HYBRID DRAWING SOLUTIONS IN AUGMENTED REALITY: BITMAP-TO-VECTOR TECHNIQUES ON 3D SURFACES

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Introduction

We introduce an innovative **AR** framework designed to enhance the drawing process on 3D models. Using **Microsoft Hololens2** and **Unity**, we developed a **hybrid drawing tool** which facilitates rapid **freehand** drawing and converts these sketches into **vector** lines. This conversion preserves the **precision** and **fidelity** of drawings.
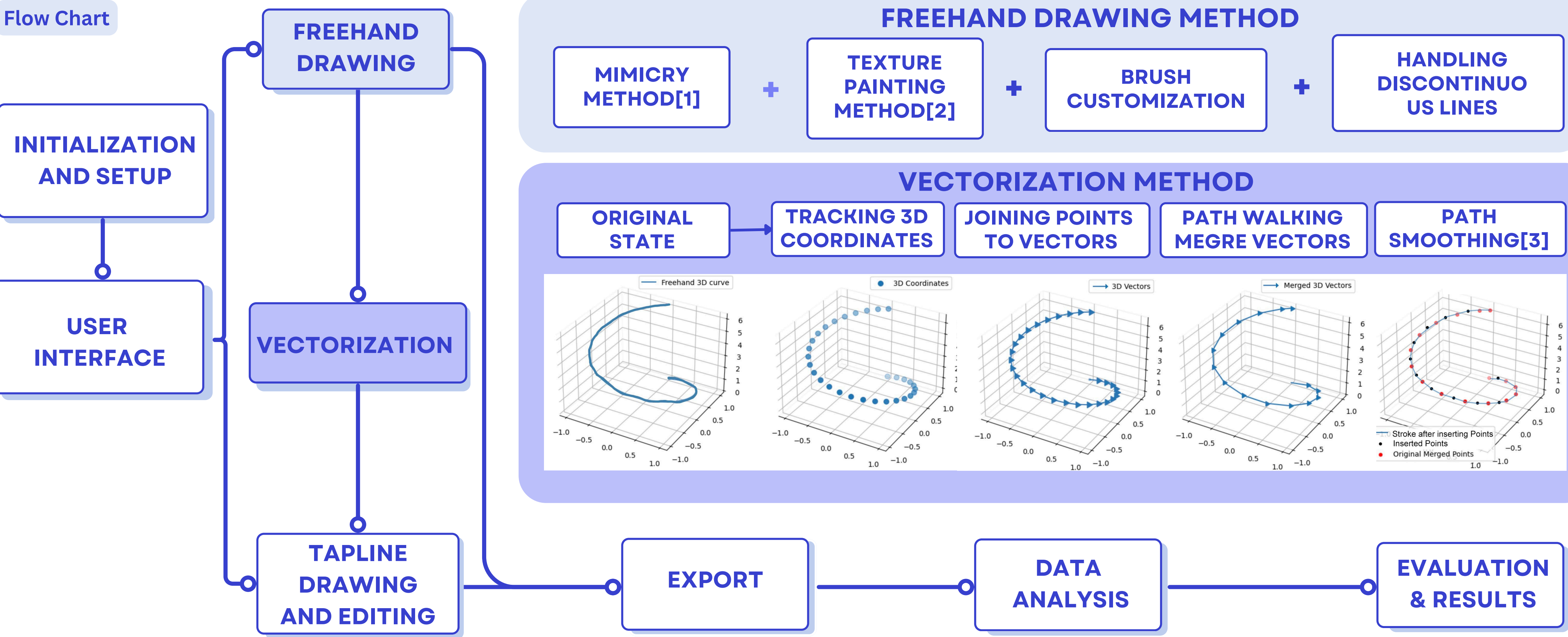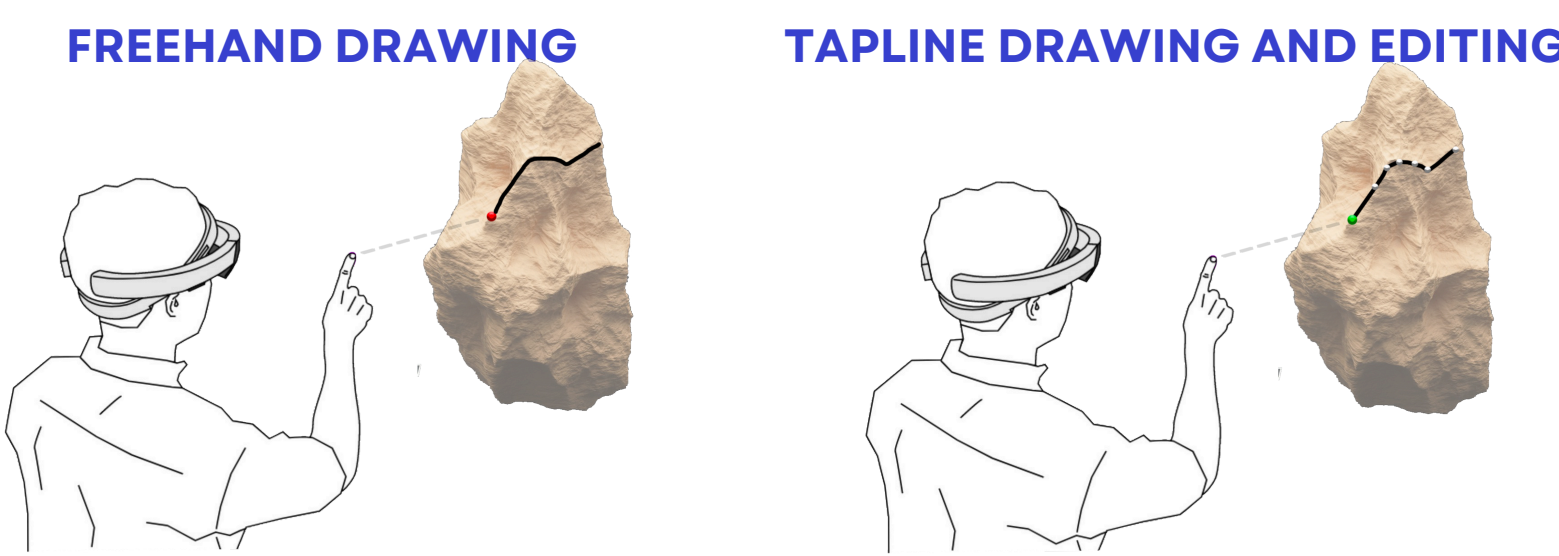
Research Question

