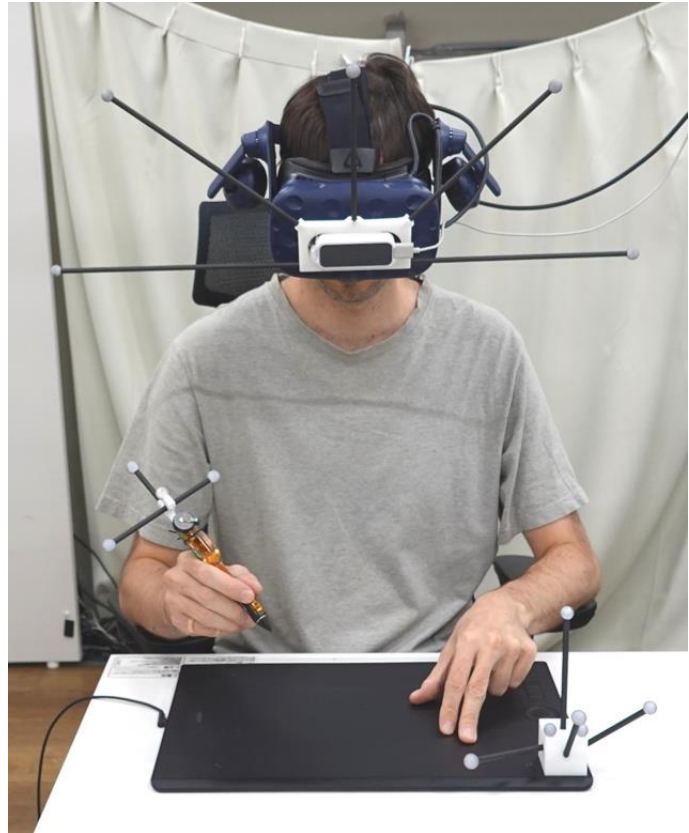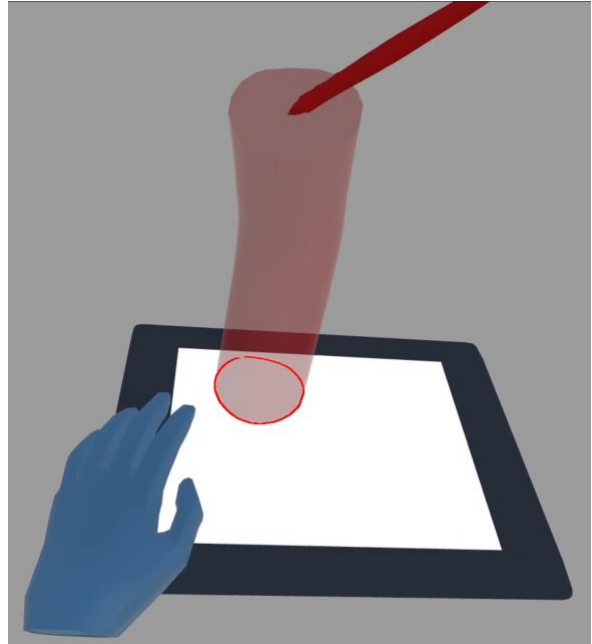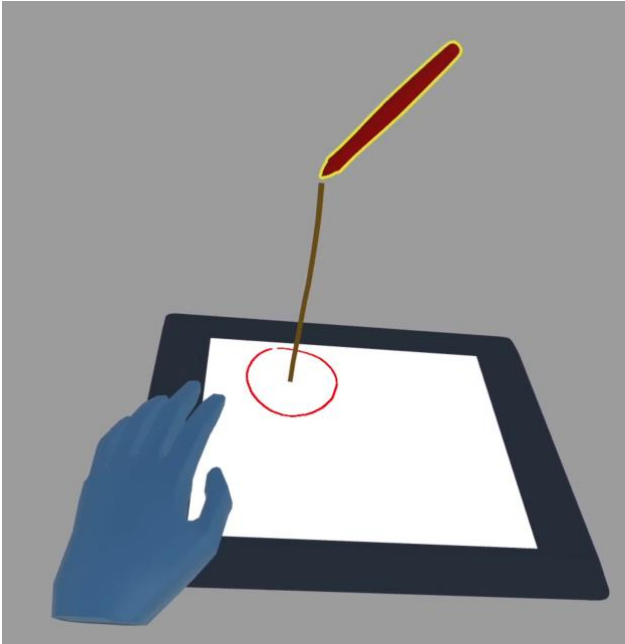# Appendix

