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# Enhancing the system model for home interior design using augmented reality

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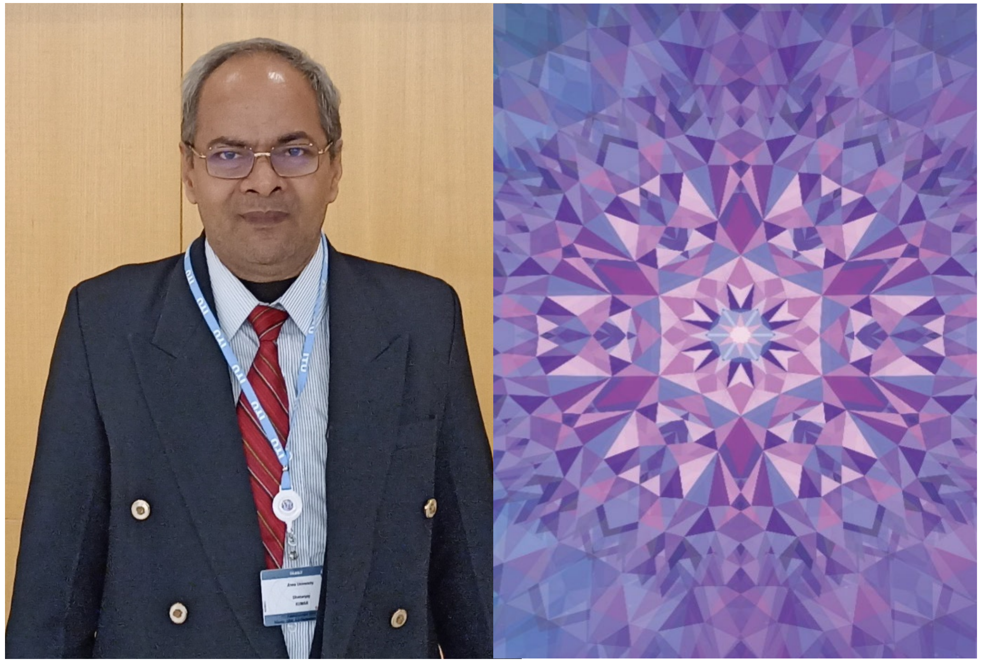


**Session 2: Networking requirements and solutions for IoT and industrial applications**

**Paper S2.2: Enhancing the system model for home interior design using augmented reality**

# Outlines

- Motivation and Challenges
- Proposed Architecture
- Generation of realistic view
- Experimental results
- Summary

# Motivation and Challenges

**Motivation:**

- Home interior design with Augmented Reality (AR) on smartphones
- A real-world experience, shopping for interior fittings
- Help to eliminate common errors in judgement, and save time/money for the store/customers
- Interactive experience for users/designers
- Marker-less augmented reality

