

# Thermal Interaction & 3D Data Visualization

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- ▶ What would thermal interaction & 3D data visualization look like?

# Outline

Background

Thermal interaction with mobile devices

Using spatial augmented reality for 3D data visualization

Conclusions

# Outline

Background

Virtual Reality

Augmented Reality

Spatial Augmented Reality

6DOF

Thermal interaction with mobile devices

Using spatial augmented reality for 3D data visualization

Conclusions

# Virtual Reality

- ▶ Completely Virtual
- ▶ Oculus Rift



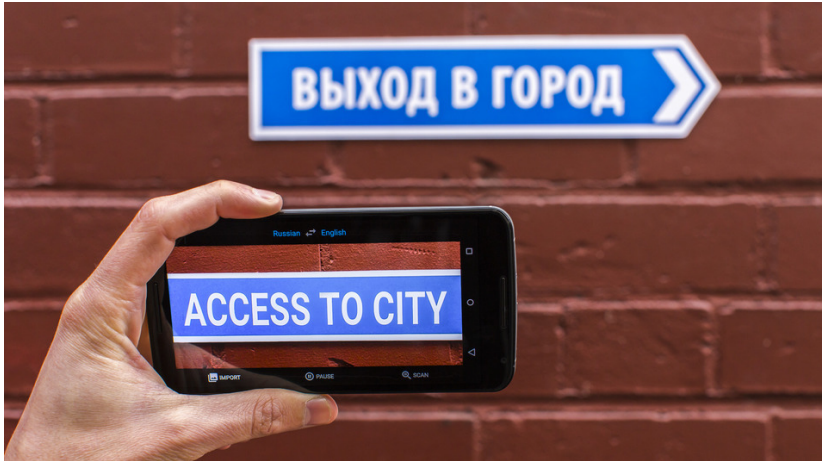
Top -

<http://appleinsider.com/articles/15/05/15/mac-development-for-oculus-rift-vr-headset-paused-ahead-of-early-2016-windows-launch>

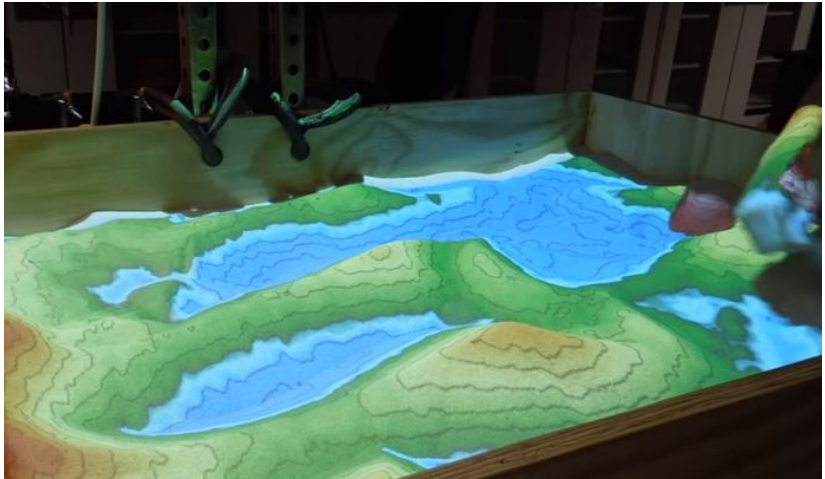
Bottom -

<http://www.theriftarcade.com/outerra-preview-fly-planes-drive-buses-and-steer-boats/>

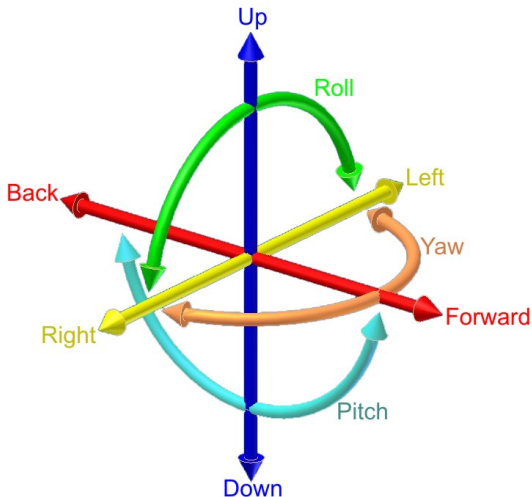
# Augmented Reality



# Spatial Augmented Reality



# 6DOF



[Wikipedia(2015)]



