Thermal Interaction in Spatial Augmented Reality

Justin Brennen YaDeau

Division of Science and Mathematics
University of Minnesota, Morris
Morris, Minnesota, USA

5 December 2015

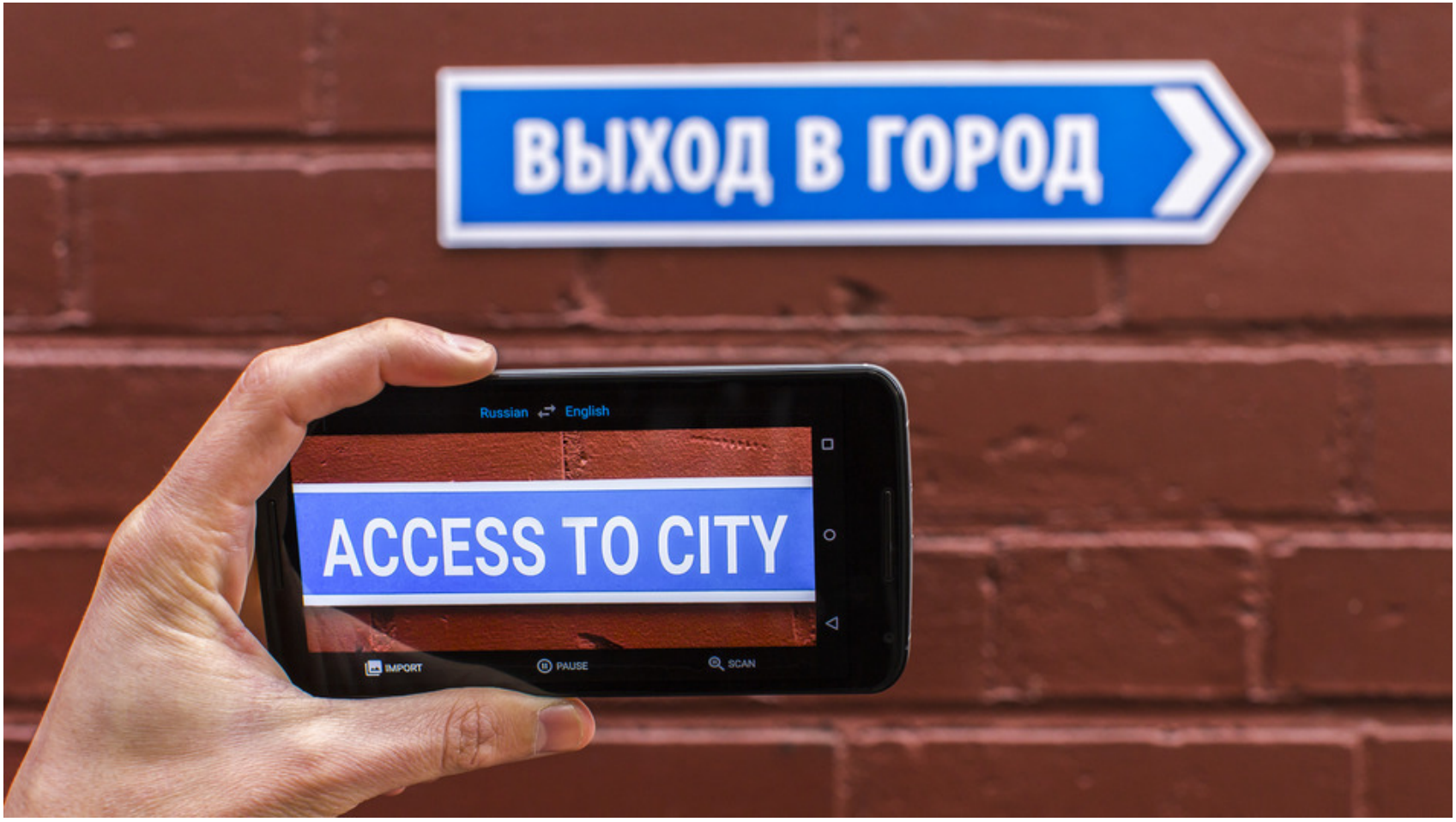
