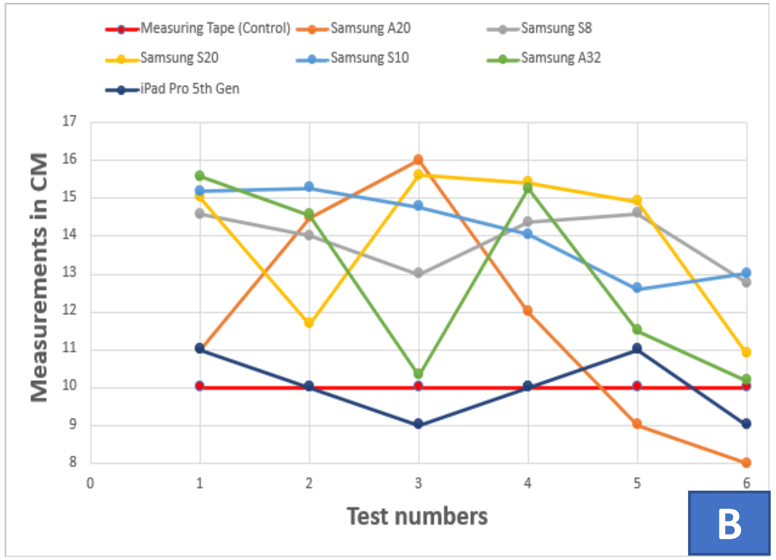
Result and Discussion

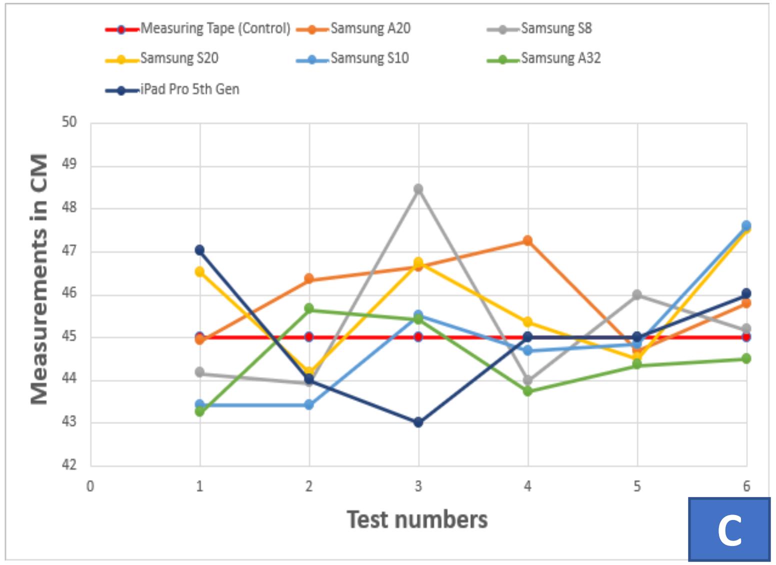
Device Name	Result 1 (CM)	Result 2 (CM)	Result 3 (CM)	Result 4 (CM)	Result 5 (CM)	Result 6 (CM)	Average (CM)	Best Result (CM)	Worst Result (CM)
Tape measure	N/A	N/A	N/A	N/A	N/A	N/A	100	N/A	N/A
Samsung S8	120	110	115	102	105	106	109.70	102	120
Samsung S10	102	98	98	94	106	99	99.55	99	106
Samsung S20	125	111	108	108	109	125	114.39	108	125
Samsung A20	90	99	102	98	99	107	98.99	99	90
Samsung A32	106	100	107	105	108	97	103.86	100	108
Apple iPad 5th Gen	97	98	103	102	98	103	100	98	103

