

Comparative Assessment of 2D and Mixed Reality Interfaces for Improving Situational Awareness

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Nazım Yiğit Kavasoglu

- Master's degree in computer engineering in İstanbul Technical University in 2023.
- Working at ASELSAN as a software engineer since 2018.
- Research interests are
 - User interface and experience
 - Computer vision
 - Machine learning

Aim and Contribution

Our study,

- Aims to improve academic knowledge and practical use of MR user interfaces in security scenarios.
- Intends to contribute to the academic understanding and practical implementation of MR user interfaces in military settings.

Introduction

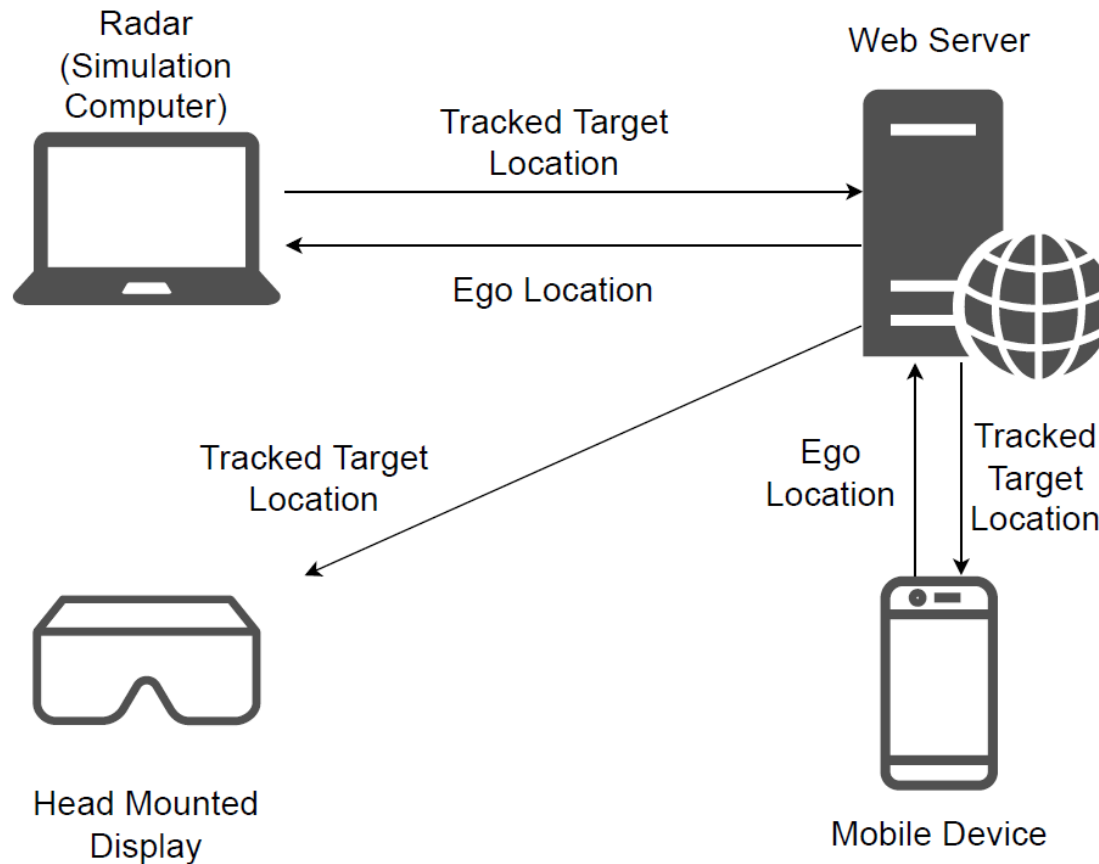
- Challenges,
 - Environmental conditions
 - fog,
 - darkness
 - harsh weather
 - The lack of knowledge and experience
- To address these challenges, we have developed an application within this study.
- Measured the effectiveness
 - task completion times
 - navigation accuracy
 - participant feedback through questionnaires

Proposed Physical Security Applications

- The maintenance of border security holds significant importance.