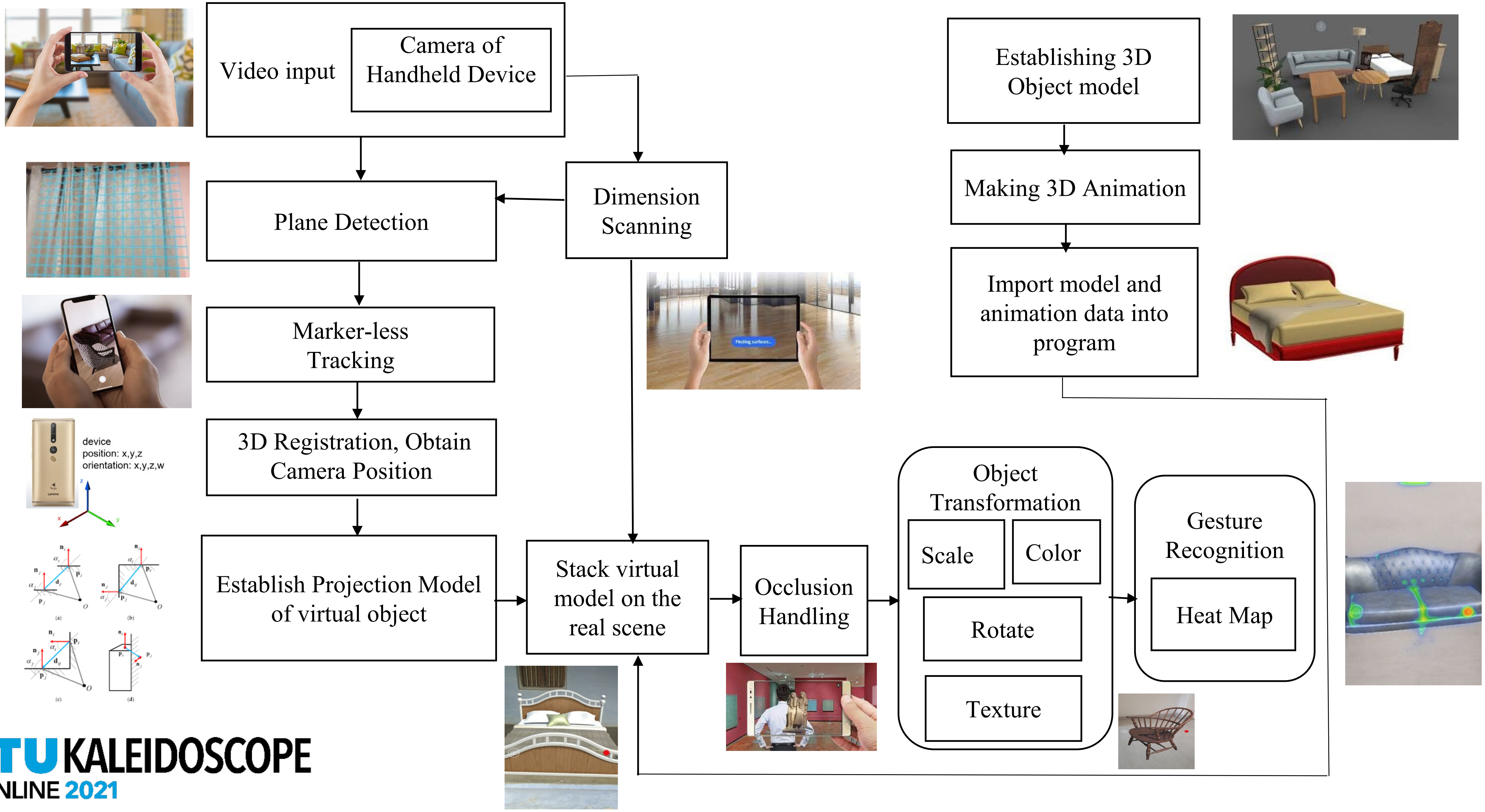
**Challenges:**

- Home interior design is inherently a challenging and time-consuming task
- Features to accomplish it on a target device with a vibrant 3D prototype
- The AR solution needs to automatically arrange the selected object in a defined 3D space
- The low performance of devices supporting AR applications
- The latency becomes a critical factor in the user's experience

# Scope of the Work

- Marker-less augmented reality on a mobile device
- Performance improvement in terms of latency while meeting the user's requirements
- The existing popular trial-ware application software is used to model, animate, and render 3D scenes
- Dynamically handling the occlusion
- Instant tracking of 3D feature points using the SLAM technique
- The system models to meet requirements listed in the ITU-T
  - G.1035 "Influencing factors on quality of experience for virtual and augmented Reality services"
  - Q.4066 "Testing procedures of augmented reality applications"

# Architecture of the Proposed System



# Tracking Object with Frames

The AR plane manager presents a prefabricated plane to represent the plane upon detection.

The AR plane contains a mesh visualizer and its corresponding components for the rendering.

Whenever the system gets a new frame from the AR camera, it first performs feature point detection.

The system projects its map into the new camera frame to search for more key point correspondences.

The SLAM algorithm helps to improve the estimate of the camera pose in tracking.

