Creating Malleable Interactive Surfaces using Liquid Displacement Sensing

Otmar Hilliges¹, David Kim¹, Shahram Izadi²

¹University of Munich, ²Microsoft Research Cambridge
- Novel approach to building multi touch surfaces, sensing
- Multiple fingertips
- Whole hands and objects
- Distinct signal and user experience
Embedded multi touch sensing
Capacitive Sensing

[Dietz Leigh’01]

[Rekimoto’02]
Embedded multi touch sensing
Capacitive Sensing
Embedded multi touch sensing
Resistive Sensing
Embedded multi touch sensing
IR Photodiodes

[Hodges et al.'07]
Camera Based Sensing
Diffuse Illumination

[Rekimoto Matsushita’97]

[Wilson’04]
Camera Based Sensing
Frustrated Total Internal Reflection

[Han’05]
Camera Based Sensing
Malleable Surfaces

[Smith et al.’07]

[Sinclair ’97]
Liquid Displacement Sensing

Overview

- Aluminum Frame
- Black Ink
- Silicone Sealant
- Latex Pouch
- Acrylic Pane
- Fluorescent Lamp
- Video Camera

Reflected Light
Absorbed Light
Liquid Displacement Sensing

Material Properties

- Liquid Viscosity
- Liquid Opacity
- Contact Surface Texture
- Surface Elasticity
- Internal Pressure
- Depth
- Surface Tension
- Contact Surface Texture
Material Elasticity

too thick & rigid

appropriate thickness
Material Elasticity

rippling effect
distortion caused by ripples
Surface Tension
Pouch Pressure

• Internal Pressure can reduce rippling effect and motion blur
• Air-gap between ink and surface
• Reduces deformation hysteresis
• Suppresses waves within the liquid
Liquid Viscosity and Tint

• High viscosity fluids (oil, gels)
  • Can reduce rippling and bridging effect
  • Increase Motion blur

• Liquid tint & opacity
  • Black liquid provides high contrast
  • Colored & transparent liquids allow for pressure, depth sensing
Liquid Volume

Raw Sensor Data -
No Image Processing Applied

Pressure Sensitivity:
Different Colors and Opacity of Dyes
Increased Liquid Volume
Conclusion

• New approach for rapid prototyping of multi-touch and object sensing surfaces
• Soft and malleable
• Recognition of shapes and outlines of objects
• Works without IR Illumination
• High signal-to-noise ratio
Future Work

• Camera based system requires space behind the panel
• Works only for horizontal surfaces
• Rear projection not possible currently
• Applications that exploit specifics of the signal
Questions? - Thank You!