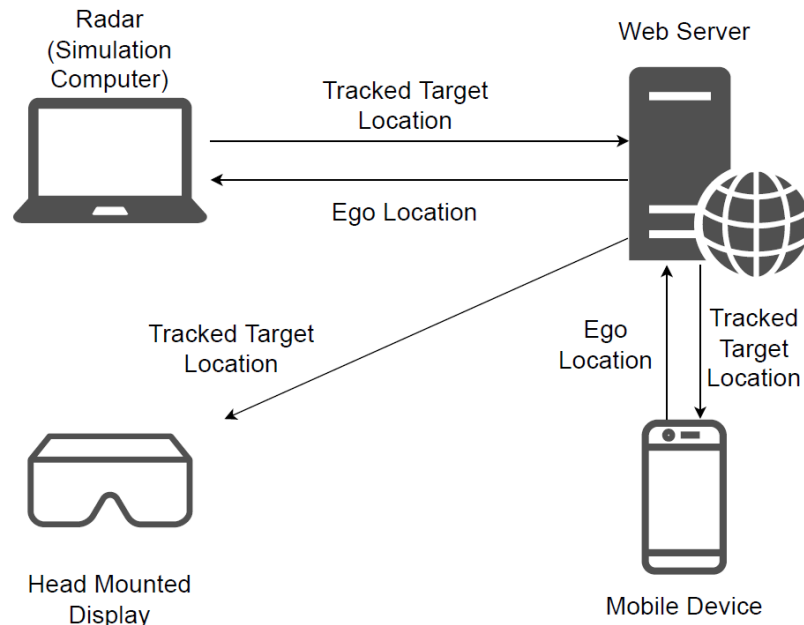


Overview of the Proposed System



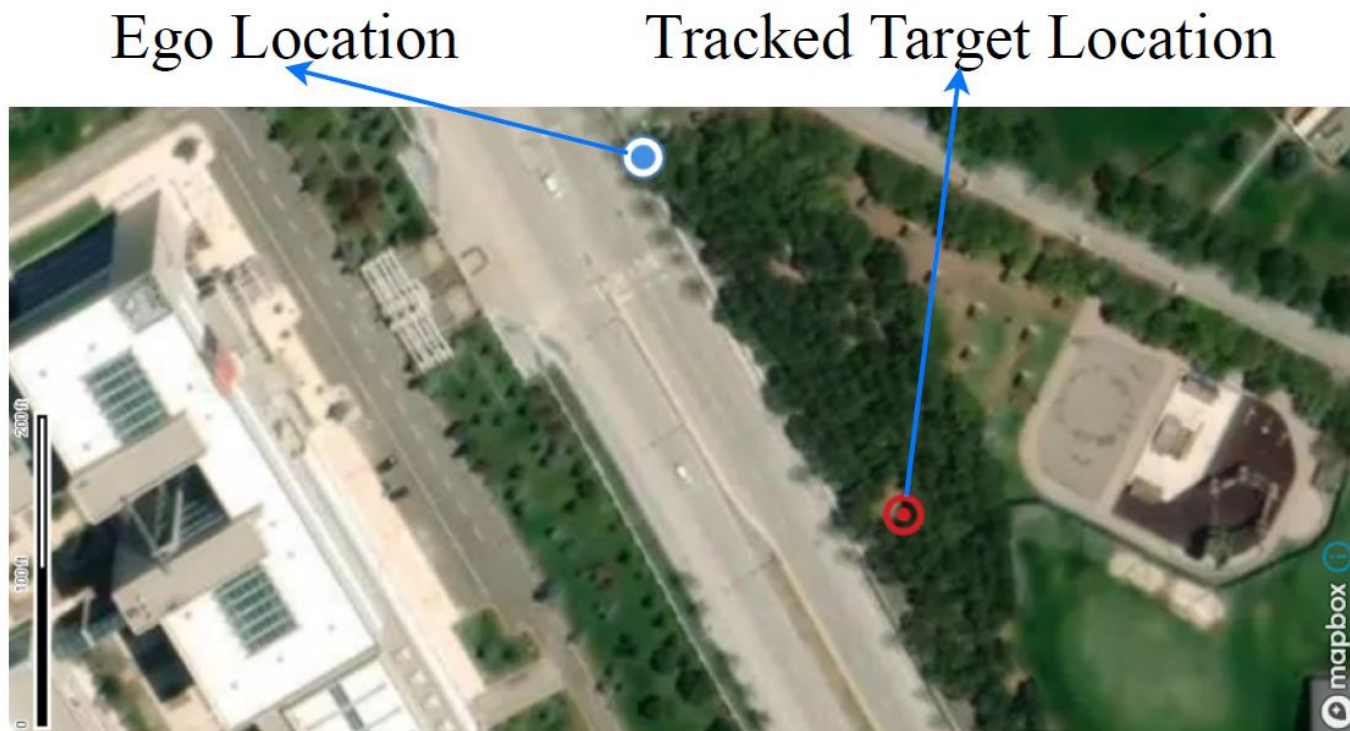
Radar and Web Server

- Example tracked target location data is presented such as `{“trackId”:1, “latitude”:39.71, “longitude”: 32.15, “horizontal”:43.7, “vertical”:28.2}`.
- The haversine formula is used for calculating distances between two points on a spherical surface using the coordinates of the two locations.



Mobile Application

- It is a 2D map-based user interface.



MR Application

- MR application is deployed on a head-mounted display.
- A red color layer is added to the target object to improve visibility.

