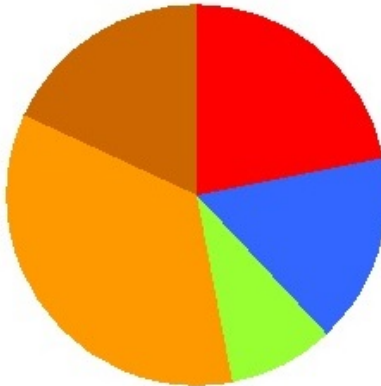# Thermal Interaction & 3D Data Visualization
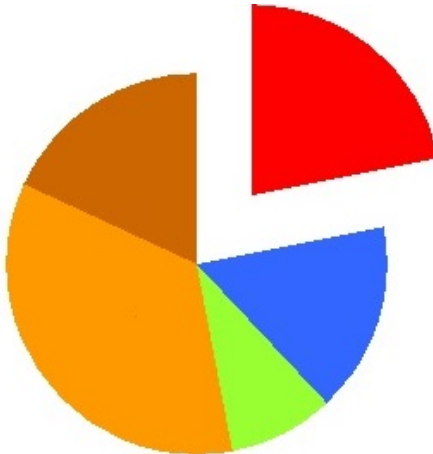
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Morris, Minnesota, USA

5 December 2015

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

https://goo.gl/yZr4BR

https://goo.gl/HXtvA3

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
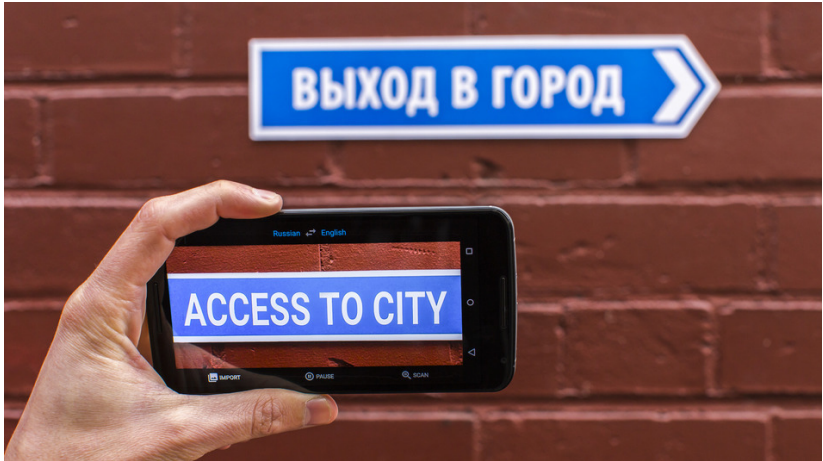
Conclusions

Virtual Reality

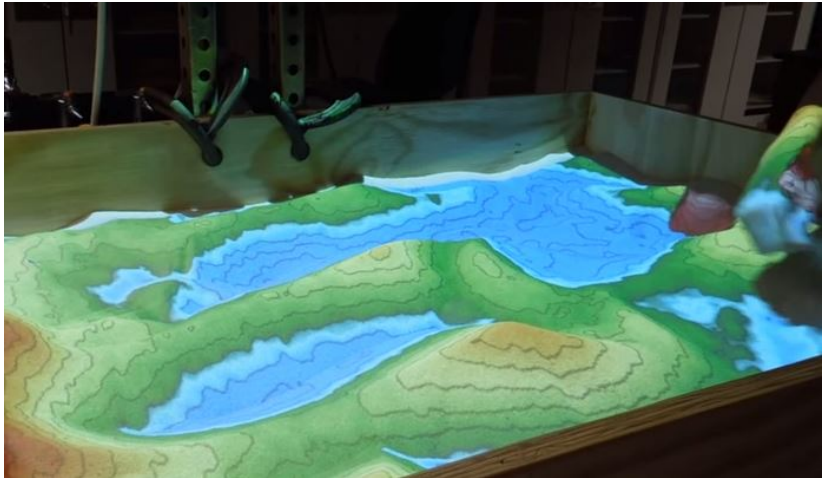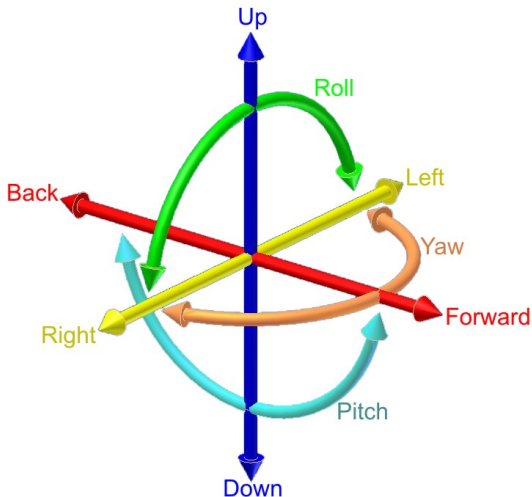- ▶ Completely Virtual
- ▶ Oculus Rift

