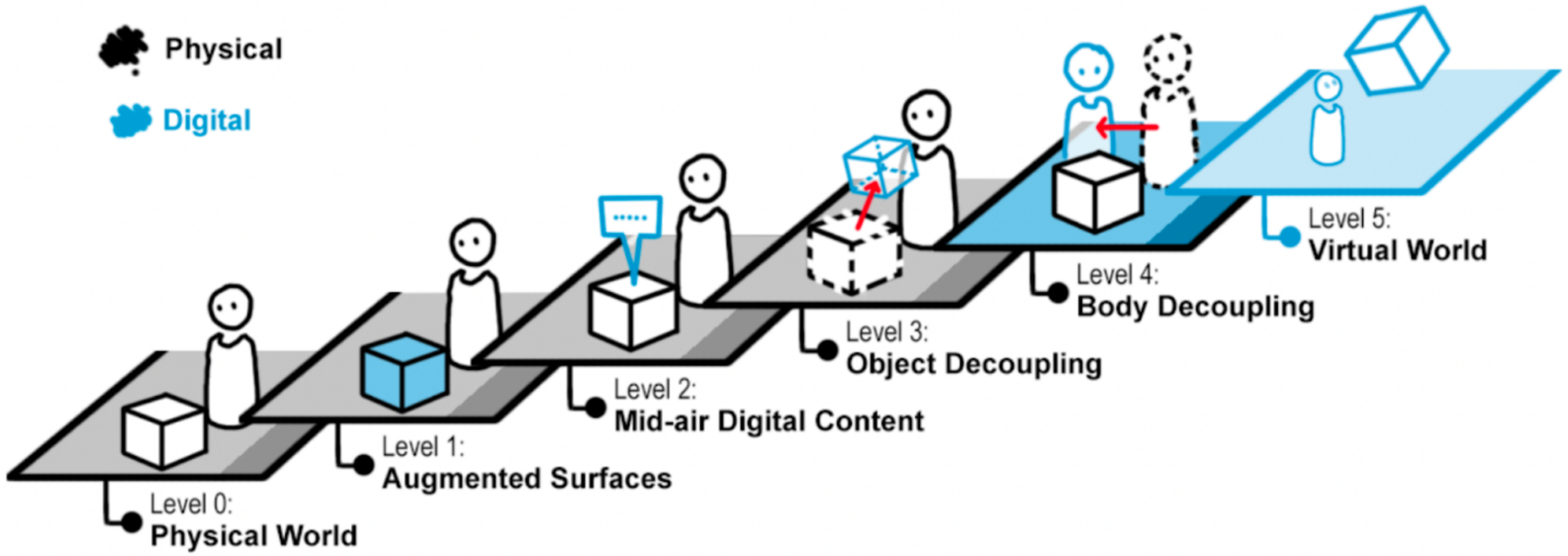
Mixed-Reality in Design

State of the art overview

Anton Savov, 7. April 2022

Spectrums of application of Mixed-Reality



Roo & Hachet, (2017) link

User input

Controller Buttons
Device motion tracking
Object Tracking
Hand Gesture
Body Tracking
Eye tracking
Voice

Dimensions of Value

Creation & Configuration	Visualisation	Knowledge Management	Integrated Analysis	Collaboration

Kent et. al, (2021) link

Use cases in the AEC sectors

Stakeholder engagement	Design support	Design review	Construction support	Operations and management	Training

Davila Delgado et. al, (2020) link

Wobbrock2009Userdefined

Wobbrock2009Userdefined
https://doi.org/10.1145/1518701.1518866

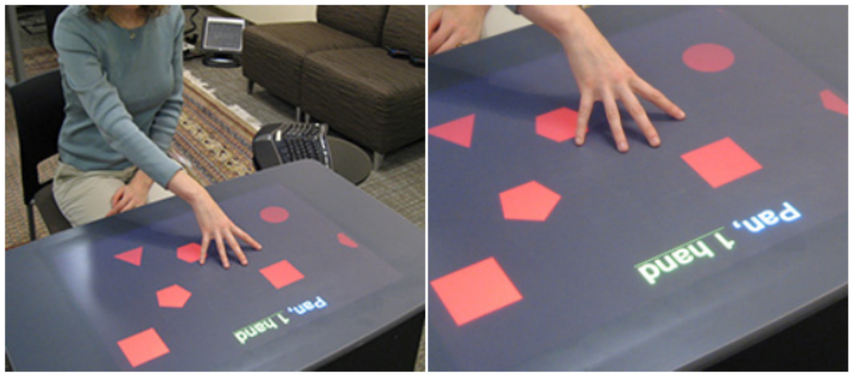


Figure 1. A user performing a gesture to pan a field of objects after being prompted by an animation demonstrating the panning effect.