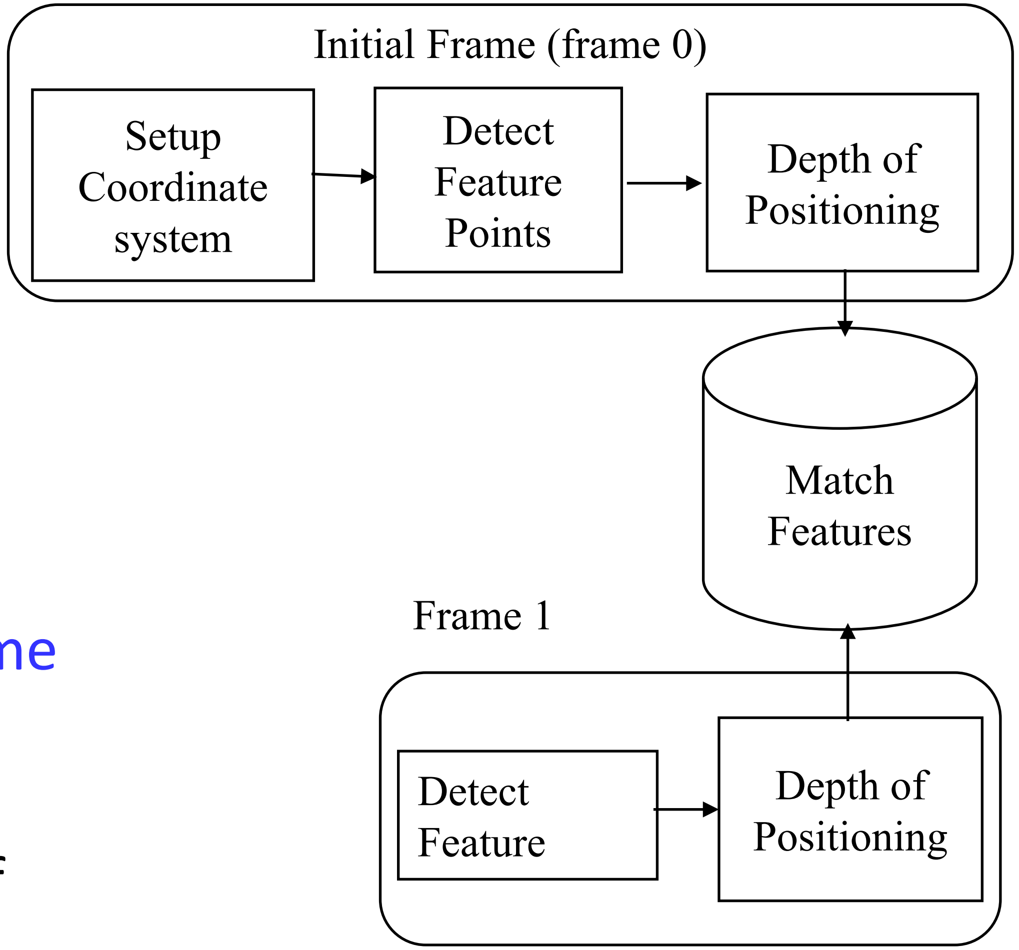
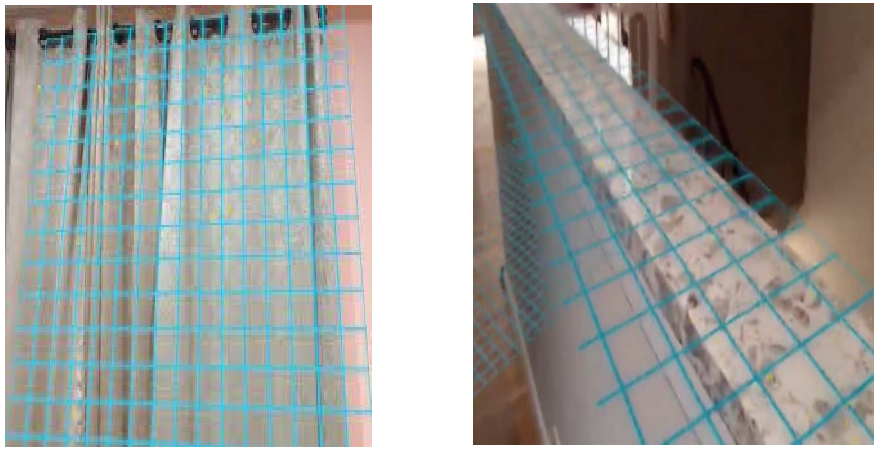