Background

- Virtual Reality
- Augmented Reality
- Spatial Augmented Reality
- 6DOF

Virtual Reality

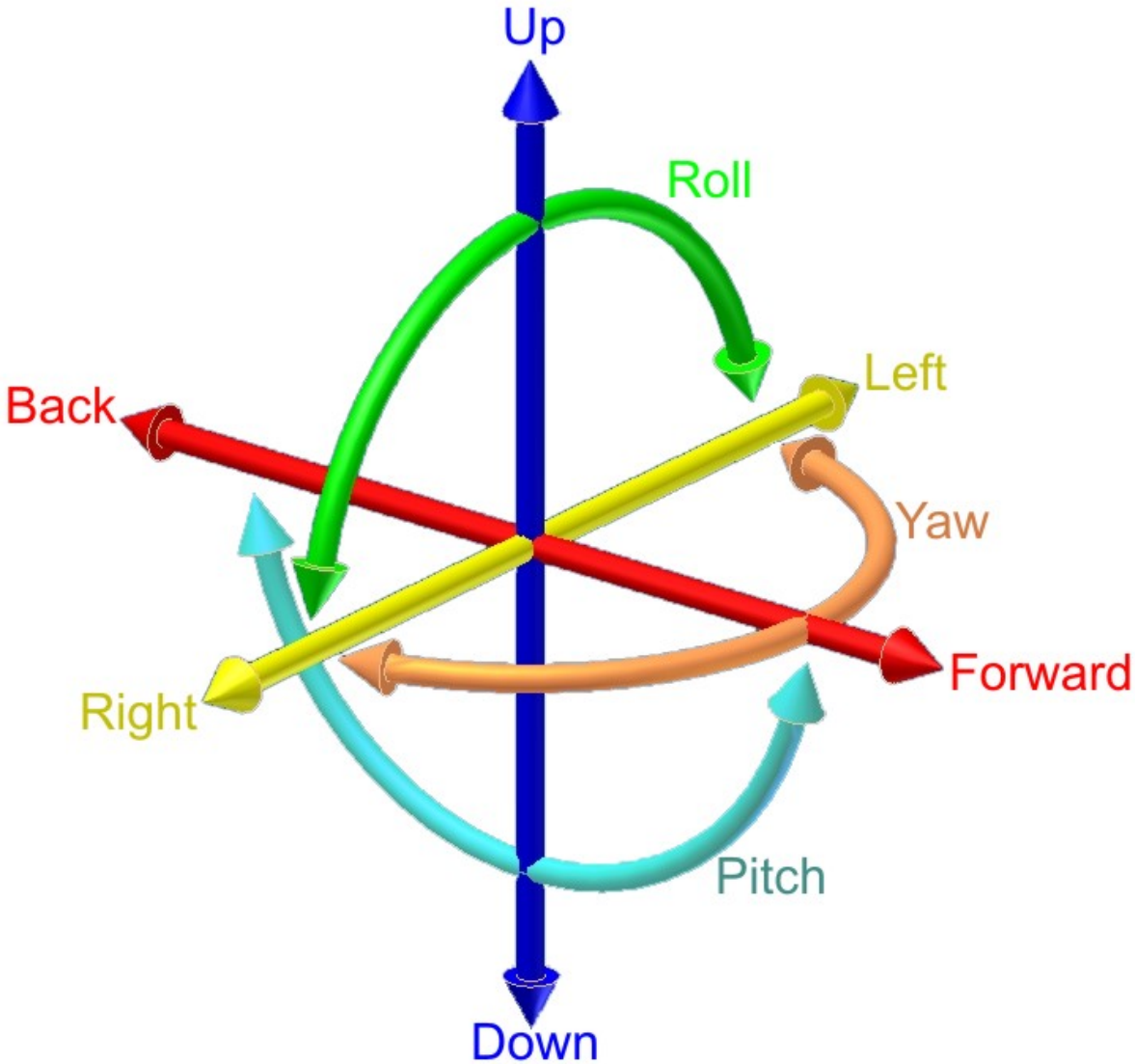
- Completely Virtual
- The Matrix
- Oculus Rift