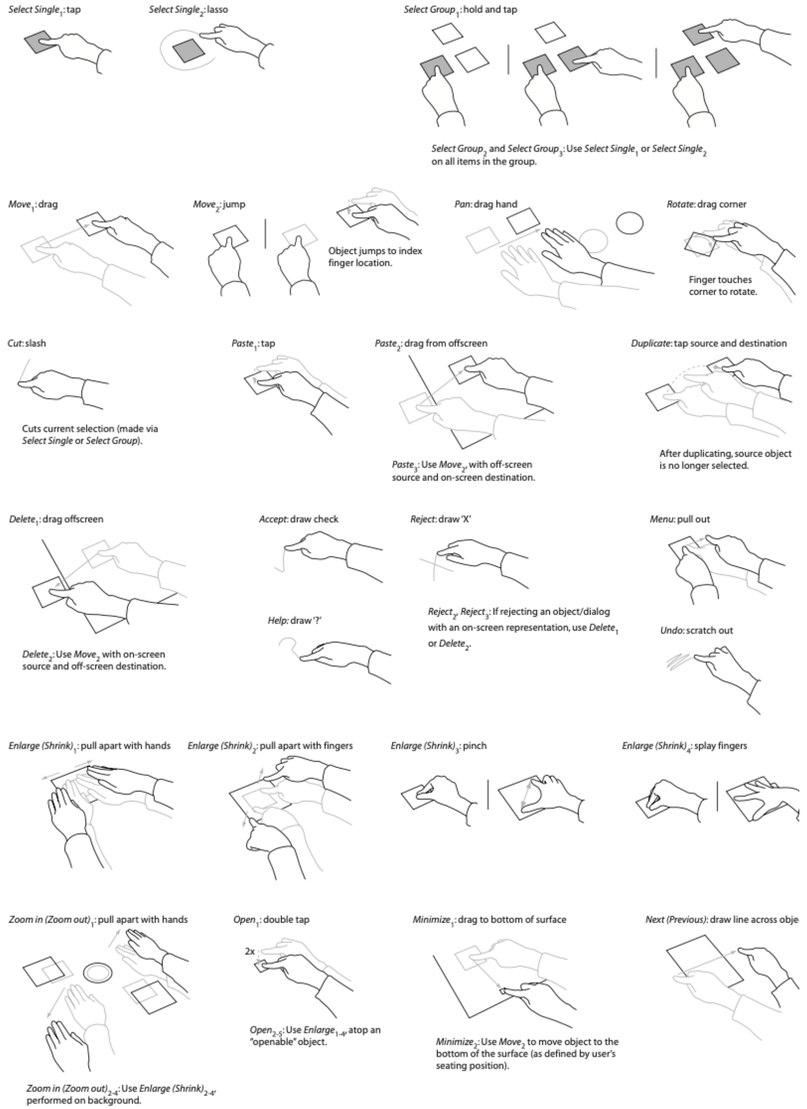
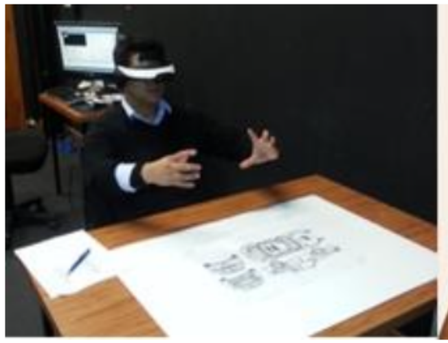


Figure 4. The user-defined gesture set. Gestures depicted as using one finger could be performed with 1-3 fingers. Gestures not depicted as occurring on top of an object are performed on the background region of the surface or full-screen object. To save space, reversible gestures (enlarge/shrink, zoom in/zoom out, next/previous) have been depicted in only one direction.

Piumsomboon2013UserDefined

Piumsomboon2013UserDefined
https://doi.org/10.1007/978-3-642-40480-1_18



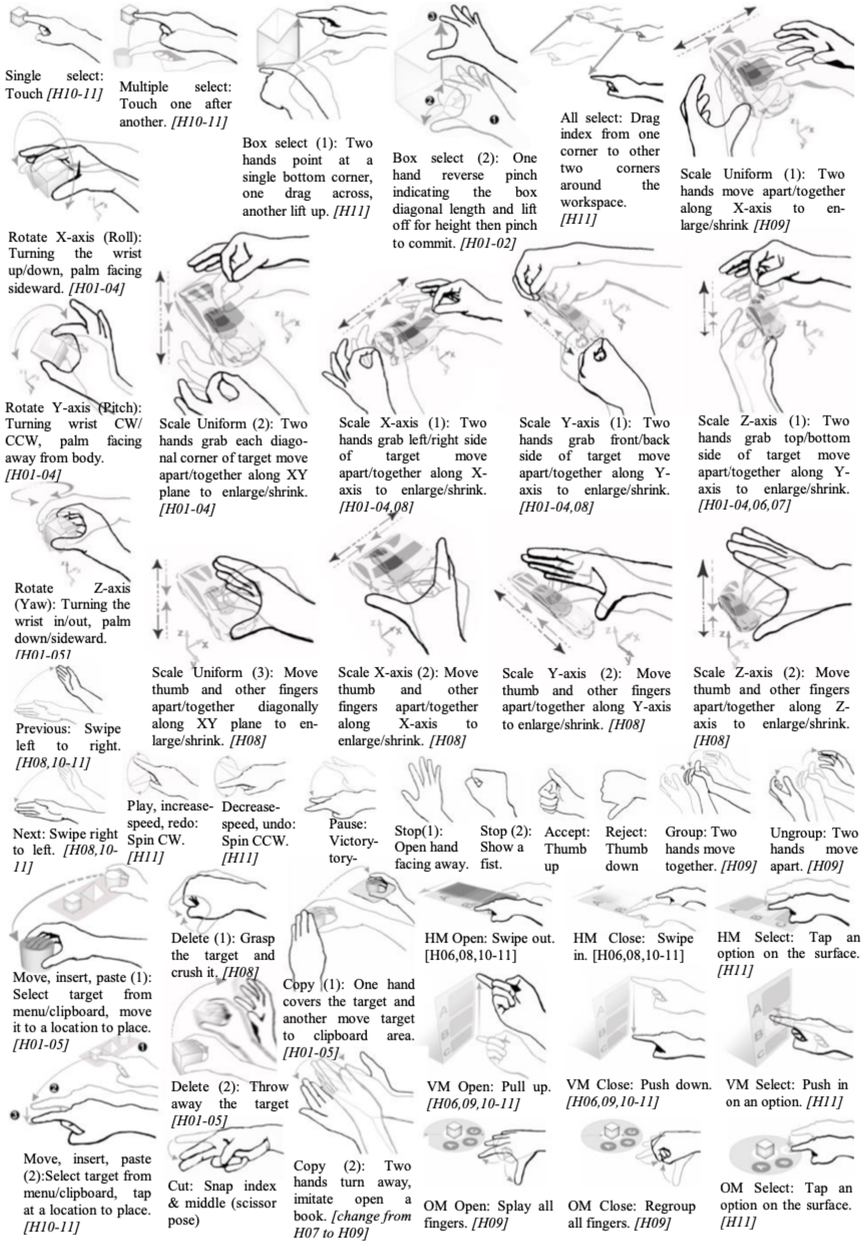


Fig. 5. The user-defined gesture set for AR. The number shown in the parenthesis indicates multiple gestures in the same task. The codes in the square bracket indicate the hand pose variants (Figure 4) that can be used for the same gesture.