**Fig. 2** - Module for Tracking Object with Frames

# Implementation

- The *Autodesk Maya:* to model, animate, and render 3D scenes
- *Substance Painter:* to texture and render the 3D meshes
- AR Foundation framework with *Lean Touch* in *Unity: deploying the proposed system*
- The real-world view of the home interior models stored in native gallery of the smartphone via *Natcoder* API
- *Seaborn* and *Matplotlib* libraries in Python are used for heatmap analysis
- Android smartphone with 4GB RAM and Snapdragon 665 Processor with 6.30 inch display

# Realistic 3D View of the Featured Models



**(a)** Vertical Plane **(b)** Horizontal Plane

**Fig. 3** – Plane detection

(a) Bed 1 (b) Bed 2 (c) Cupboard (d) Chair

**Fig. 4** – Sample Home Interior Models in real world view

- Once the plane is detected, the 3D model to be rendered is instantiated and deployed in the real scene.
- Transformations (scaling and rotation) carried out on the models.
- Users can also move around the interiors to get a clearer picture on how it would look like from multiple perspectives.

**(a) Scale** **(b) Rotate**

**Fig. 5** – 3D transformations

**(a) Top view** **(b) Side view** **(c) Front view**

**Fig. 6** – Multi-perspective view of home interior models

# Realistic 3D View of the Featured Models cont.

When multiple objects are placed in the scene, occlusion occurs which is handled dynamically.


(a) Plants, soccer ball rug (b) Chair, bookcase, nightstand

**Fig. 7 –** Spawning multiple models in real scene


(a) Diagonal length (b) Length and width

**Fig. 8** – Dimension scanning

In dimension scanning, anchors are used to hold the hit results obtained from *AR Raycasting* while pose updates to track the physical feature across the reshaping since hit results do not happen in the same frame.

# Results

Enhancing performance in terms of latency while meeting the user's requirements.

This requires support of the field-of-view and perspective of the user, thereby allowing the environment to react accordingly.

**Table 1** – Average response time of home interior models

| Model Name | Mean Response Time (s) (before SLAM) | Mean Response Time (s) (after SLAM) |
|---|---|---|
| Plant | 0.94828 | 0.41224 |
| Soccer ball | 0.74901 | 0.36415 |
| Rug | 0.79299 | 0.39041 |
| Pillow | 0.88311 | 0.49107 |
| Armchair | 0.97388 | 0.58739 |
| Wooden Bookcase | 1.62302 | 0.98908 |
| Couch | 1.22955 | 0.74487 |
| Bed | 1.58708 | 0.95165 |
| Chair | 0.90057 | 0.58805 |