Top - http://goo.gl/nfUBv0
Bottom - http://goo.gl/t78Qvr

Augmented Reality

http://www.emergingedtech.com/2015/08/translate-language-text-on-the-fly-using-phone-google-translate-app/

Spatial Augmented Reality

http://peanutchuck.com/augmented-reality-sandbox/

6DOF

[Wikipedia(2015)]

Outline

Interactions with Objects
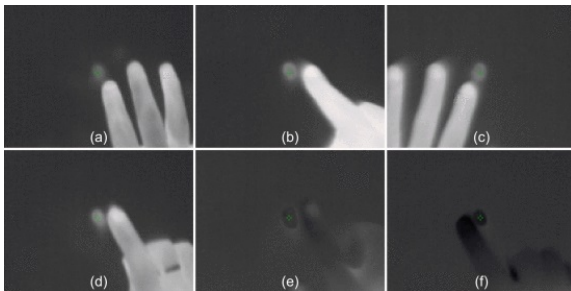
[Kurz(2014)]

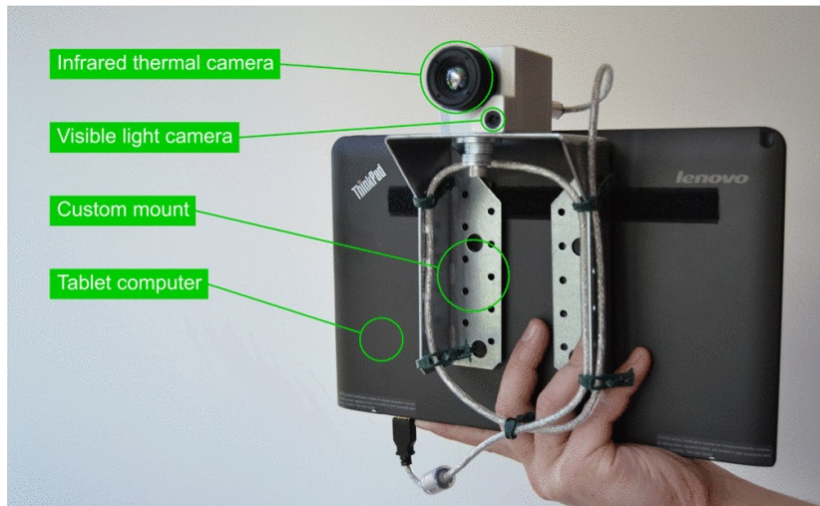- ▶ Interactions leave thermal impressions on the object
- ▶ Using these impressions to interact with a device in a new way
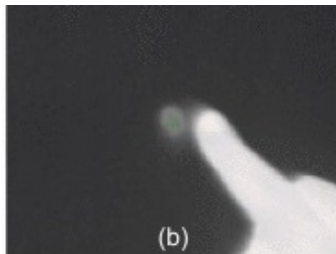
Hardware

[Kurz(2014)]