Augmented Reality



Spatial Augmented Reality

6DOF



Outline

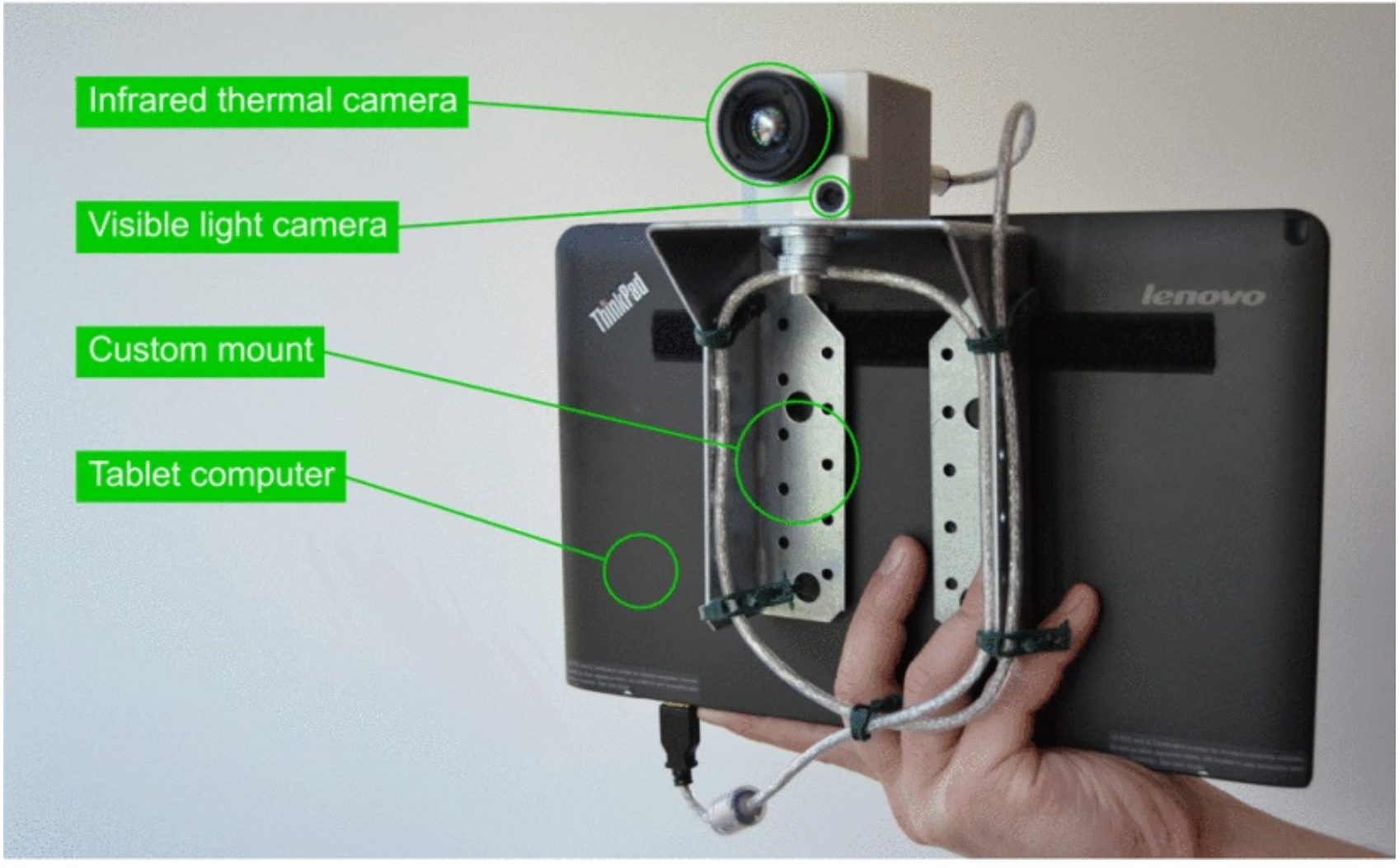
Thermal interaction with mobile devices

Using spatial augmented reality for 3D data visualization

Conclusions

Outline

Hardware


Infrared thermal camera
Visible light camera
Custom mount
Tablet computer
ThinkPad
lenovo