How to enable AR drawing on 3D Surfaces that's **quick, scalable and editable**?

Key Contribution

A tool for **rapid and intuitive** drawing on 3D model surfaces in **AR**. Vectorization of sketches to maintain **precision and detail**, with **editable** key points. Usability and efficiency evaluation in **real-world engineering contexts**.

System Design

- **Freehand Drawing:** Mimicry Method to ensure accurate drawing on the surface and utilizes Texture Painting for real-time updates and flexible drawing.
- **Vectorization:** Employs an enhanced algorithm with real-time 3D tracking and Catmull-Rom Interpolation[3] for smooth, continuous lines.
- **Tapline Drawing:** After Vectorization, it will be switched to tapline drawing mode to connect lines users tapped.

FREEHAND DRAWING

TAPLINE DRAWING AND EDITING

Flow Chart

INITIALIZATION AND SETUP → USER INTERFACE → FREEHAND DRAWING → VECTORIZATION → TAPLINE DRAWING AND EDITING → EXPORT → DATA ANALYSIS → EVALUATION & RESULTS

FREEHAND DRAWING METHOD

MIMICRY METHOD[1] + TEXTURE PAINTING METHOD[2] + BRUSH CUSTOMIZATION + HANDLING DISCONTINUOUS LINES

VECTORIZATION METHOD

ORIGINAL STATE → TRACKING 3D COORDINATES → JOINING POINTS TO VECTORS → PATH WALKING MEGRE VECTORS → PATH SMOOTHING[3]


Future Work

- Implement editing tools including **"Undo"** and **"Eraser."**
- Include advanced drawing functionalities such as **annotation** capabilities and **color-filling** features.
- Improve **pressure sensitivity and gesture recognition**.