1 DEVICE TRACKING SYSTEM

Wacom pen with custom mount bearing tracking markers and Bluetooth shutter button
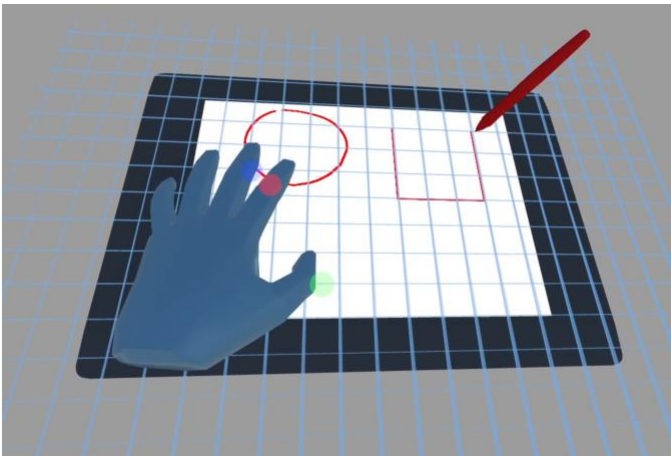

HTC Vive Pro + Leap Motion and Wacom Intuos Pro L with attached tracking markers

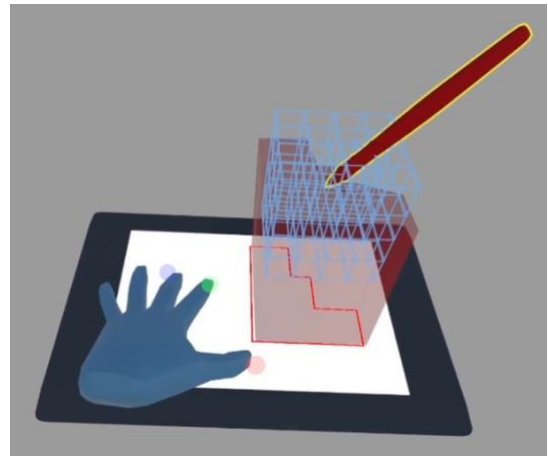## 2 INTERACTIONS OF THE APPLICATIONS IN VR

2.1 Modelling

Shape extrusion along freehand path (*pen transitions from surface to midair*)

2D grid activated with two fingers of the other hand and locked with third finger on the surface, while the pen traces on grid lines (*bimanual surface interaction*)

3D Grid activated by the other hand on the surface for the pen to extrude along path with straight segments (*bimanual surface interaction followed by transition of the pen to midair space*)
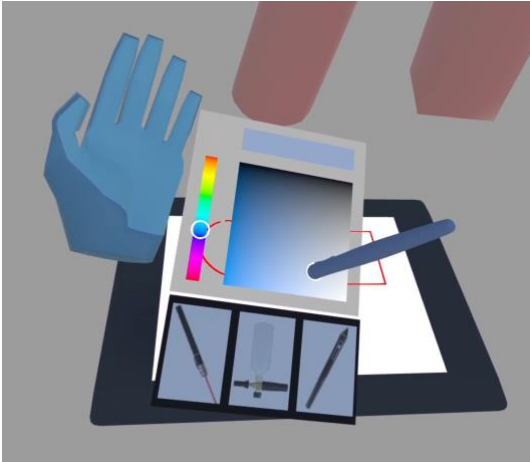
Hand menu with colour palette and tools. Pen selects colour from palette (*bimanual midair interaction*)
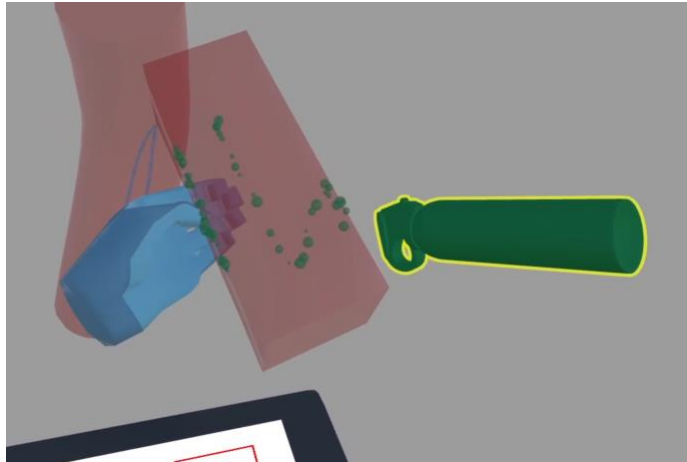