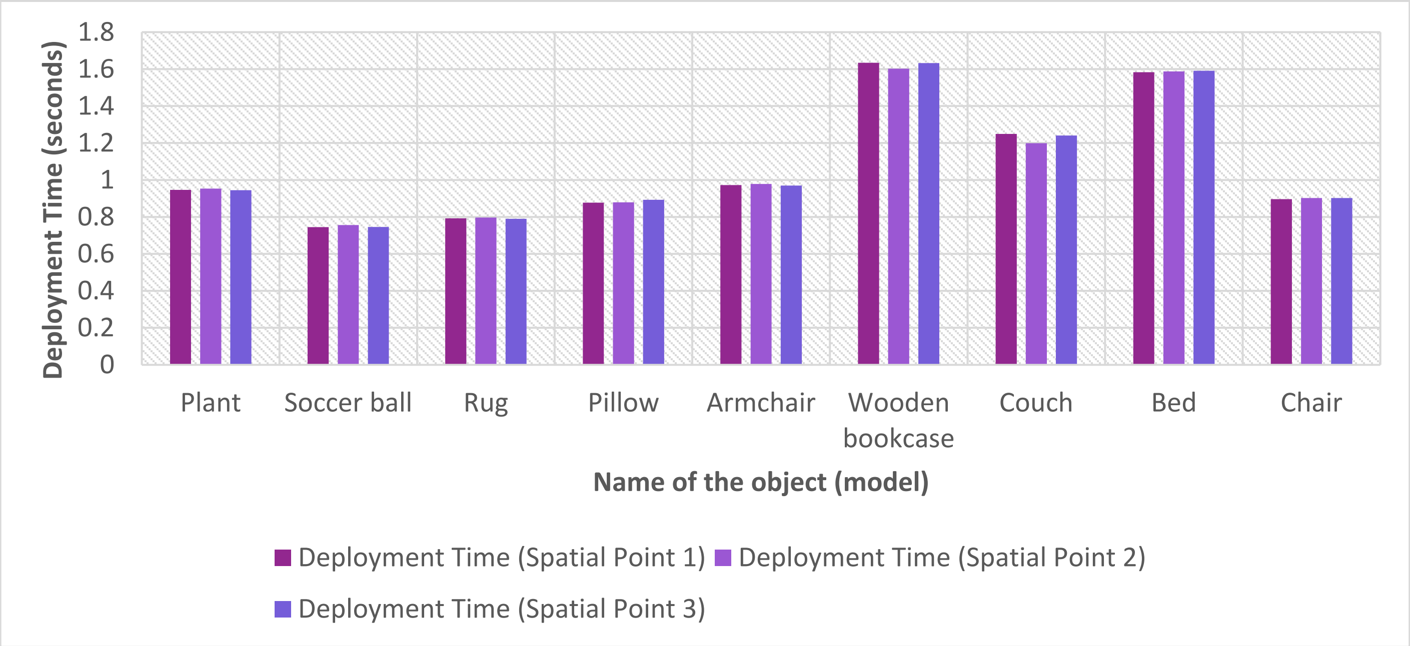



**Fig. 9** – Home interior models with high latency

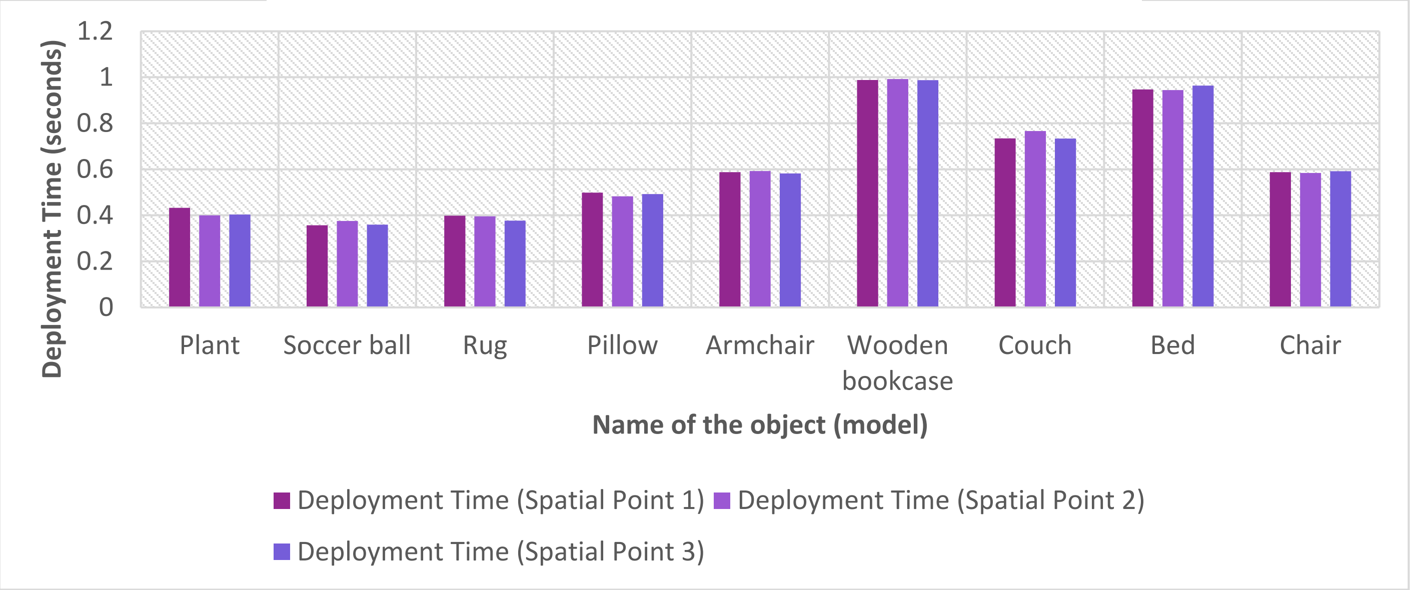



**Fig. 10** – Home interior models with minimized latency

# Results (cont.)

By combining AR Foundation with *Lean Touch* recognition and by dynamically handling the occlusion using SLAM technique, instant tracking of 3D feature points is achieved, thereby latency gets minimized