# Outline

## Background

### Thermal interaction with mobile devices

- Interacting with Objects

- Hardware

- Thermal Detection

- Object Tracking

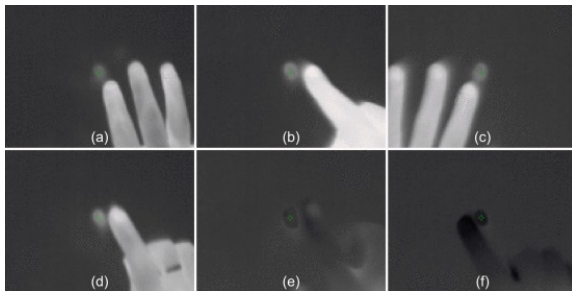
- Materials Tested

- Applications

Using spatial augmented reality for 3D data visualization

Conclusions

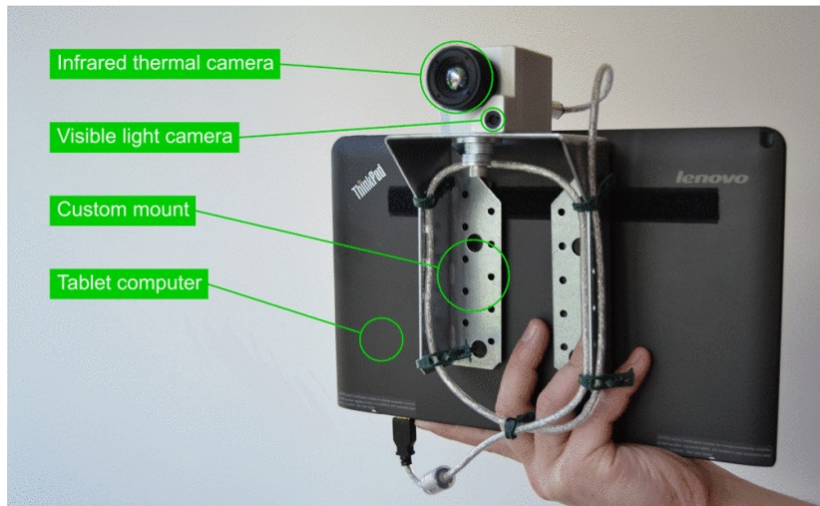
# Interactions with Objects



[Kurz(2014)]

- ▶ Interactions leave thermal impressions on the object
- ▶ Using these impressions to interact with a device in a new way

# Hardware



[Kurz(2014)]

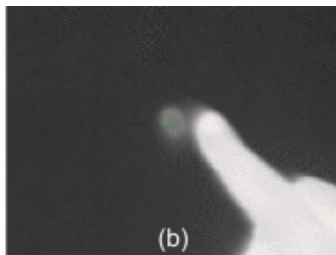
# Thermal Detection

- ▶ Assumes a controlled environment
- ▶ Object-only, hand-only, obstruction-by-hand, and touch-by-hand
- ▶ Using the OpenCV SimpleBlobDetector

# OpenCV SimpleBlobDetector

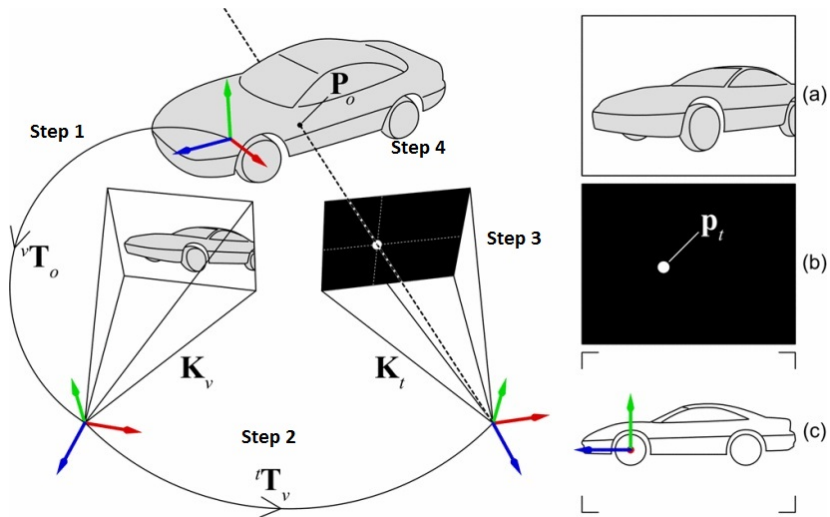
$$t_1 = (1 - \frac{1}{16})t_{min} + \frac{1}{16}t_{max} \quad t_2 = (1 - \frac{3}{8})t_{min} + \frac{3}{8}t_{max}$$