Other hand grips and moves object while pen spray paints it (*bimanual midair interaction*)
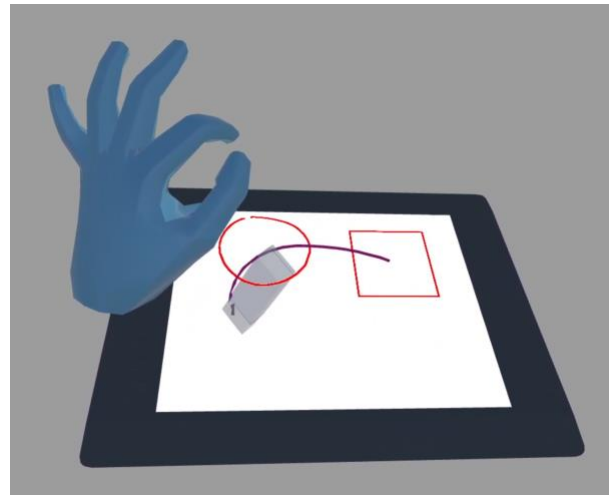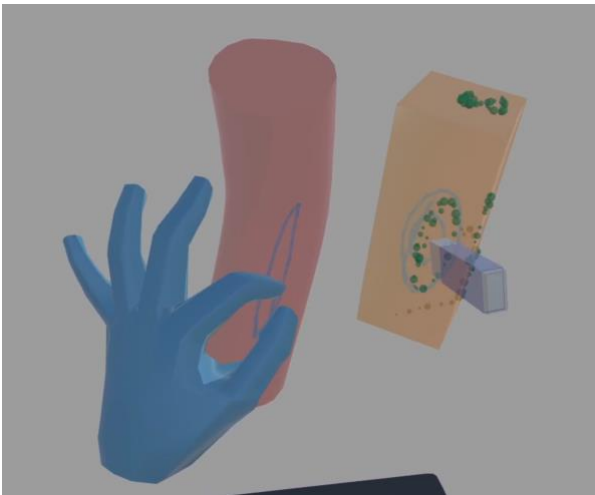
Delete mode activated by posture of the other hand (ok sign). Pen changes to eraser. 3D volumes and 2D shapes can be deleted by respectively pressing the pen button when inside the volume (bimanual midair interaction) and crossing out shapes (*cross-space interaction with the other in midair and pen on surface*) while the mode is active.
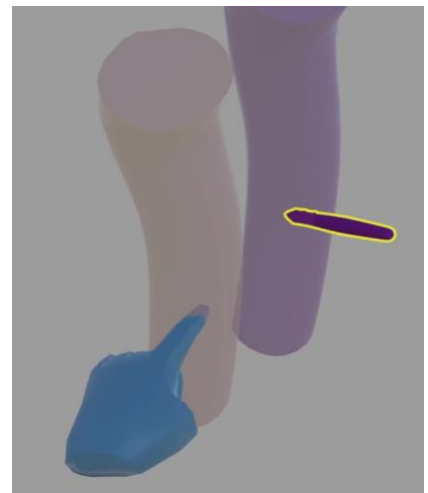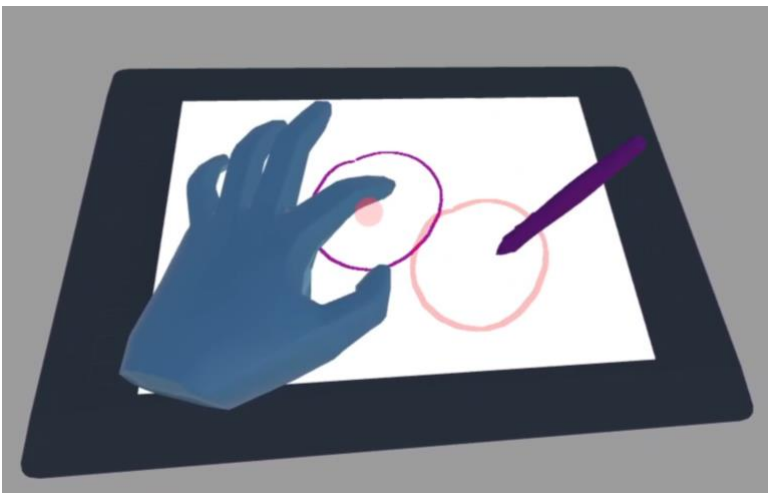