Kim2019User

Kim2019User
https://doi.org/10.3390/app9153171

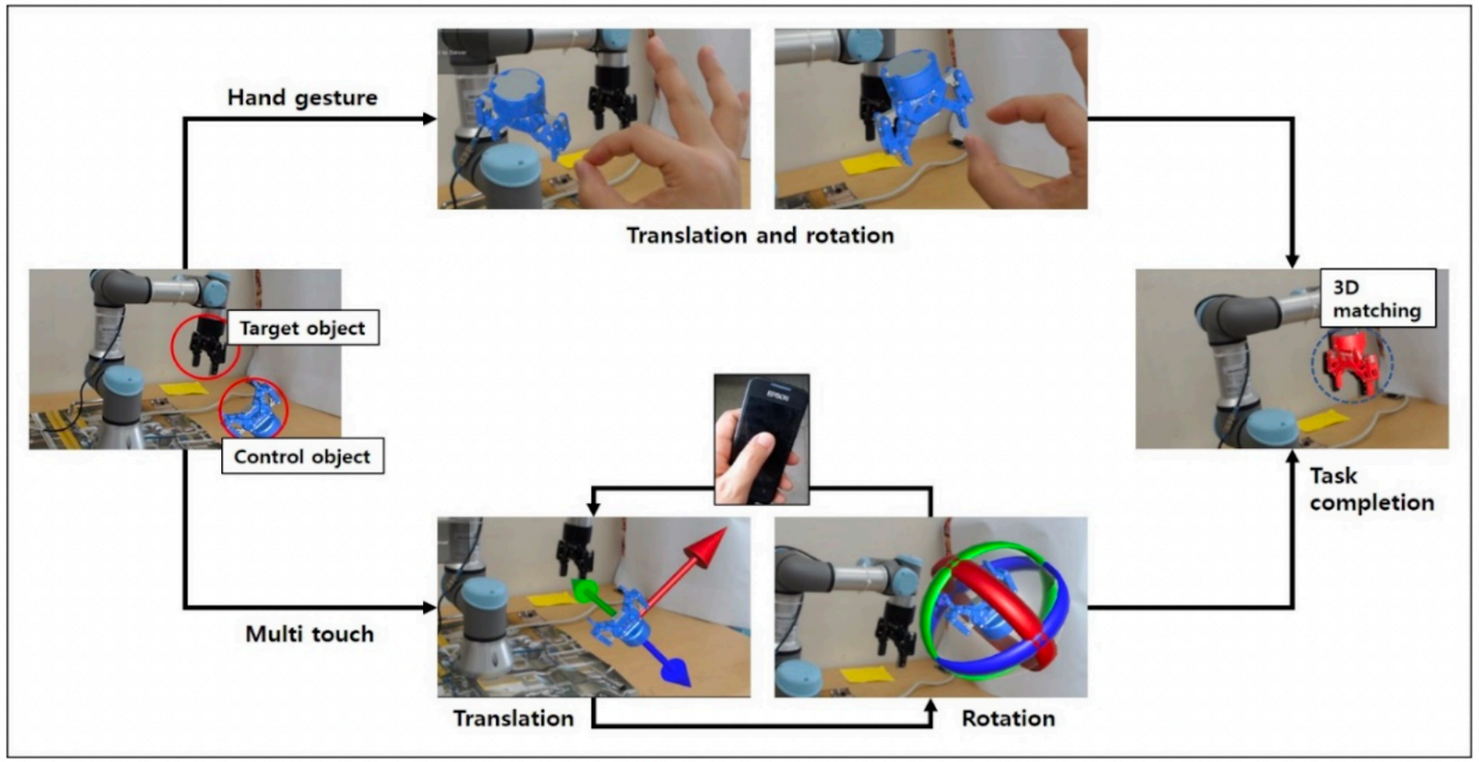


Figure 14. 3D (three-dimensional) matching task between a virtual control object and a physical target object; the gripper of the UR3 robot is used for 3D matching.

Designing Form in MR

Jailungka2018Intuitive

https://doi.org/10.1007/978-3-319-91250-9_21

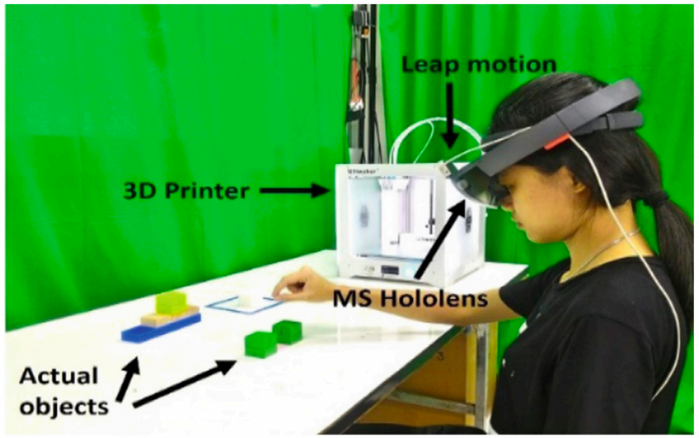
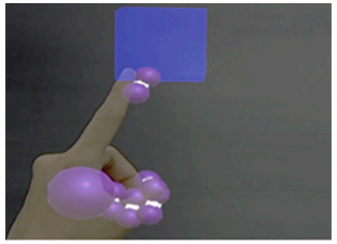
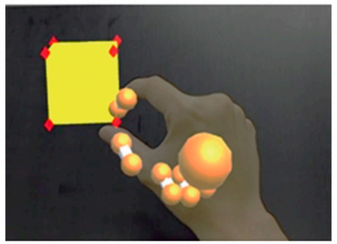
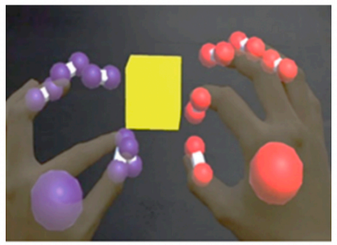
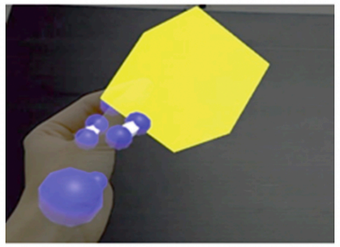
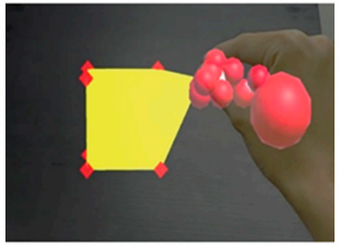
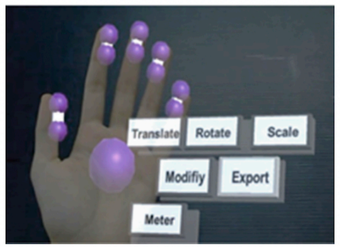