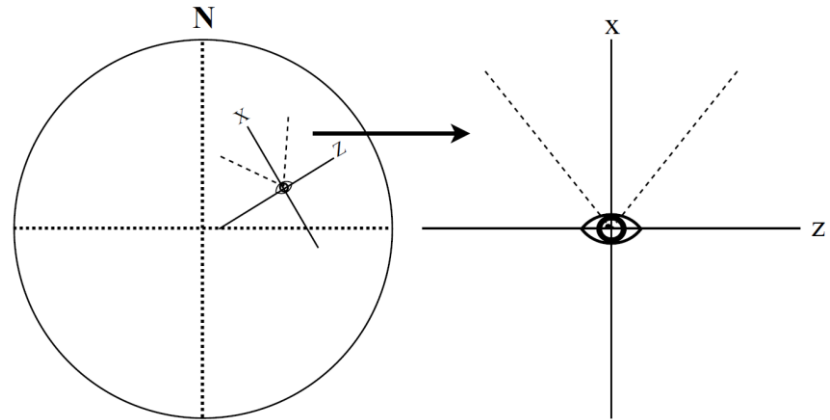


Distance to
Tracked Object

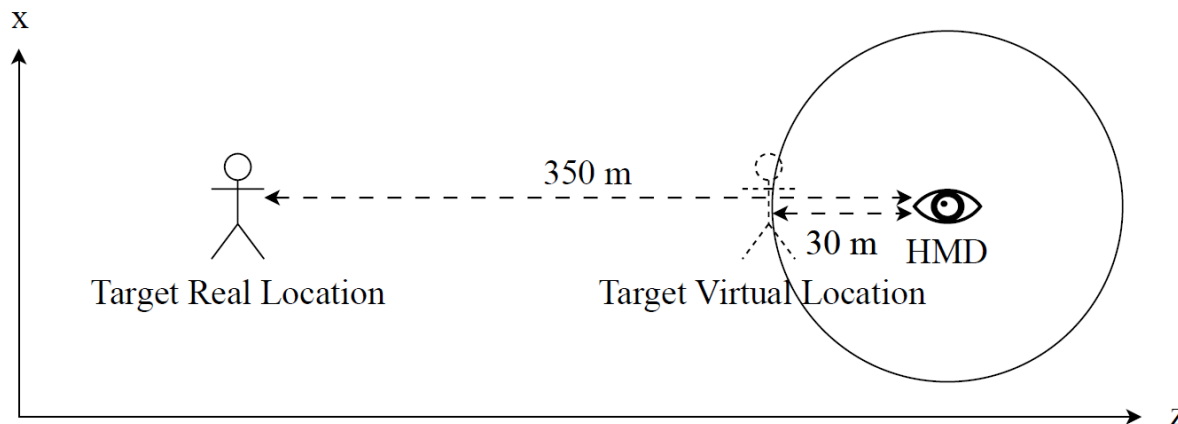
Tracked
Object

MR Application

- MR Engine (right panel) and Real-world (left panel) coordinate systems



- HMD draw distance



Experiments

Origin location Longest path Shortest path Targeted location Target movement

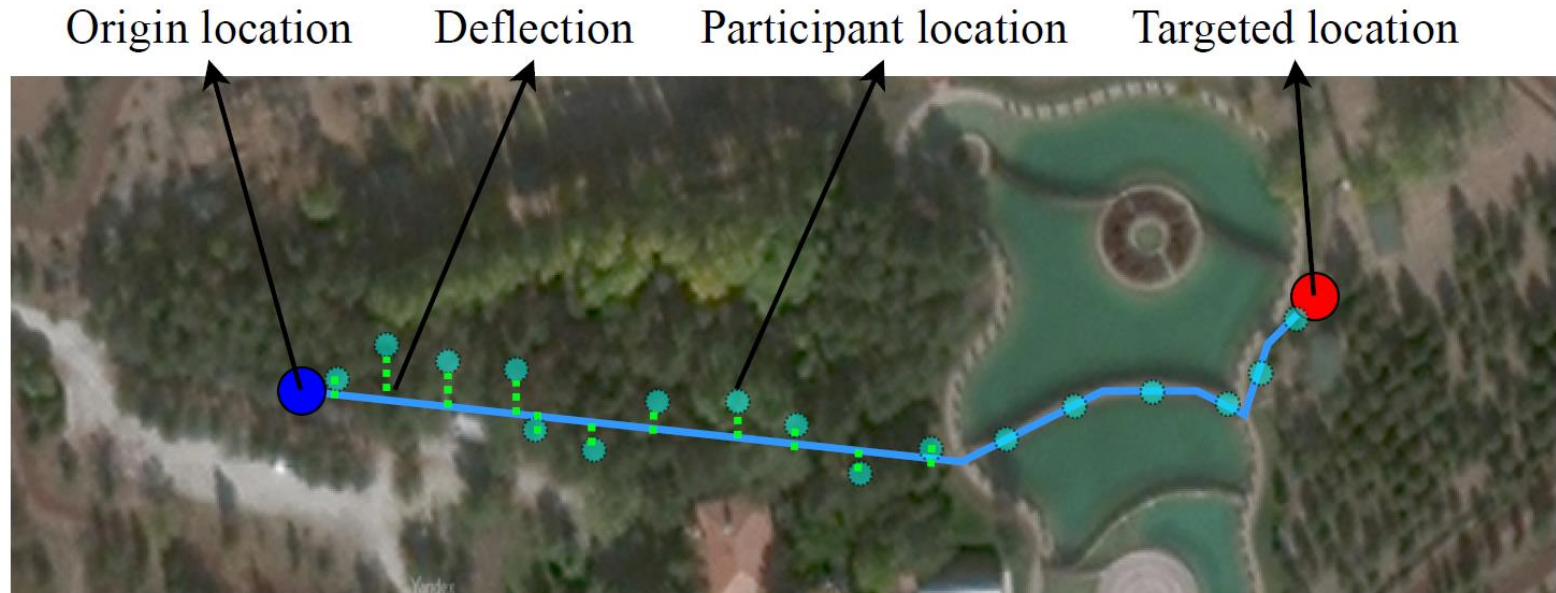


Participants

Group	Number of Participant	Prior experience
Group 1 – Mobile Application	15	%100
Group 2 – MR Application	15	%53

Evaluation Metrics

- Objective measurements
 - Task completion time
 - Navigation accuracy
- Subjective measurement surveys
 - NASA Task Load Index (TLX)
 - Post Study System Usability Questionnaire (PSSUQ).



Results

- Task completion performance

Group	Time (min.)
Group 1 – Mobile Application	3:37 ± 1:01
Group 2 – MR Application	2:54 ± 0:28