Thermal Detection

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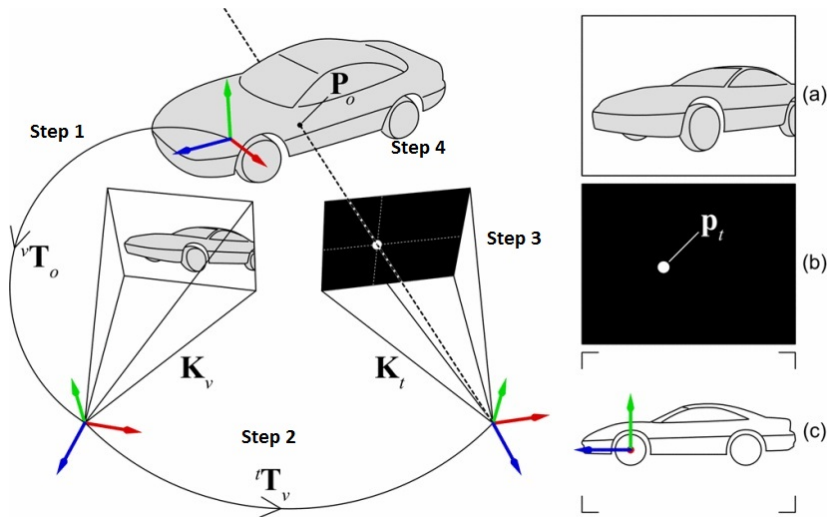
OpenCV SimpleBlobDetector

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

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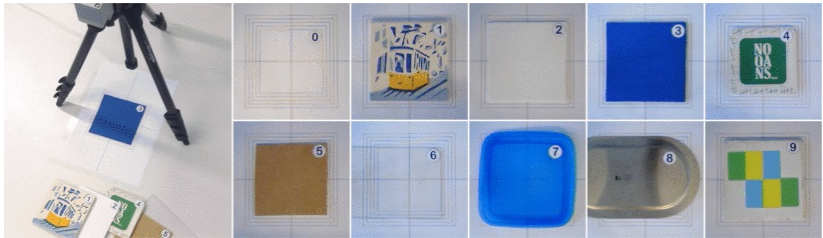- With a fixed size range of $0.32cm^2$ and $1.54cm^2$

(b)

[Kurz(2014)]

Object Tracking

[Kurz(2014)]

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
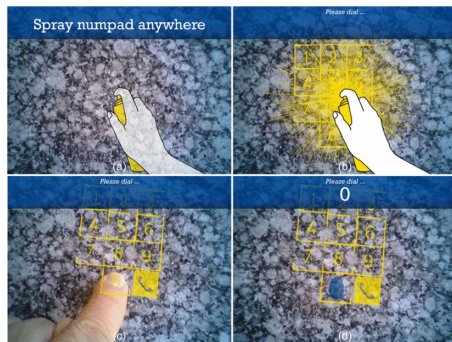
[Kurz(2014)]

Applications

Some applications that use thermal imaging with mobile technology

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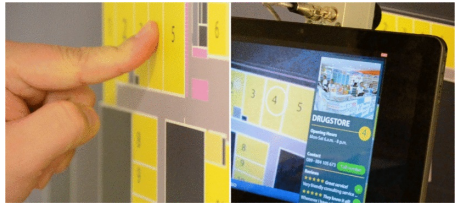- ▶ Augmented floor plans

"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)]

Outline

Visualizing Data

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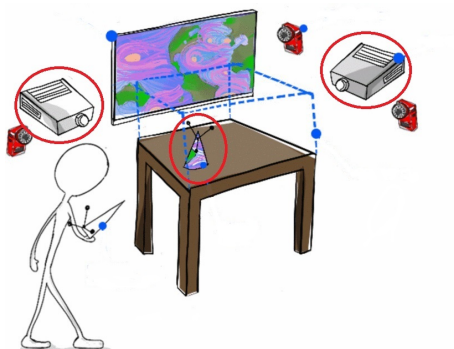- ▶ The importance of visualizing data