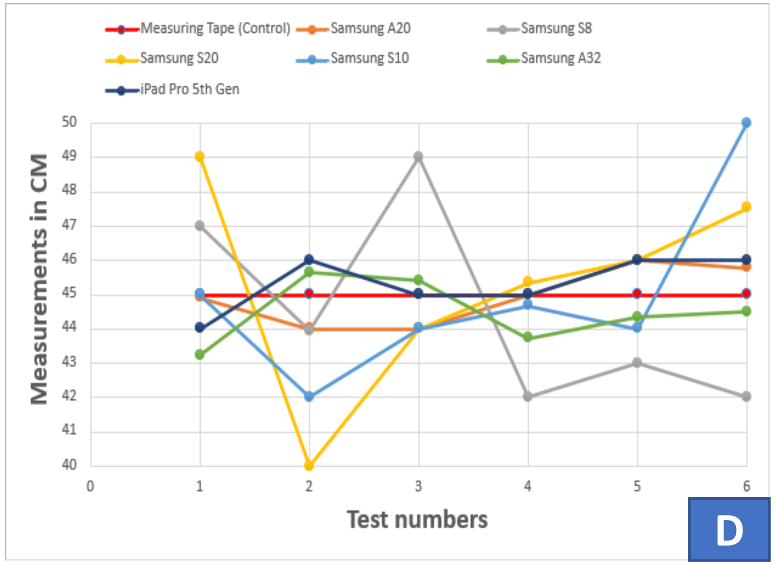
100cm taken from 1 meter

Result and Discussion (con't)









<u>Sample results</u>

Figure A: 10cm AR measurements taken from 1 meter away

Figure B: 10cm AR measurements taken from 2 meters away

Figure C: 45cm AR measurements taken from 1 meter away

Figure D: 45cm AR measurements taken from 2 meters away

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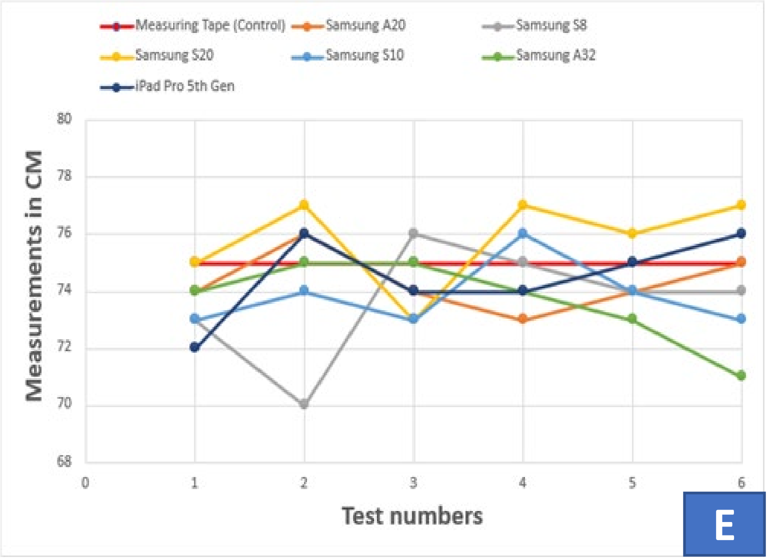
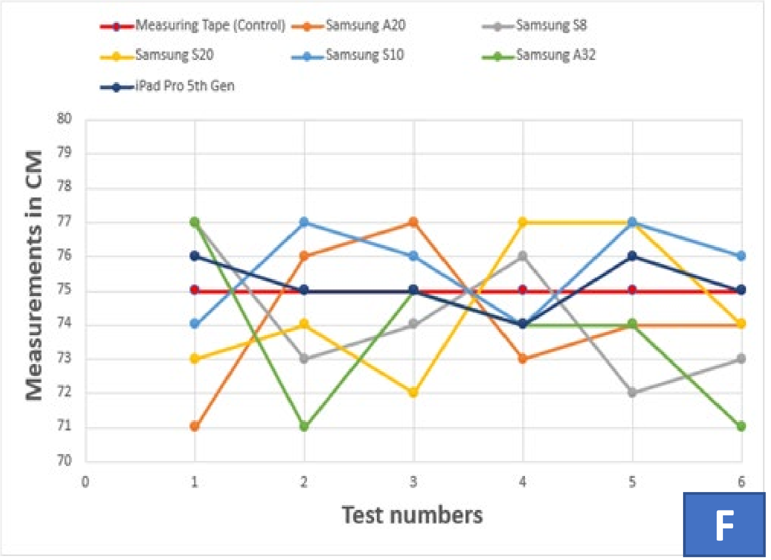
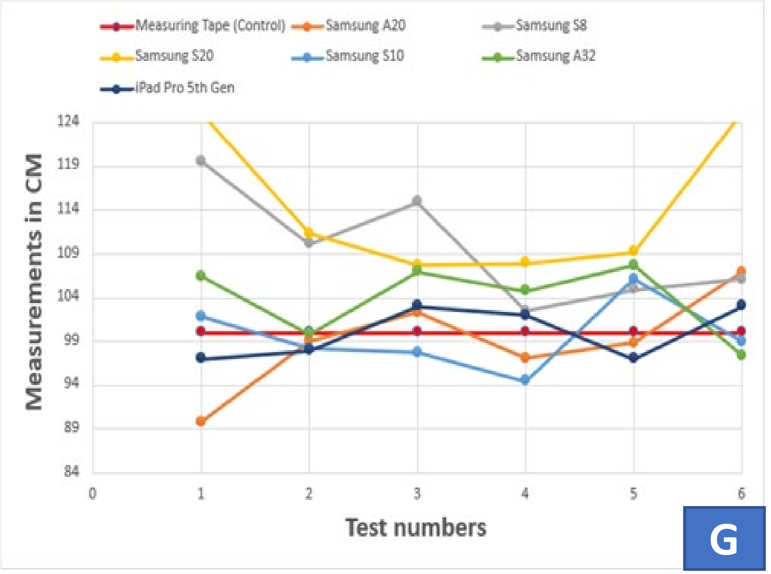
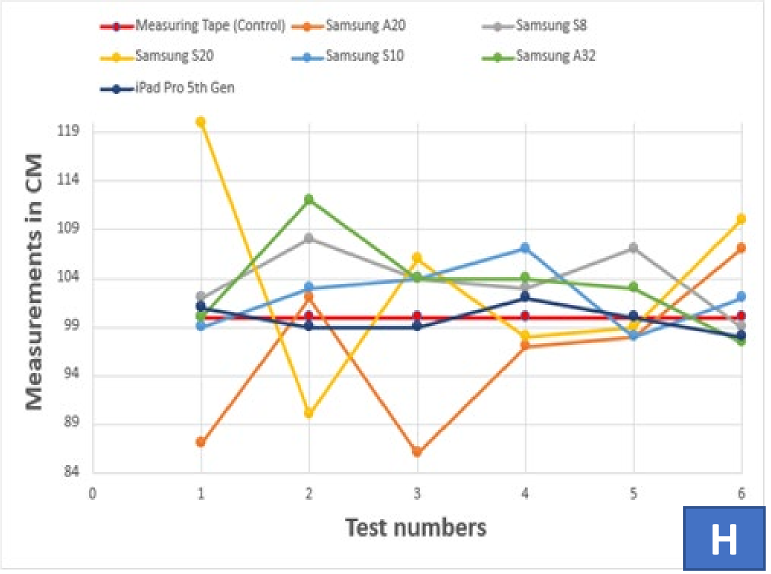
Result and Discussion (con't)