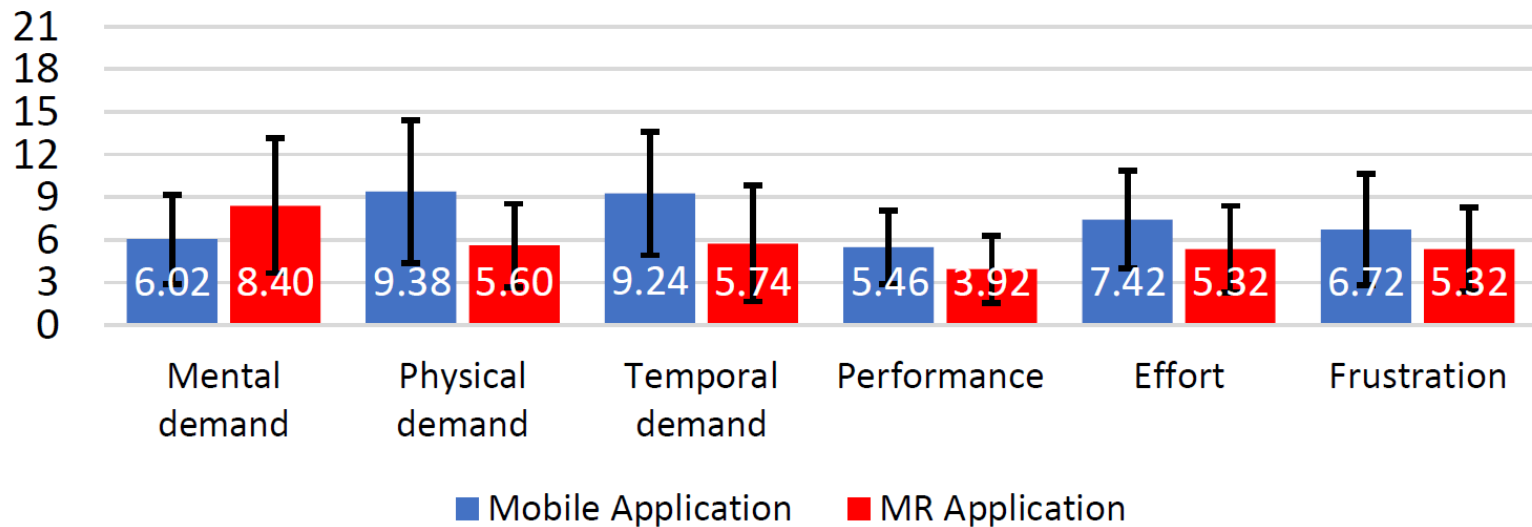
Results

- Navigation accuracy

Group	Error (meters)
Group 1 – Mobile Application	6.60 ± 2.10
Group 2 – MR Application	3.17 ± 1.34