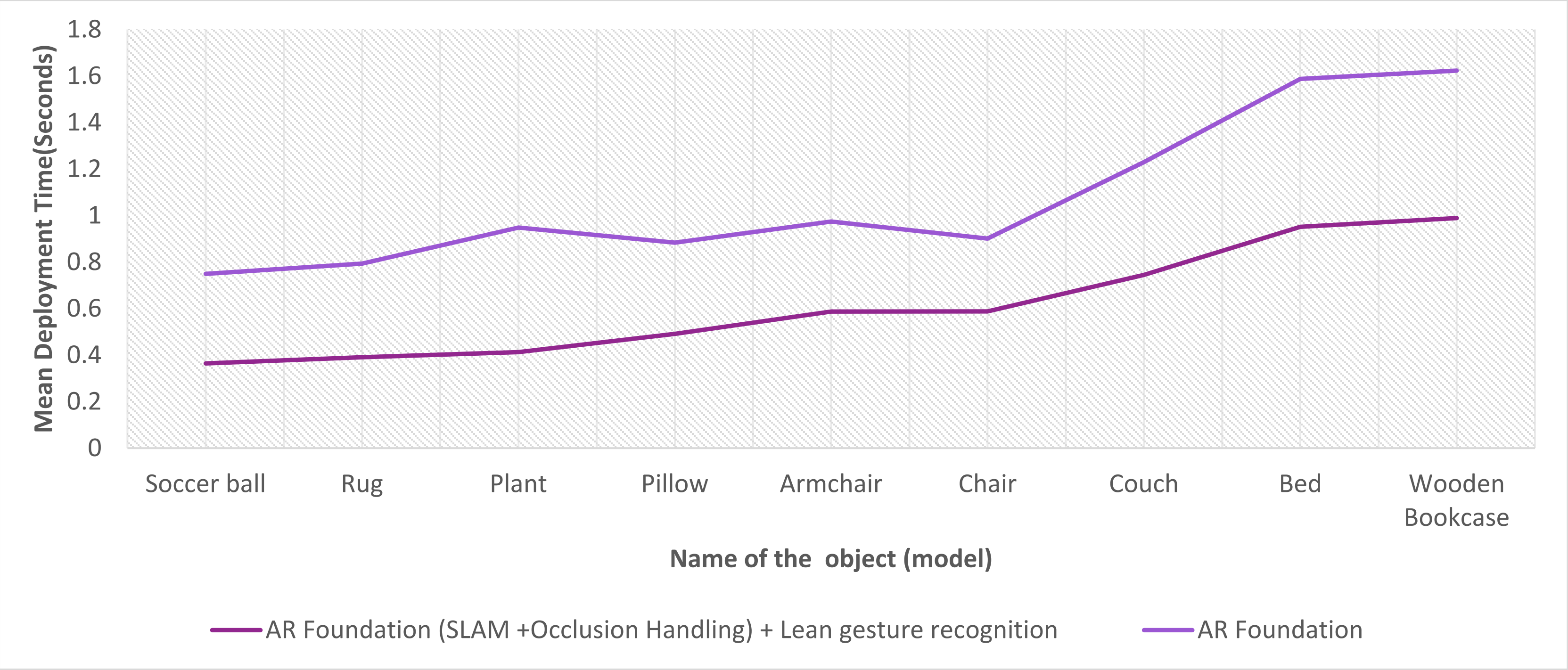



**Fig. 11** – Deployment latency

The heatmap (color spectrum) provides information on a system's usefulness of touch gesture and the quality of user interface.

Heatmap parameters: Tap counts, number of clicks, drags, swipes for each person uniquely.
Start screen position, last screen -> position value of the finger in pixels

**Fig. 12** – Heatmap analysis

# Summary

**Conclusion:**

- Marker-less augmented reality implemented on a mobile device
- Enhancement of user experience in applications of the home interior design related with furniture shopping
- The existing popular trial-ware application software is used design, experiment, and implement the proposed system

**Future work**

- The application can collect images of the target room at the start time of a design session and can stream them to a server where they are analyzed
- A candidate technology of virtual and augmented reality services being standardized in ITU-T Study Group 16

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# Thank you!