2D and 3D object duplication: Respectively, finger of the other hand taps inside + pen drags (*bimanual surface interaction*) and index finger of the other hand + pen inside object + pen move (*bimanual midair interaction*)
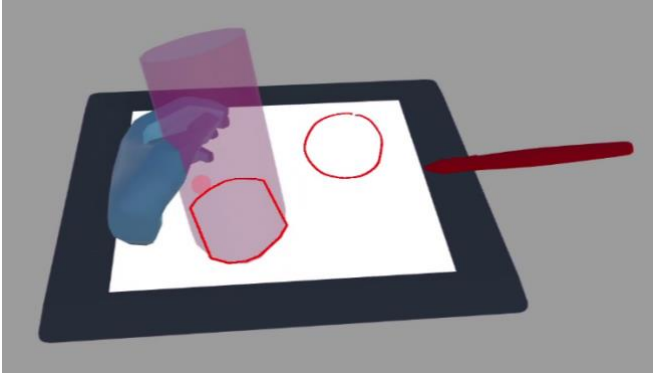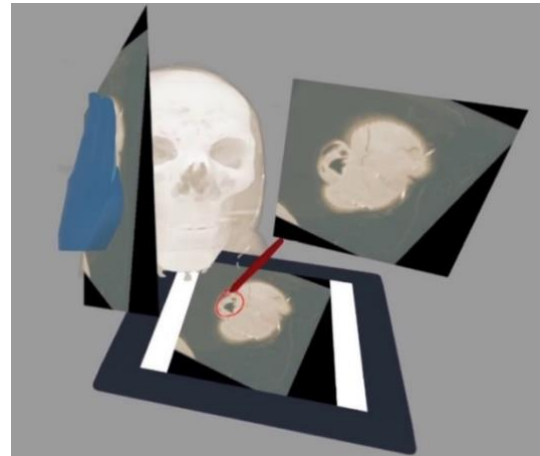
Stamping a volume grabbed by the other hand on the canvas (*other hand transitions from midair to surface*). A new shape is created from the intersection.
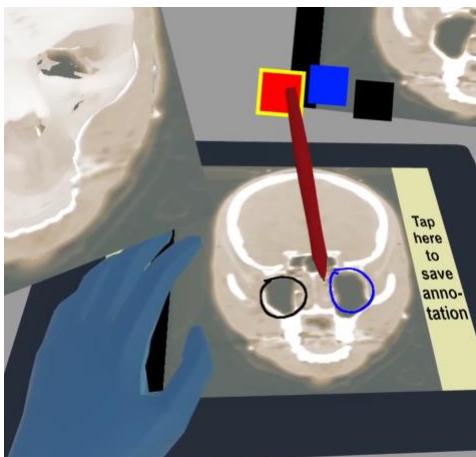
2.2 Volumetric Rendering
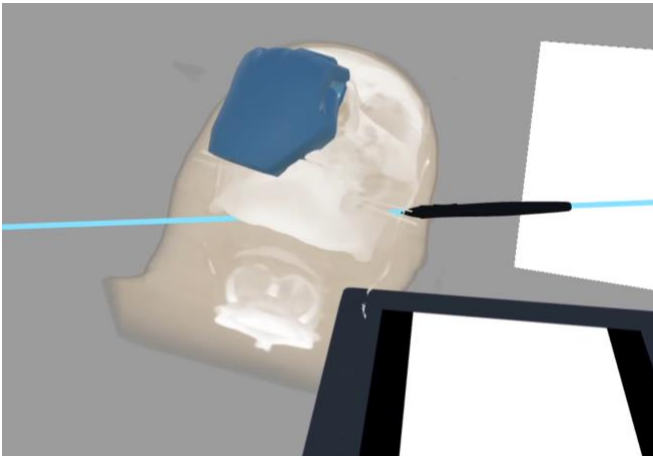
Using the pen as an axis to constrain rotations with the other hand (*bimanual midair interaction*)