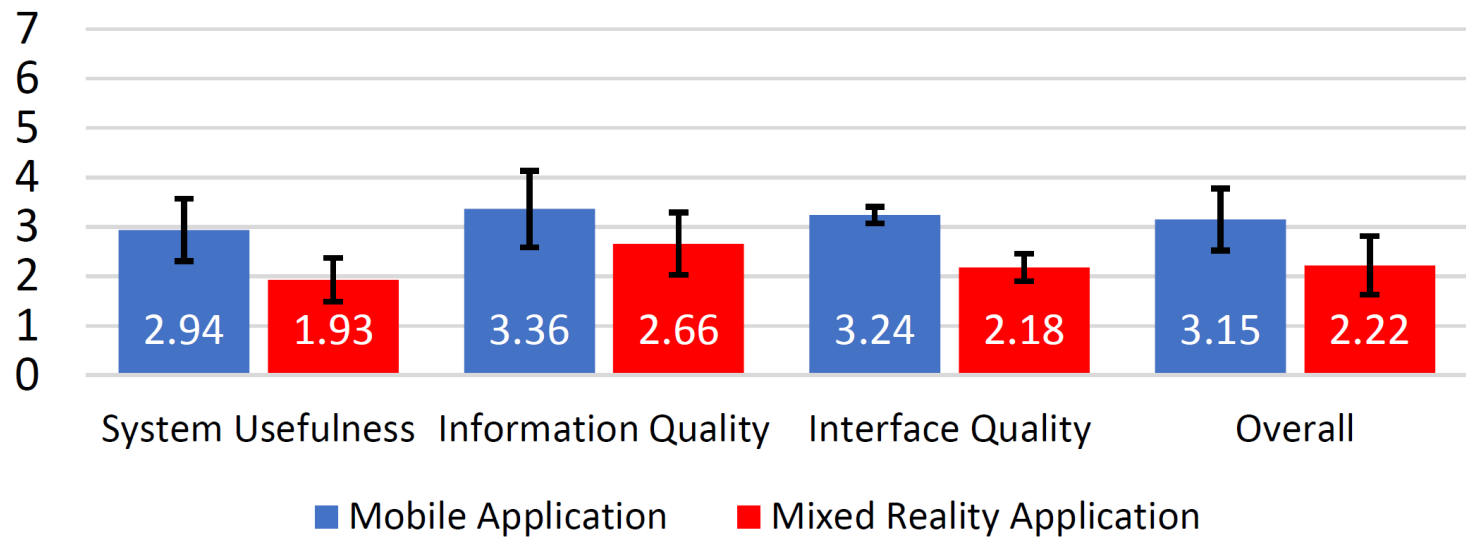
Results

- NASA TLX Questionnaire



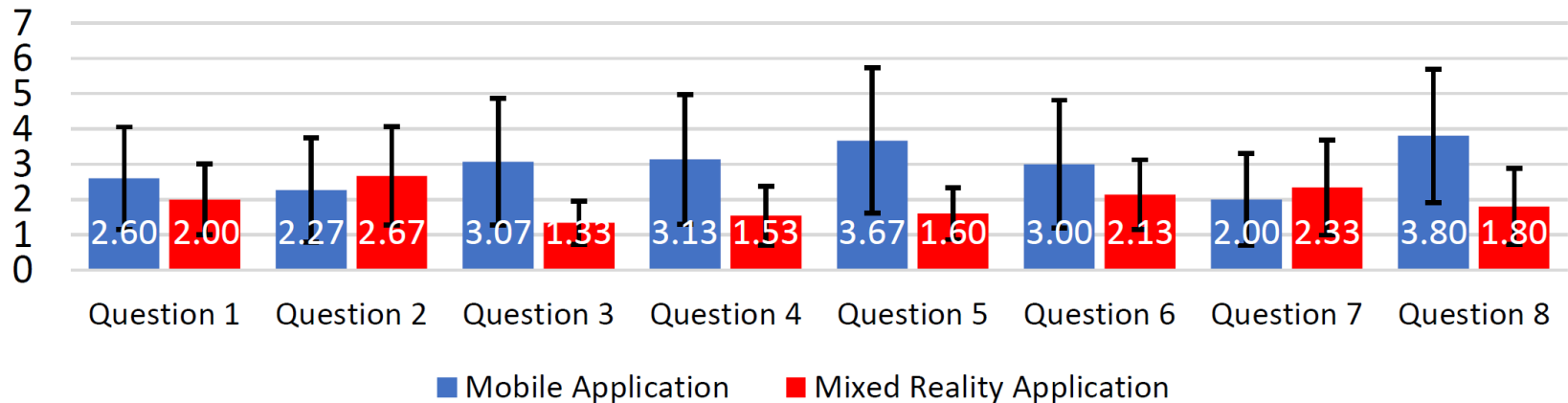
Results of PSSUQ

- Post Study System Usability Questionnaire



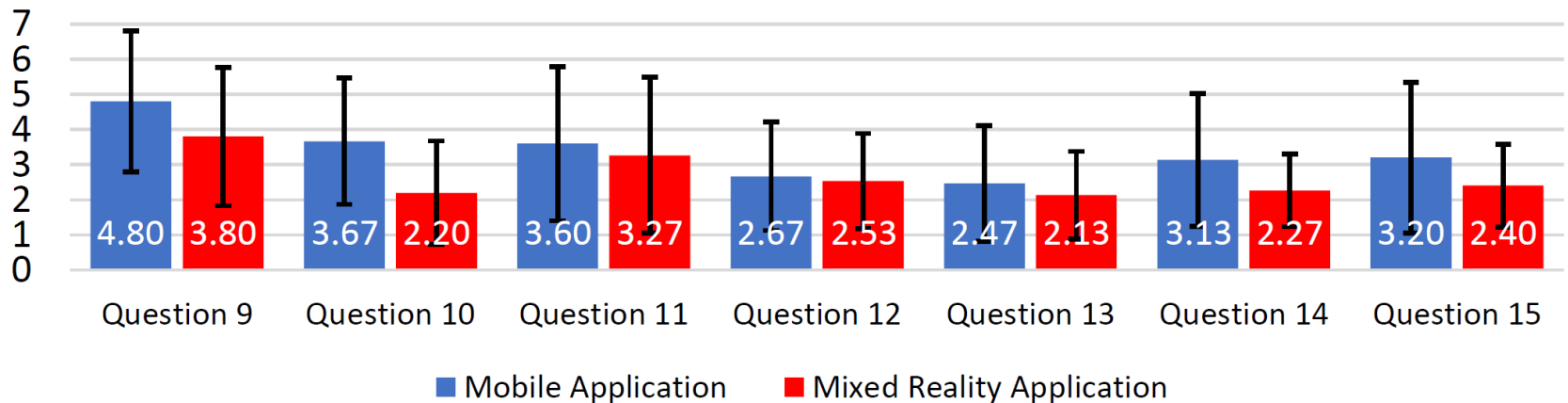
Results

- Post Study System Usability Questionnaire
System Usefulness



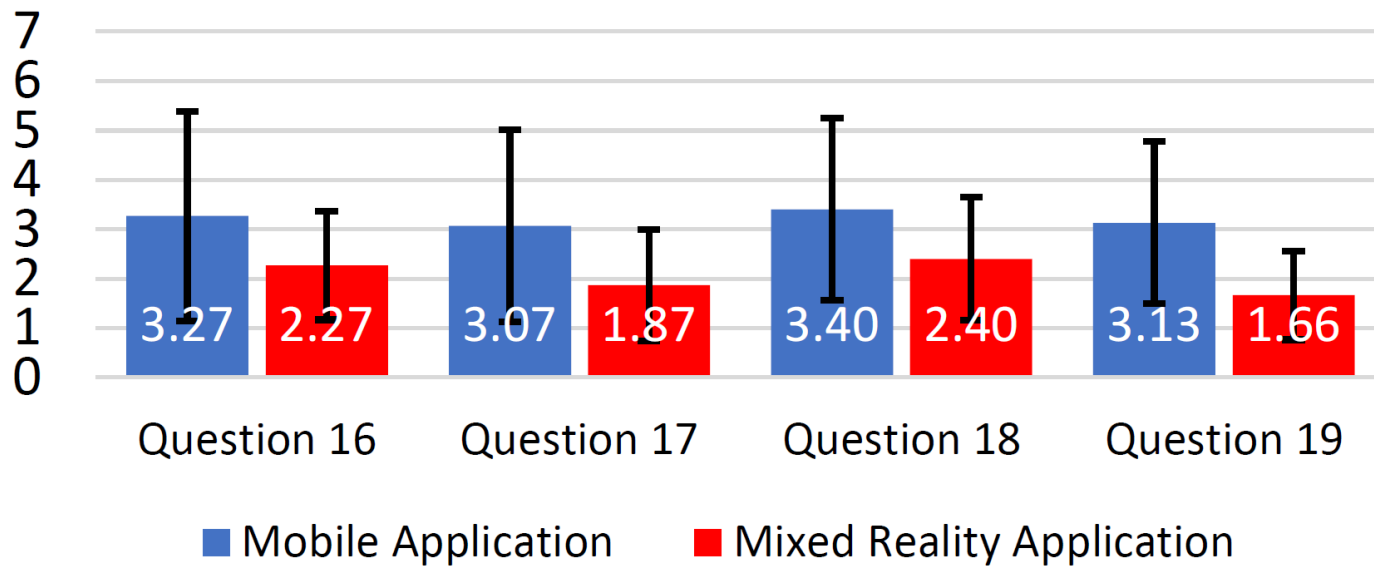
Results of PSSUQ

- Post Study System Usability Questionnaire
Information Quality



Results of PSSUQ

- Post Study System Usability Questionnaire
Interface Quality



Discussion

- Findings show that MR technology significantly improves situational awareness for security personnel.
- We've explored several methods to optimize MR usage,
 - Using navigation arrows
 - Utilizing celestial cues like the sun and moon,
 - Integrating elevation maps to refine object placement
 - Testing with varied and complex security scenarios

Conclusion

- Based on the tests conducted using the MR application resulted in an enhanced SA.
- MR application was more efficient than mobile application in terms of task completion time and deflections from the ideal route.
- Results of questionnaires, the mobile application was easier to learn than the MR application.
- MR application users reached productivity faster.