Thermal Detection

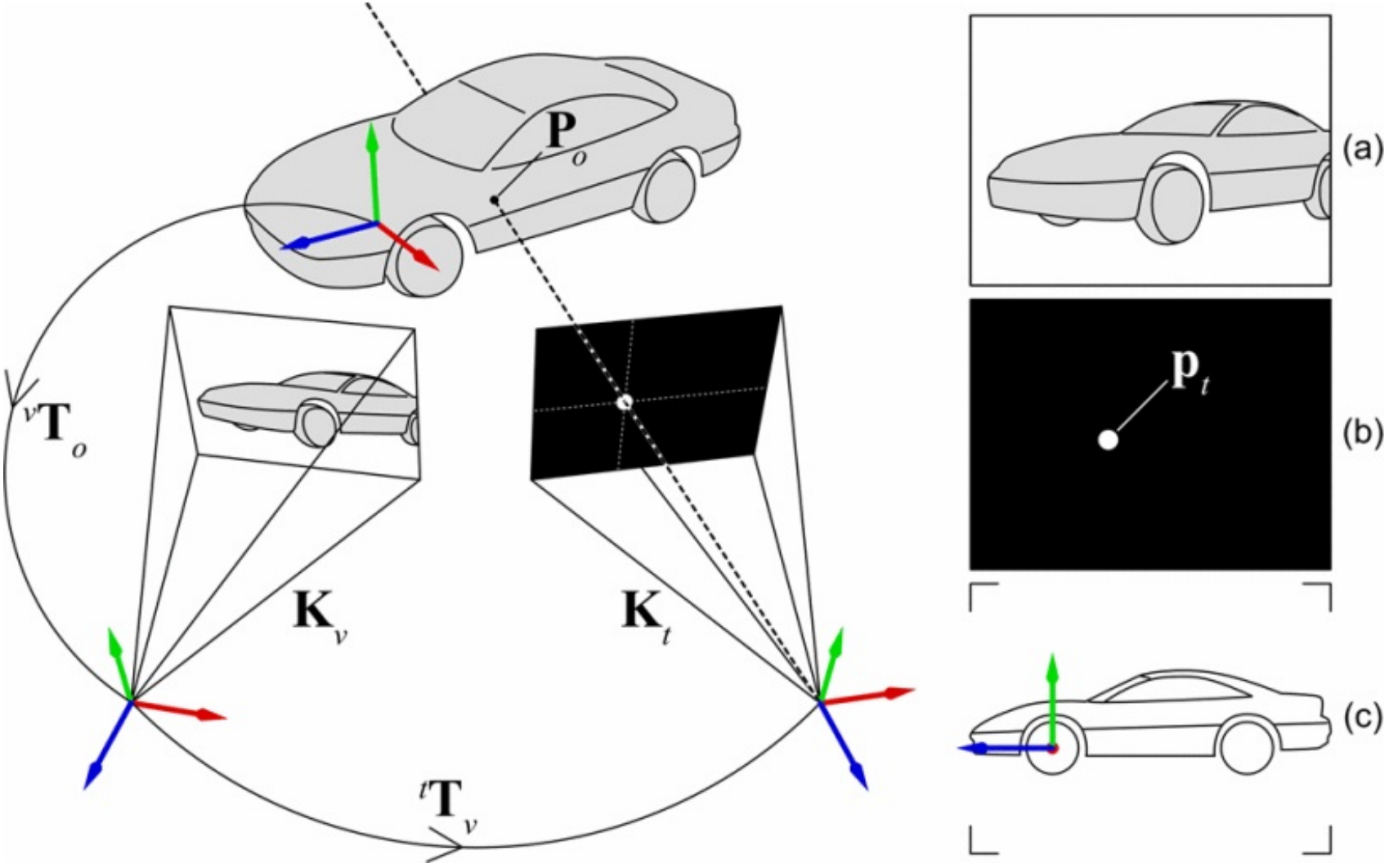
- Assumes a controlled environment
- Object-only, hand-only, obstruction-by-hand, and touch-by-hand
- Interactions leave thermal impressions on the object
- Using the OpenCV SimpleBlobDetector