Reference

1. **Rahul Arora et al.,** "Mid-Air Drawing of Curves on 3D Surfaces in Virtual Reality", 2021
2. **Shahriyar Shahrabi,** "Mesh Texture Painting in Unity Using Shaders", 2021
3. **Edwin Catmull and Raphael Rom,** "A class of local in terpolating splines", 1974
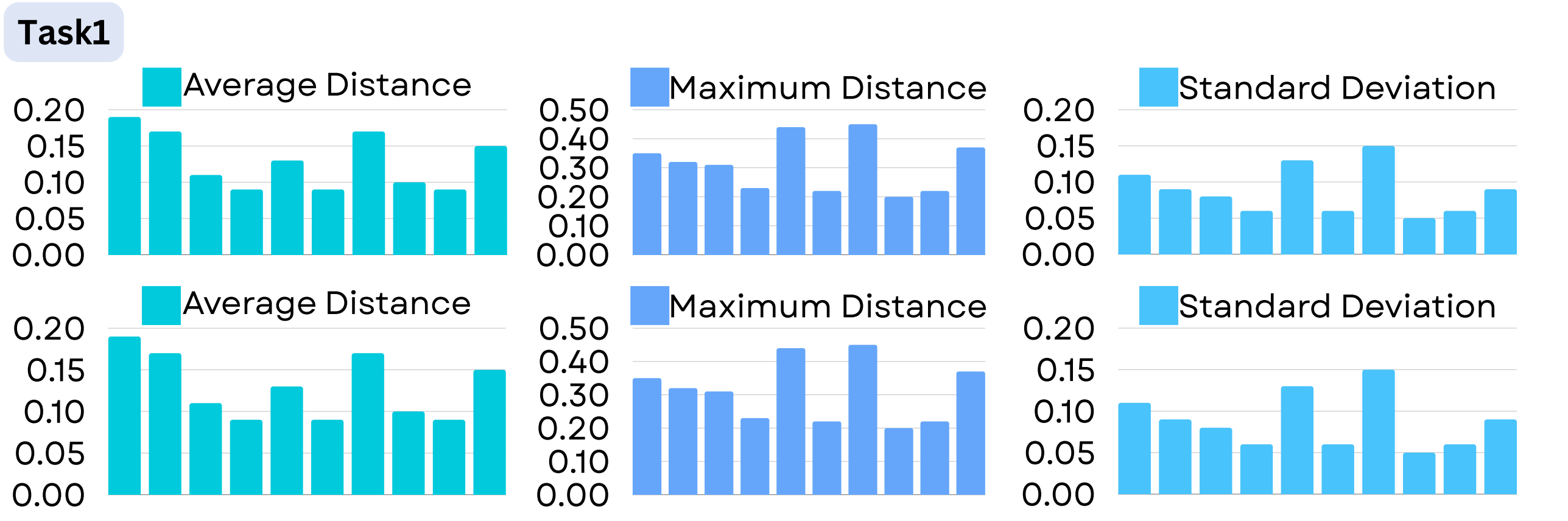
Evaluation & Results
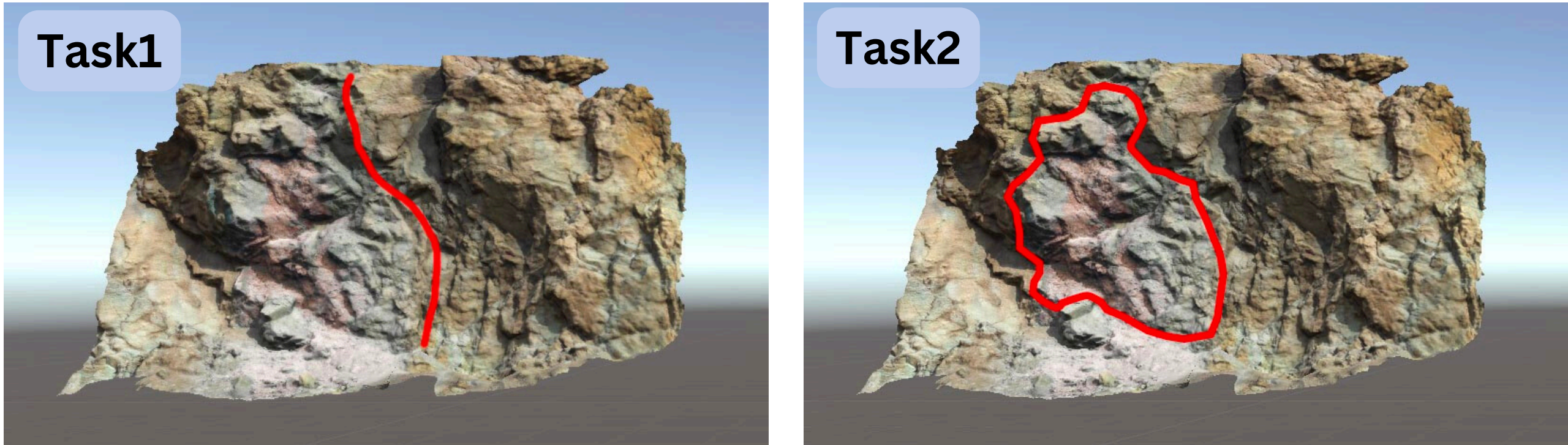
Task1

Task2

Participants   **10** participants, completed **2** drawing tasks.

Data size   Reduced by **86.8%** for Task 1 and **85.9%** for Task 2 after vectorization

Curve Accuracy

The average distances between the original and vectorized curves were minimal.

Task1

Average Distance / Maximum Distance / Standard Deviation

Curve Smoothness

The average angles between vectors were significantly reduced after vectorization.

Task1

Avg_Angle_Before / Avg_Angle_After / Std_Angle_Before / Std_Angle_After

Task2

Avg_Angle_Before / Avg_Angle_After / Std_Angle_Before / Std_Angle_After