Measurement System – Design & Implementation Explanation

Overview

The goal of this assignment was to implement an interactive 3D measurement tool that behaves predictably across different line orientations while remaining performant and maintainable. I approached this problem by focusing on three core aspects: **interaction flow**, **text orientation logic**, and **explicit memory management**, following patterns commonly used in CAD and 3D design tools.

Measurement Interaction Flow

The measurement system follows a simple and intuitive two-click workflow:

- **First click** captures the start point in world space.
- **Mouse movement** dynamically updates a dashed preview line from the start point to the cursor position, giving real-time visual feedback.
- **Second click** finalizes the measurement by creating a permanent dimension line and a distance label.
- Pressing **Escape** cancels an in-progress measurement.
- Deactivating the tool ensures all temporary visuals are cleaned up.

This interaction model keeps the system predictable, avoids ambiguous states, and mirrors how professional drafting tools behave.

Text Rotation & Flip Logic (Angle-Based)

A key requirement of this assignment was ensuring that measurement text remains readable across all line orientations.

To achieve this, I calculate the direction vector between the start and end points of the measurement and derive its angle using atan2. This angle is applied directly to the text label's rotation so that the text aligns with the measurement line.

However, simply rotating text is not sufficient for steep or vertical measurements. When the angle exceeds ±90 degrees, the text would appear upside down. To handle this, I implemented a flip condition that adds π radians to the rotation when the line orientation crosses that threshold. This guarantees that the text remains upright and readable regardless of direction.

This approach ensures:

- Horizontal lines display straight text
- Angled lines display rotated text
- Vertical or steep lines automatically flip the text for readability

Memory Management & Cleanup

Because measurement tools can be used repeatedly, explicit memory management is essential. All temporary geometries and materials used for preview lines are properly removed from the scene and disposed of when a measurement is canceled or completed. This prevents unnecessary GPU memory usage and avoids lingering references.

Finalized measurements are grouped logically, making future extensions such as deletion, selection, or styling straightforward without requiring architectural changes.

Design Decisions

Some design choices were made beyond the explicit requirements:

- **Preview lines use dashed materials** to visually distinguish temporary interactions from finalized measurements.
- **Text is rendered using canvas-based sprites**, allowing lightweight, readable labels without introducing additional geometry complexity.
- **Measurement logic is isolated in its own system**, following a clean separation of concerns and making the feature easy to extend or reuse.

Conclusion

This implementation focuses on correctness, clarity, and real-world usability rather than visual shortcuts. The result is a measurement system that behaves consistently across all orientations, manages resources safely, and follows patterns used in professional 3D and CAD applications.