Fig. 1. System overview

Gesture Commands	Features	Definition
	Object Selection	The object selection feature is used to select the holographic object at the tip of index finger pointed on holographic object by tapping gesture. This feature sends the tip position of index finger (X_{tip}, Y_{tip}, Z_{tip}) and tap command.
	Object Translation	The object translation feature is used to move the position of holographic object by pinch gesture. The holographic object can be moved along axis in 3D space. This feature sends the new position at pinch position (X_t, Y_t, Z_t) and pinch command.
	Object Scaling	The object scaling feature is used to enlarge or shrink the holographic object by pinching two hands. This feature sends the detected pinch positions from left hand and right hand including pinch command.
	Object Rotation	The object rotation feature is used to rotate the orientation of holographic object along axis by grabbing the holographic object. The factor value of orientation increases the orientation of holographic object along axis while the arrow is grabbed.
	Object Deformation	The object deformation feature is used to move the vertex position of holographic object in 3D space by pinch gesture.
	Hand Panel	The hand panel feature is GUI panel for mode selection such as translate, rotate, scaling, modify, meter, and export a STL file format.

Reipschlager2019DesignAR

https://doi.org/10.1145/3343055.3359718

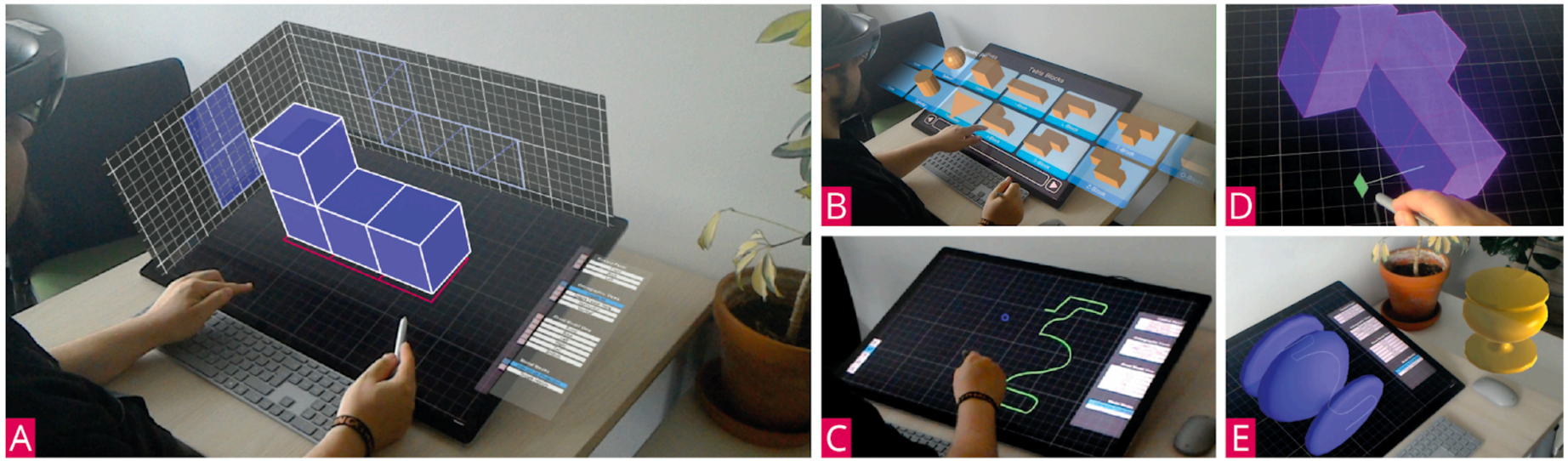


Figure 1: A general overview of *DesignAR*, highlighting (a) the augmented workstation as a whole, (b) The AR object browser, (c) sketching contours, (d) modeling by extruding faces, and (e) rotational solids and AR instances.

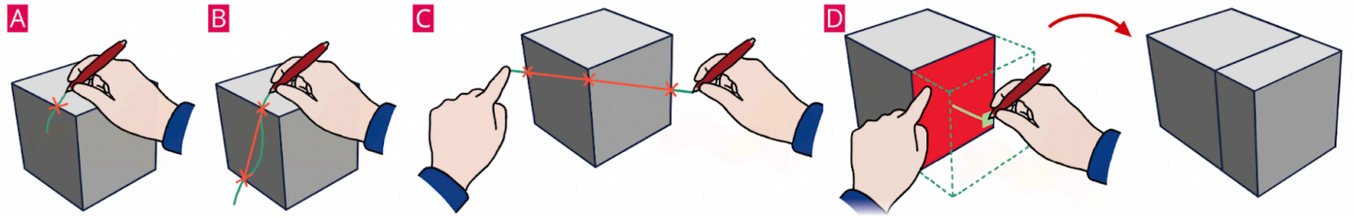
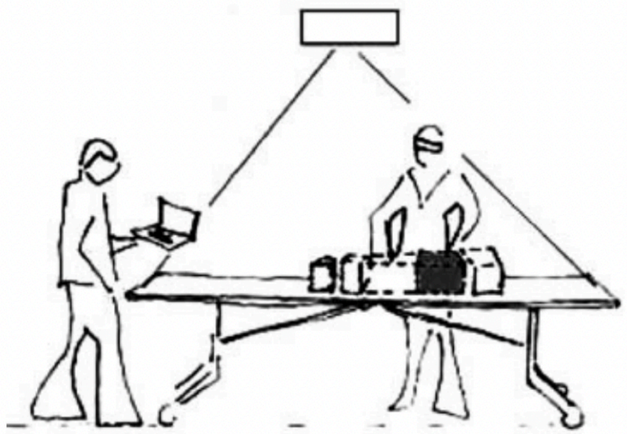


Figure 3: Sketches illustrating our interaction techniques for refining 3D models: (a) creating a new vertex by crossing a single edge with a pen stroke, (b) creating a new edge by crossing two or more edges with a single pen stroke, (c) slicing the whole model by using pen and touch to define a slicing plane, (d) extruding a face by first selecting it with the finger and then dragging it out with the pen.

