3D Touch-And-Drag:

Constraint-Based Modeling Technique for Mid-Air Interaction

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ABSTRACT

We define a new modeling technique called "3D touch-and-drag," where users **select vertices** simply **by approaching** them. Operations are **finished by removing** the 3D cursor (e.g., a **forefinger**) from a line or plane in 3D space.
These lines or planes **constrain** the modeling operations, as is the case when using 3D widgets.

BACKGROUND

Current geometric modeling tools are usually controlled by mouse and keyboard.
It is difficult to perform interactions in a 3D space since users are not experienced with 3D interactions in virtuality, so **adding constraints** to generic 3D interaction techniques can **improve usability**.
Thus, current geometric modeling systems very often provide **3D widgets** for modeling operations.

Users often have to select vertices to start touch-and-drag operations. In the two-dimensional case, selection can be performed by clicking a mouse button when the mouse cursor is hovering over a vertex. Selecting vertices would be difficult without explicit confirmation since, for example, users have to hover over many parts of a surface before reaching a target vertex in the middle of it.

3D TOUCH-AND-DRAG

In 3D space, vertices can also be selected **purely by approaching** them with the 3D cursor (e. g. forefinger), but in this case, it is not clear **how to release** them. If, however, the modeling operation is constrained to a plane, it can be finished by **removing the 3D cursor from the plane**, similar to lifting a finger from a touchscreen. We call this technique "3D touch-and-drag".

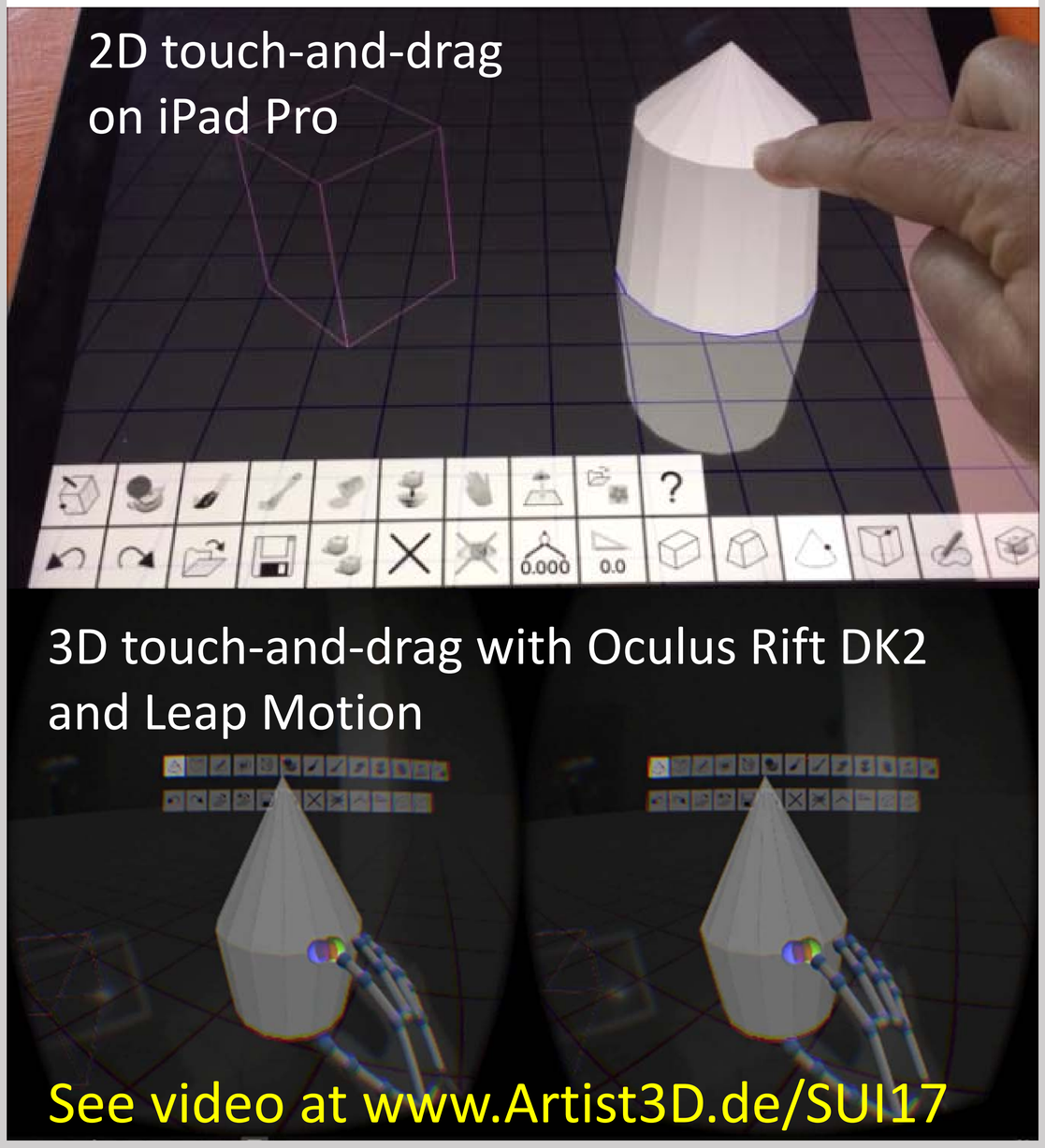
ADVANTAGES

- This kind of 3D interaction is promising since it could be **adapted with only moderate effort** to modeling systems which use **constraints**.
- Selection **gestures can be avoided**, which **increases performance**, especially when starting an operation.
- Since users can perform 3D touch-and-drag similarly to using a mouse in 2D, this **knowledge** can easily be **transferred** and the **learning** effort **reduced**.

PATENT PENDING: WO2017080579A1

APPLICATION (ARTIST3D)

We have successfully implemented an immersive version of **Artist3D** using a **Leap Motion** device and an **Oculus Rift** DK2 headset since this modeling system **constrains all modeling operations** to planes or lines.
Modeling operations and planes are chosen implicitly when the user selects an edge or vertex. For example, rotational solids can be designed by beginning with a cone. Users can insert a ring by clicking on a vertical edge and adjust the ring's height and radius by moving its vertex with the cursor. In this case, movement is constrained to a modeling plane spanned by the object's vertical axis and the vertex.



USER TEST (MOVE A SPHERE ON A LINE)

We found that the method is **as fast as a pinch**-gesture-based method while being **easier** to start. The precision of 3D touch-and-drag is even as high as using a button on a controller.