- ▶  $t_1$  and  $t_2$  is the expected temperature range of the interaction
- ▶ With a fixed size range of  $0.32cm^2$  and  $1.54cm^2$

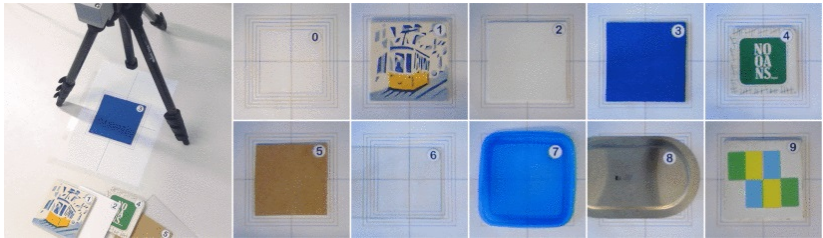


[Kurz(2014)]

# Object Tracking



# Materials Tested



Different materials used during the evaluation: (0) paper on a plastic table-top, (1) ceramic, (2) rigid PVC, (3) foam plastic, (4) cardboard, (5) laminated fiber sheet, (6) glass, (7) thin plastic, (8) steel, (9) multi-layer board

[Kurz(2014)]

# Applications

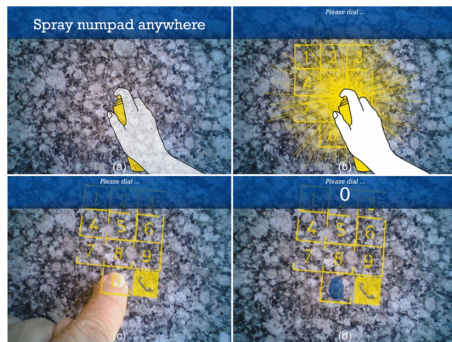
Some applications that use thermal imaging with mobile technology

- ▶ "Spray on" graphical user interfaces (GUI)
- ▶ Augmented floor plans



# "Spray on" GUIs

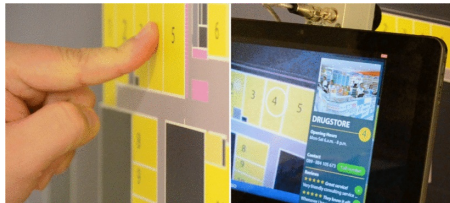
- ▶ The screen displays a dial pad, but there is no dial pad on the surface
- ▶ Looking at the screen to interact with dial pad
- ▶ Devices without touch screens



[Thomas(2014)]

# Augmented Floor Plans

- ▶ Similar interaction, different interface
- ▶ Using the areas on the map as buttons



[Thomas(2014)]

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Visualizing Data

Applications

Limitations

Conclusions

# Visualizing Data

- ▶ Representing data with images
- ▶ Examples: weather maps, pie and bar charts, etc
- ▶ The importance of visualizing data

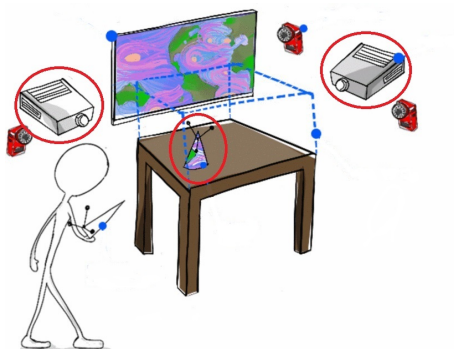
# Applications

Some applications that use spatial augmented reality for 3D data visualization

- ▶ Table-Top
- ▶ CAVE

## Table-Top

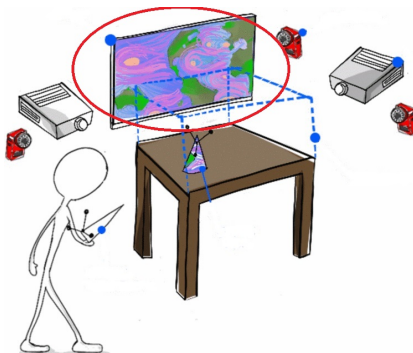
- ▶ Physical object represents the 3D space
- ▶ The display is a 2D representation of the 3D space
- ▶ 6DOF trackers