Sandor2005Rapid

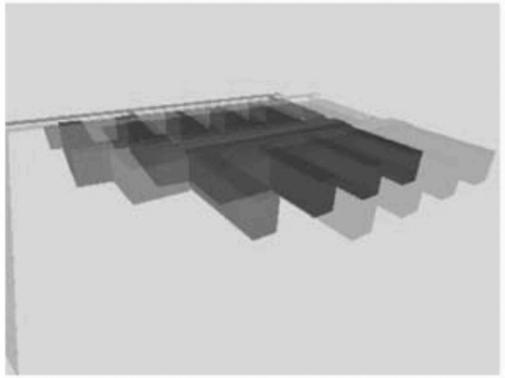
https://doi.org/10.1007/s00779-004-0328-1



(a) Conceptual drawing of the setup (courtesy of Manja Kurzak)

(b) Tangible objects for modelling and visualization: sun and wall

(a) Audience wearing red-cyan glasses



(b) View rendered in red-cyan

(c) The tangible camera controlling the viewpoint for the presentation

Millette2016DualCAD

https://doi.org/10.1109/ISMAR-Adjunct.2016.0030

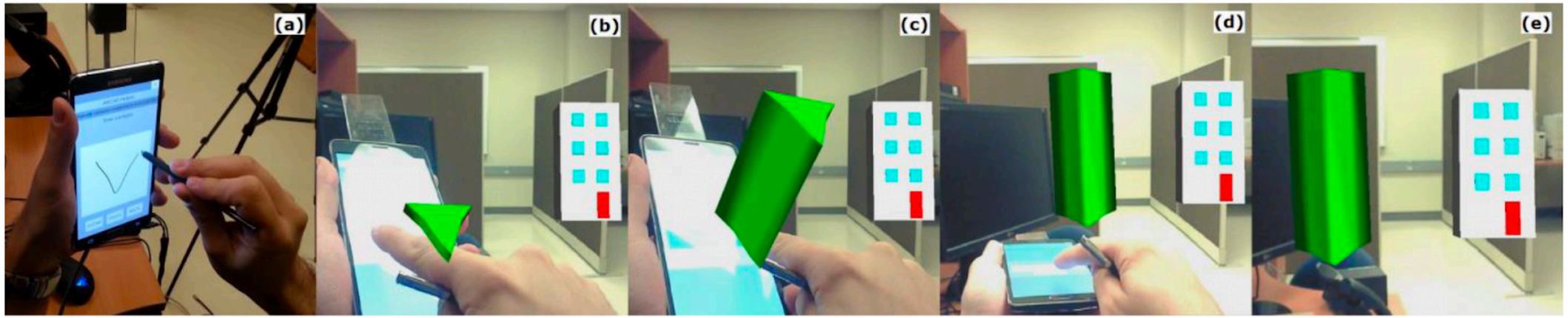


Figure 3: The Draw-and-Drop interaction technique. The user draws a polygon using the stylus (a), the polygon becomes a prism (b) which is then extruded by sliding a finger (c), moved into position on the scene (d) and finally detached (e).

Frohlich2018VRBox

https://doi.org/10.1145/3242671.3242697

Figure 3. A user performs a pinch gesture for spawning objects.

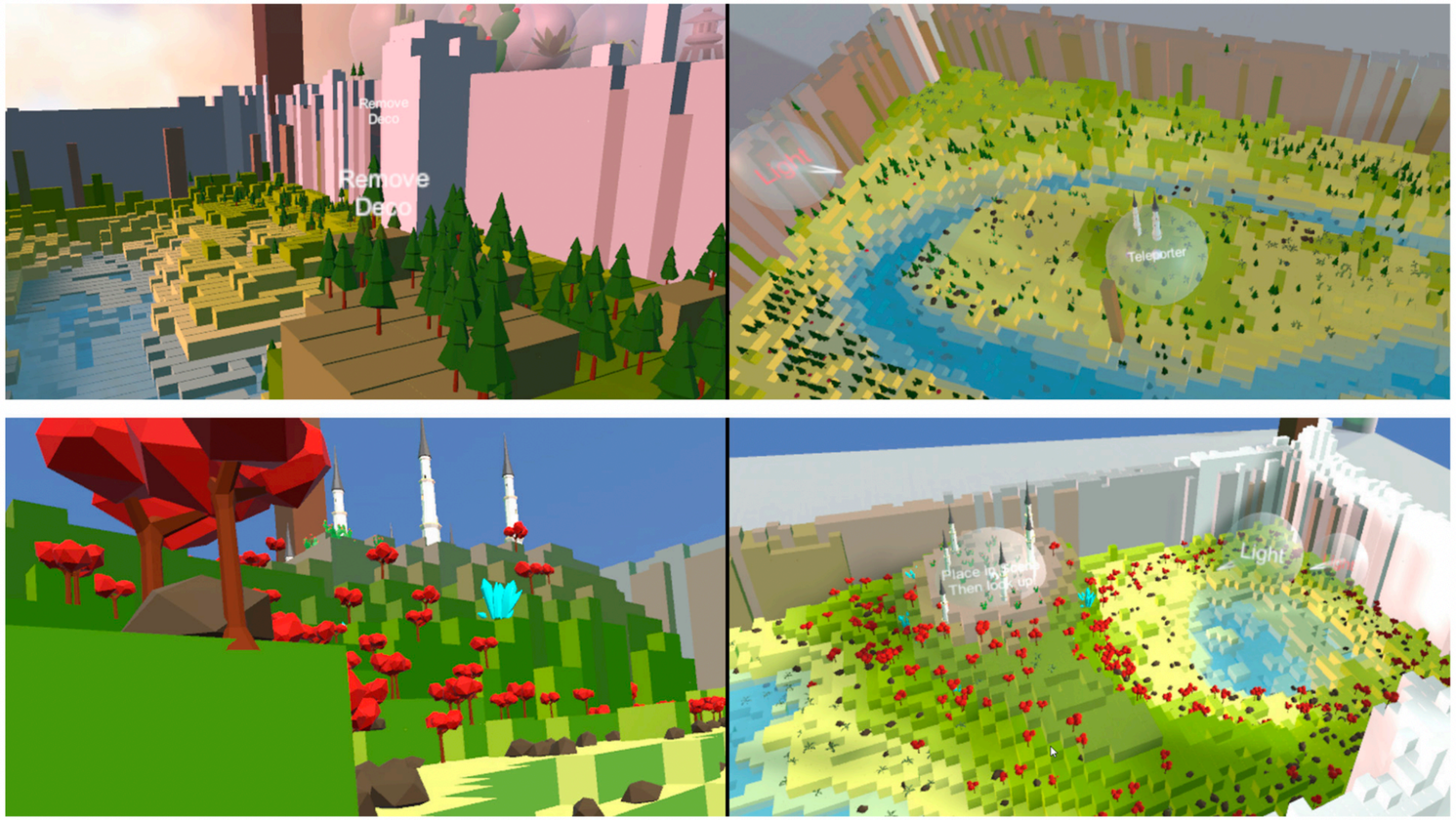


Figure 6. Two resulting 3D worlds (top row and bottom row) from our user study. On the left are the first-person views and on the right the tabletop views of the respective models.