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

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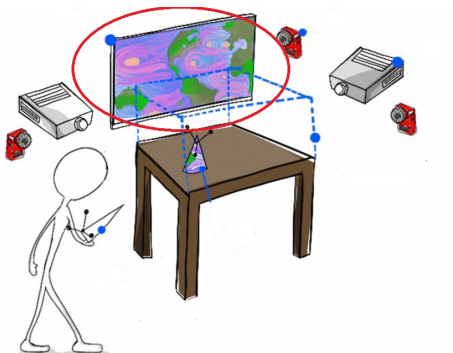

[Thomas(2014)]

Table-Top

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

[Thomas(2014)]

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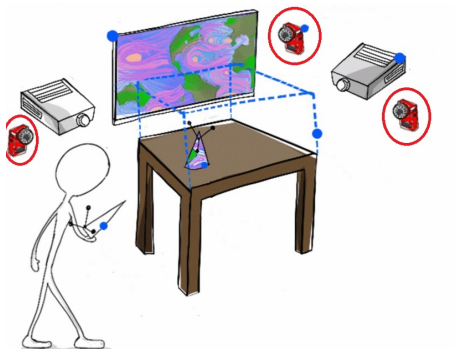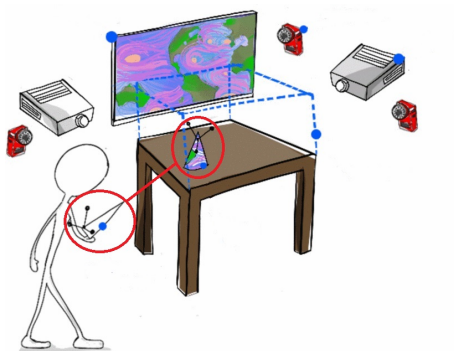
- ▶ Using a hand held pointing device a user can zoom in or out of the visualization
- ▶ Interactions happen inside the virtual volume

[Thomas(2014)]

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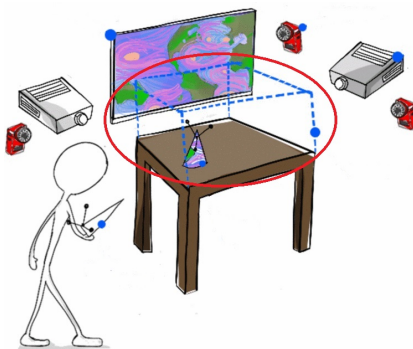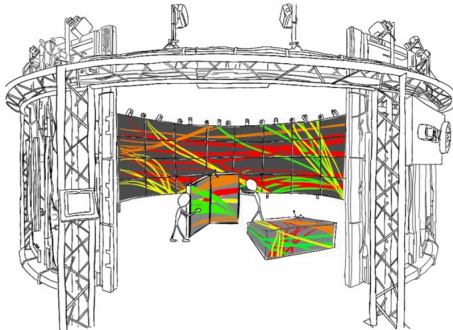
- ▶ Using a hand held pointing device a user can zoom in or out of the visualization
- ▶ Interactions happen inside the virtual volume
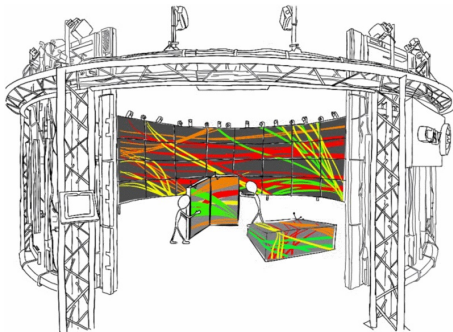

[Thomas(2014)]

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

Outline

Background

Thermal interaction with mobile devices

Using spatial augmented reality for 3D data visualization

Conclusions

Conclusions

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

Bibliography I

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`[Online;accessed1-November-2015].`

Thanks!

Thank you for your time and attention!

Contact:

- `yadea003@morris.umn.edu`

Any Questions?