[Thomas(2014)]

## Table-Top

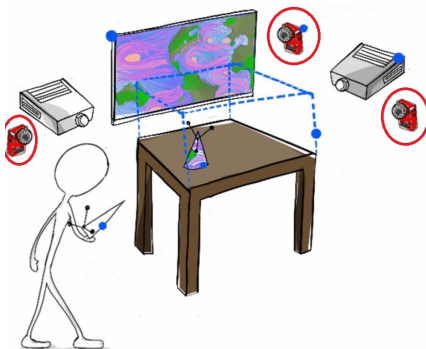
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[Thomas(2014)]

## Table-Top

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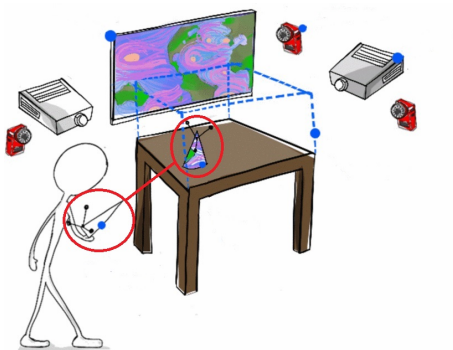


[Thomas(2014)]



## Table-Top

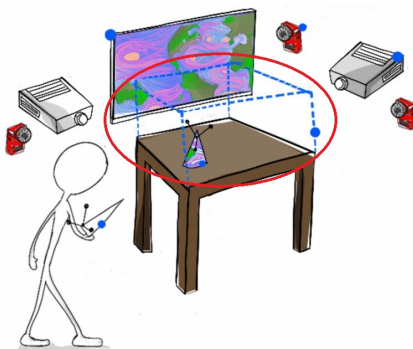
- ▶ Using a hand held pointing device a user can zoom in or out of the visualization
- ▶ Interactions happen inside the virtual volume



[Thomas(2014)]

## Table-Top

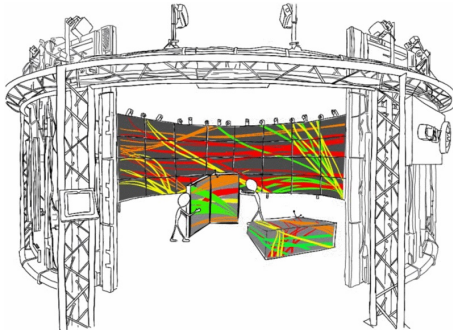
- ▶ Using a hand held pointing device a user can zoom in or out of the visualization
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[Thomas(2014)]

# CAVE

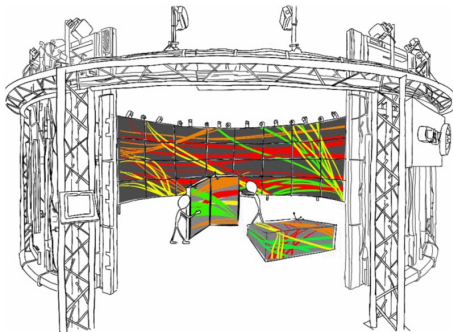
- ▶ CAVE - Cave Automatic Virtual Environment
- ▶ Larger area than the table-top method



[Thomas(2014)]

# CAVE

- ▶ Similar interactions as the table-top method
- ▶ Increase in collaborators/viewers



[Thomas(2014)]

# Limitations

- ▶ Strength of the projectors
- ▶ Need for a controlled environment for projectors and 6DOF trackers
- ▶ Solution

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# Conclusions

- ▶ Utilizing both thermal interaction and 3D data visualization new applications are possible
- ▶ Examples: education and transportation

# Bibliography I



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[https://en.wikipedia.org/w/index.php?title=Six\\_degrees\\_of\\_freedom&oldid=683426652,](https://en.wikipedia.org/w/index.php?title=Six_degrees_of_freedom&oldid=683426652)  
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# Thanks!

Thank you for your time and attention!

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## Any Questions?