Roo2017One

https://doi.org/10.1145/3126594.3126638

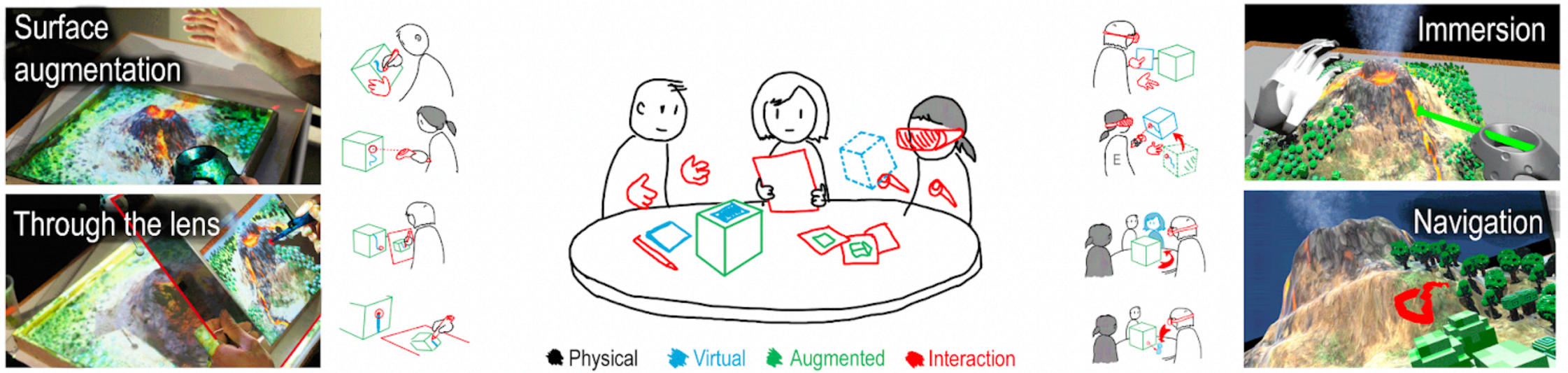


Figure 1. The presented system, exemplified here by an augmented volcano mock-up, allows one or more users to use and transition between multiple mixed reality modalities while interacting with augmented artifacts. The increase in instrumentation provides increasing flexibility, while keeping the interaction framed in the physical world.

Arora2018SymbiosisSketch

https://doi.org/10.1145/3173574.3173759

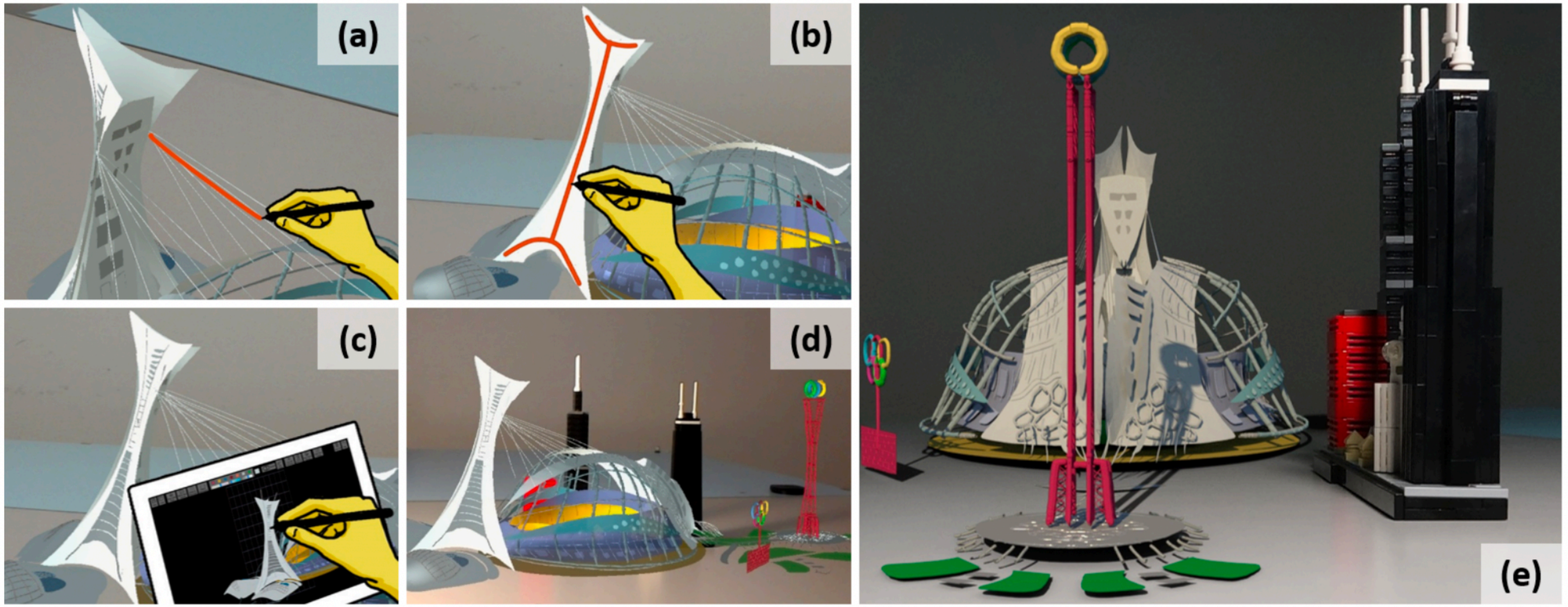


Figure 1. SymbiosisSketch combines mid-air 3D interactions (a) with constrained sketching. Users can create planar or curved *canvases* (b), and use a tablet (c) to sketch onto them. Designs are created in situ, in context of physical objects in the scene (d), allowing quick post-processing operations to seamlessly blend the virtual objects into the real world (e).