A cross-section slice defined by the other hand is locked to allow annotations with the pen on the surface (*cross-space interaction with other hand in midair and pen on surface*)
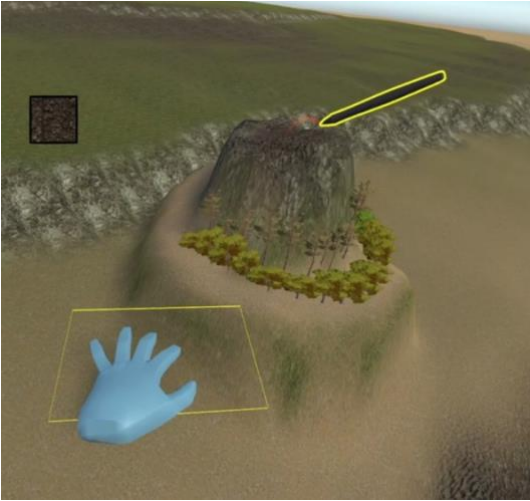

Pen tilt menu (*unimanual cross-space interaction, where the pen hand touches the surface and the pen top interacts with menu in midair*)
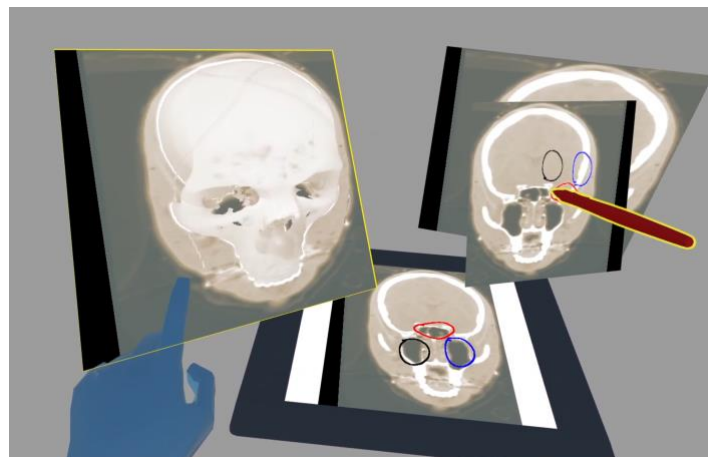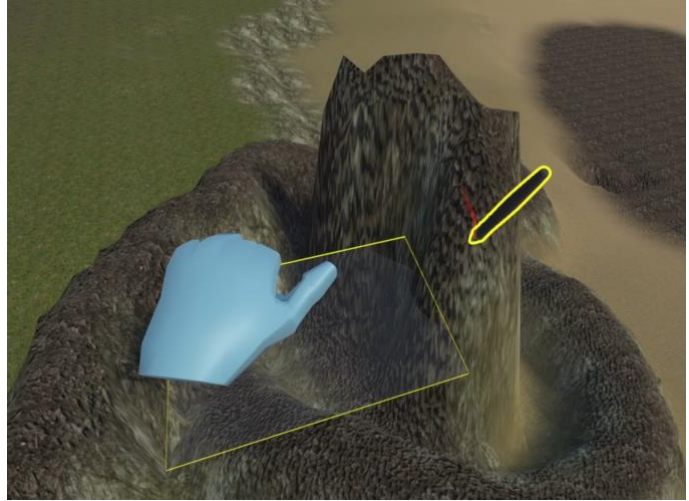

Bimanual slice copy. The other hand selects object, the pen creates and moves a copy (*bimanual midair interaction*)
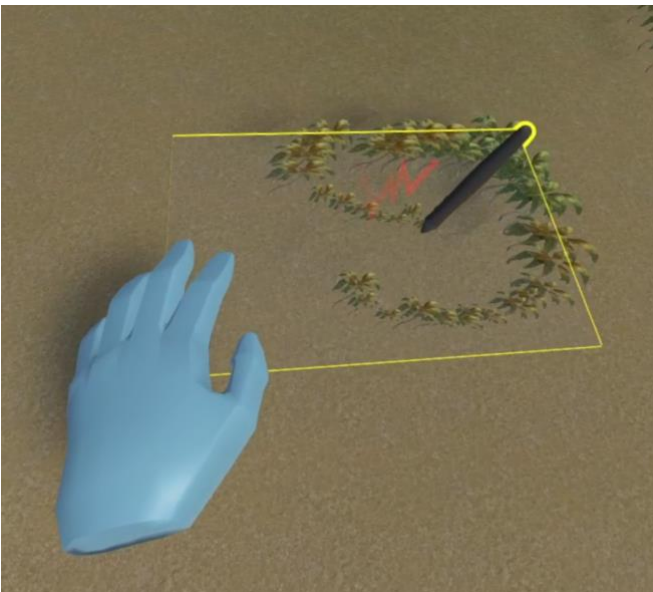
4