Sample results

Figure E: 75cm AR measurements taken from 1 meter away

Figure F: 75cm AR measurements taken from 2 meters away

Figure G: 100cm AR measurements taken from 1 meter away

Figure H: 100cm AR measurements taken from 2 meters away

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Results and Discussion

- Overall, ARCore attained 89.42% accuracy with a 10.58% deviation rate
- Overall, ARKit attained 99.36% accuracy with a 0.64% deviation rate

Framework	Average accuracy score	Deviation
ARCore	89.42%	10.58%
ARKit	99.36%	0.64%

Conclusion and Outlook

- Compared augmented reality frameworks (ARKit and ARCore) – AR measurements
- Based on dominating mobile operating systems (Android and iOS)
- Experiment was conducted using four-distance measure criteria
- Six devices used amongst the frameworks
- For each device average accuracy measured after six test runs
- **Findings**
  - Overall ARKit was the most accurate and reliable in ⅞ tests.
- **Outlook**
  - Additional testing parameters
  - Time taken to acquire measurements, system utilization (CPU and RAM), quality mapping and plain detection coverage.

Framework	Average accuracy score	Deviation
ARCore	89.42%	10.58%
ARKit	99.36%	0.64%

References

- [1] H. Fabrício, G. Renan and T. Liane, "A Comparative Analysis of Augmented Reality Frameworks Aimed at the Development of Educational Applications," Creative Education 2017, doi: 10.4236/ce.2017.89101
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Thank you!