Kwan2019Mobi3DSketch

https://doi.org/10.1145/3290605.3300406

(a) 3D sketching in mobile AR (b) “Phoenix” (34.2 mins) (c) “Spiderman” (36.3 mins)

Figure 1: *Mobi3DSketch* is designed for users with reasonably good drawing skills to create 3D concept designs in the context of real-world environments using a single AR-enabled mobile device (a). (b) and (c) are 3D concepts created with *Mobi3DSketch* in situ. The small figures show the results from other viewing angles.

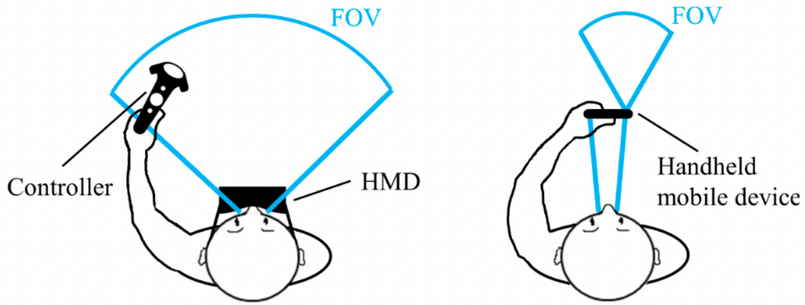


Figure 2: Small-sized mobile screens result in a much narrower field of view (FOV) than VR HMDs. 2D/3D input and display are coupled in our case.

Designing Layouts in MR

Gai2017Supporting

https://doi.org/10.1145/3025453.3025494

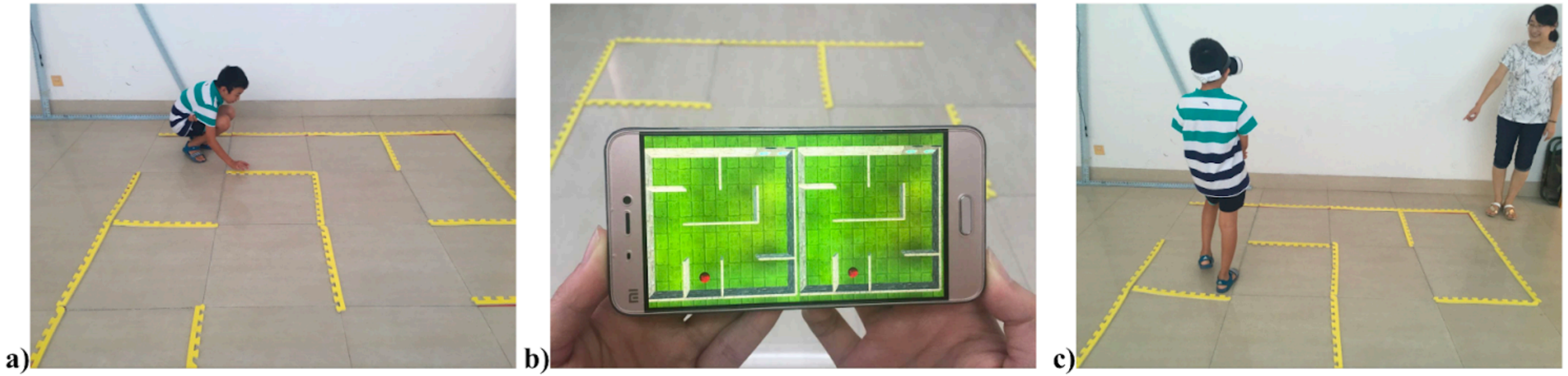


Figure 1. Illustration of the design and play of a maze on a mobile device: a) Design a maze on the floor, b) Generate a 3D maze; c) Play in the maze.

Arrighi2019User and Maurya2019Mixed

https://doi.org/10.1007/s10845-016-1276-0 and https://doi.org/10.1007/s12008-018-0499-z

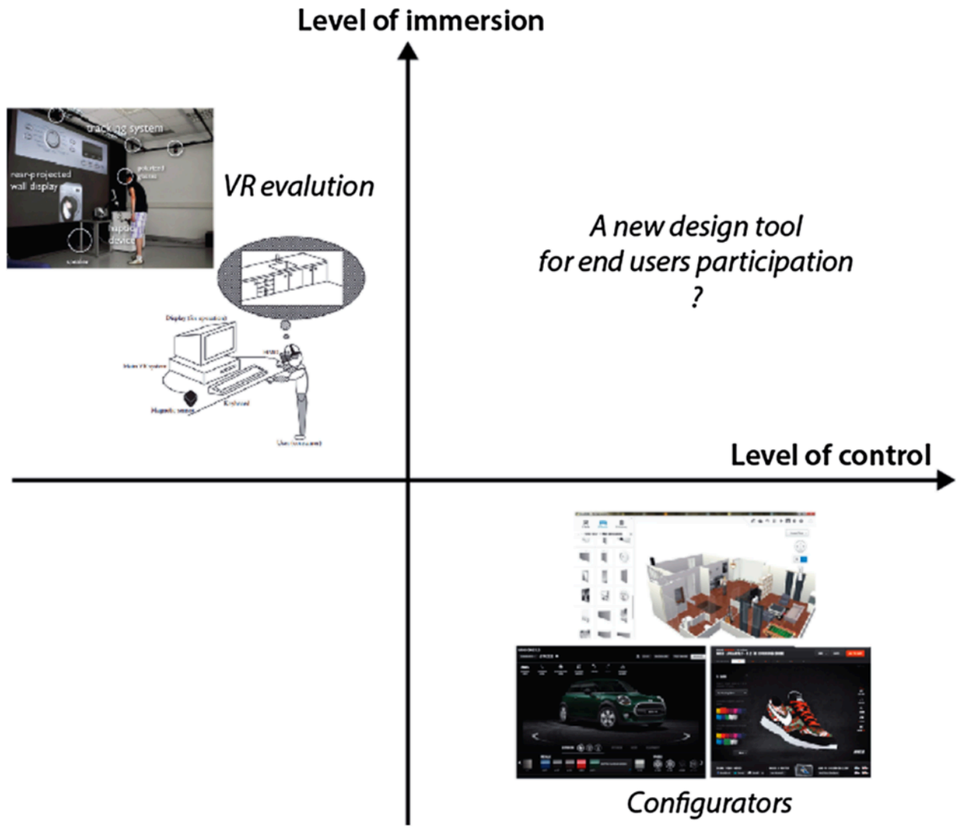
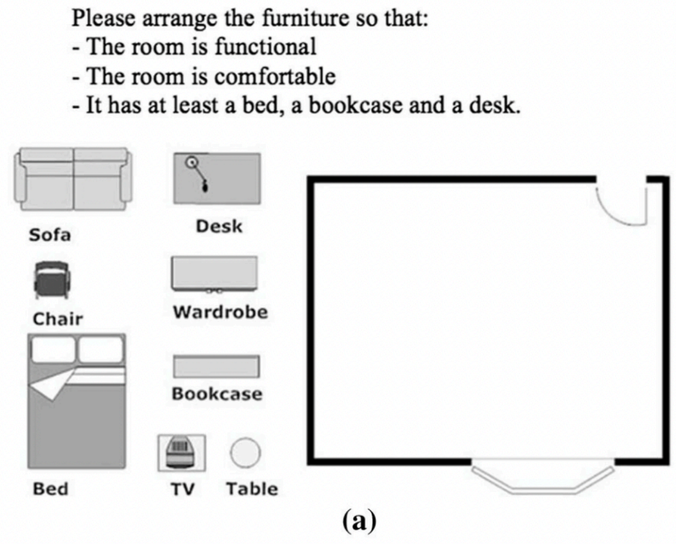