2.3   Terrain Editing

Sculpting terrain with the pen in midair while moving the camera with touch input on the surface using the other hand (*cross-space interaction*)


Sculpting terrain with the pen while moving the camera with the other hand in midair (*bimaual midair interaction*)


Adding trees with the pen on the surface and controlling size with pen pressure (*unimanual surface pen interaction*)
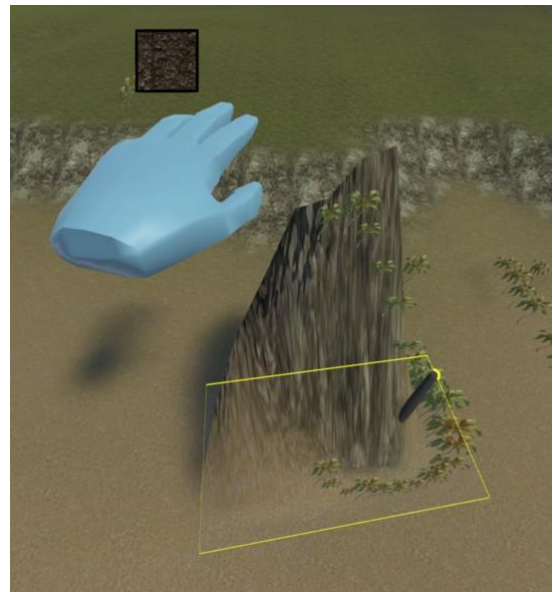
Adding terrain with the pen on the surface and controlling height with the other hand in midair (*cross-space interaction with the other hand in midair and the pen on the surface*)
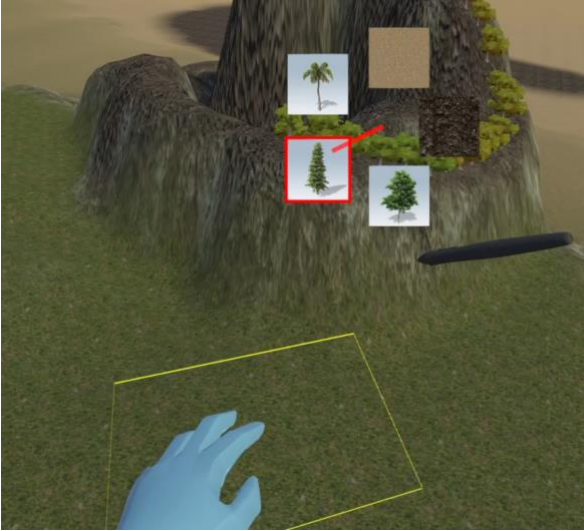
Marking menu invoked with four fingers of the other hand touching the surface and marking by dragging with that same hand (*unimanal surface interaction of the other hand*)
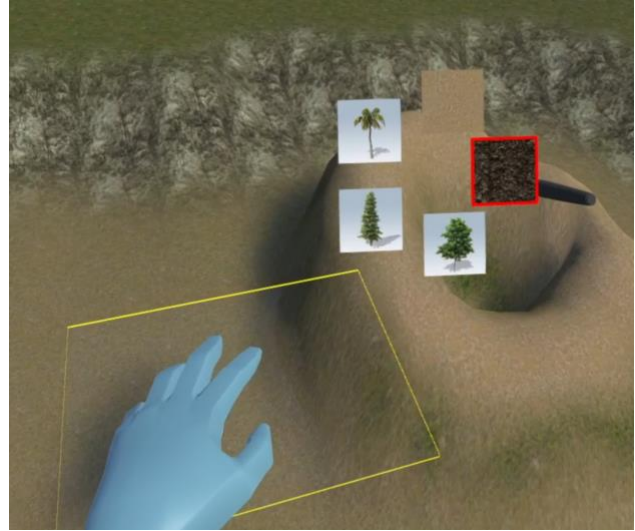
Marking menu invoked with four fingers of the other hand touching the surface and selecting menu item with the pen in midair (*cross-space interaction with the other hand touching the surface and the pen in midair*)