Fig. 6 A new tool that simultaneously offers high level of control and immersion



Son2020CSpace

https://doi.org/10.1145/3313831.3376452

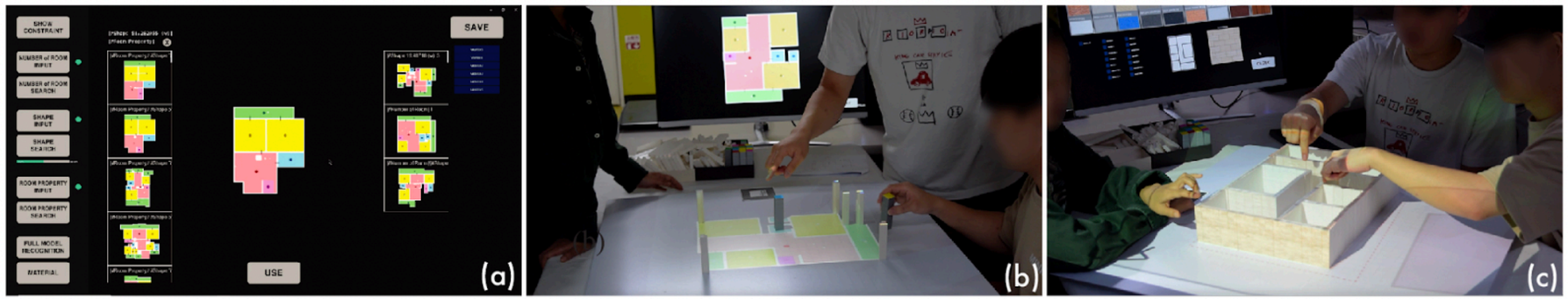


Figure 1. An interactive design process through C-Space: (a) retrieving design references through graphical user interface; (b) discussing and altering the retrieved references through tangible user interface; (c) testing finishing materials using projection mapping.

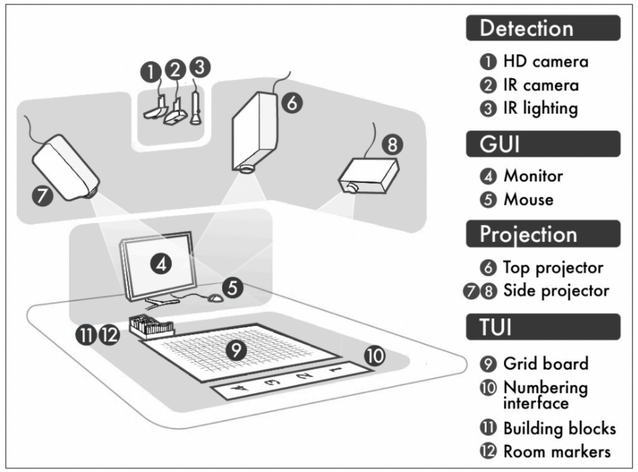


Figure 16. C-Space configuration.

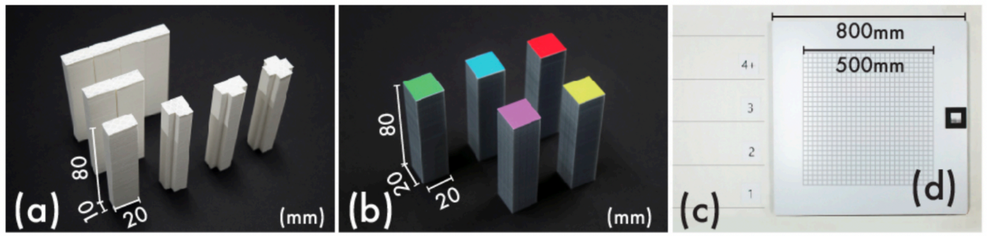


Figure 2. Physical modeling components and dimensions: (a) modular building blocks; (b) room marker blocks; (c) a numbering interface; (d) a grid board with an AR marker.

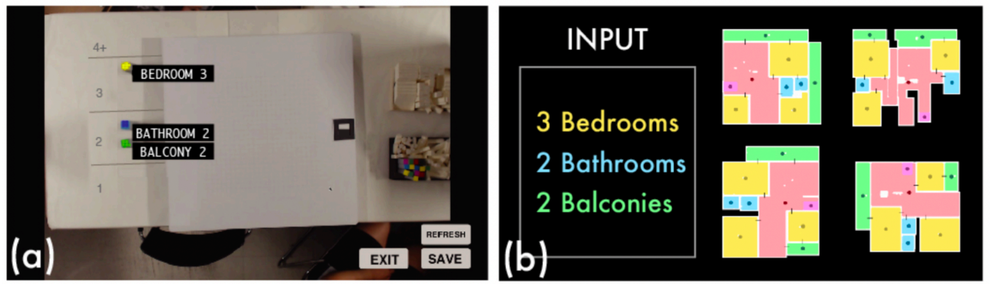


Figure 9. Number of rooms-based retrieval method: (a) input interface; (b) retrieved reference samples.