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 $1.54cm^2$

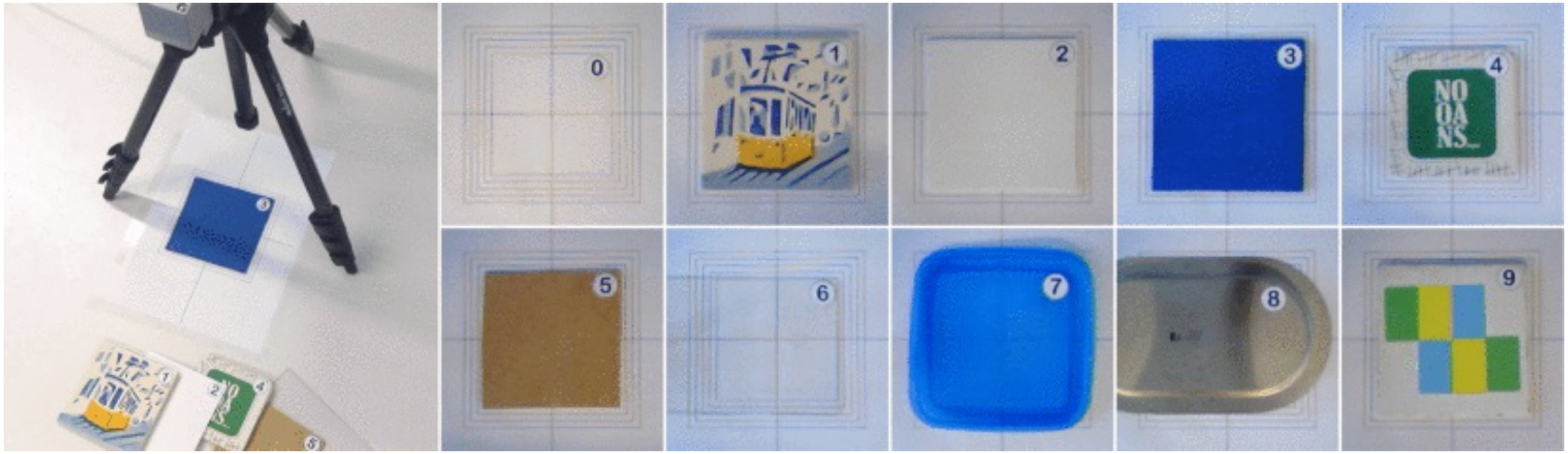
Object Tracking



Object Tracking

- Metaio software
- Spatial rigid transformations to obtain locations relative to the cameras

Materials Tested



(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

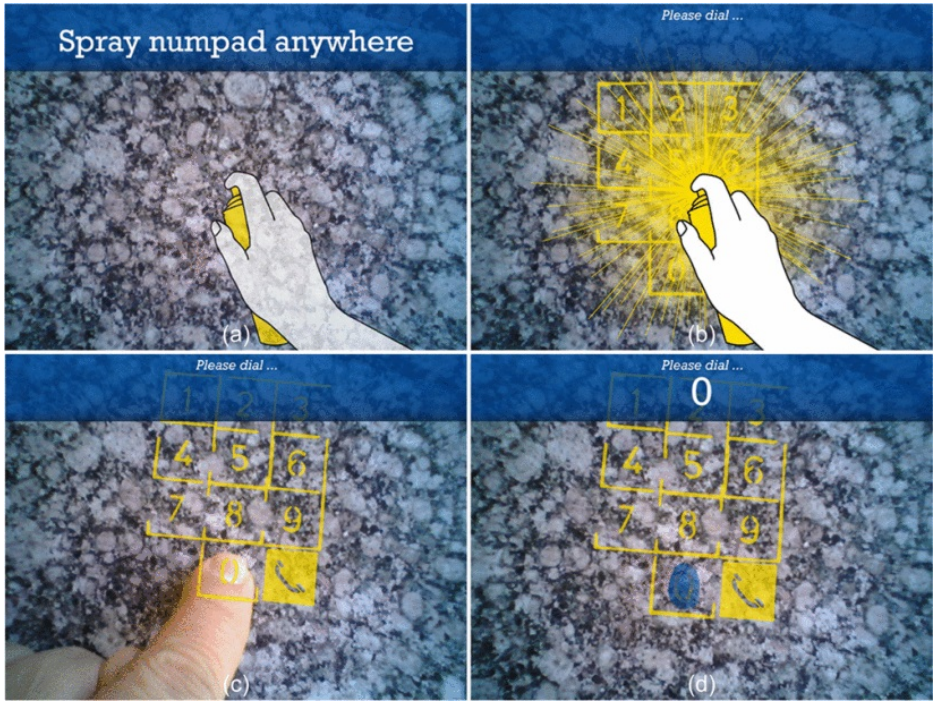
Applications

Applications that use thermal imaging with mobile technology

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

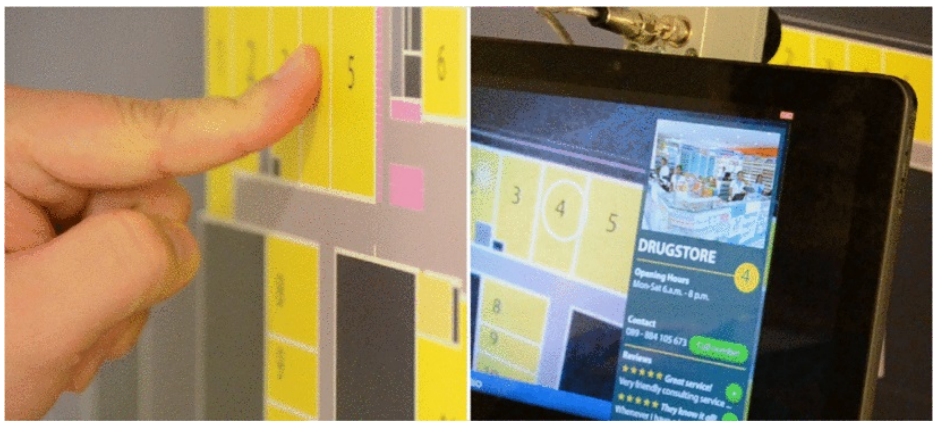
"Spray on" GUIs

- 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



Augmented Floor Plans

- Similar interaction, different interface
- Using number sections as buttons



Outline

Data Visualization

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

Applications

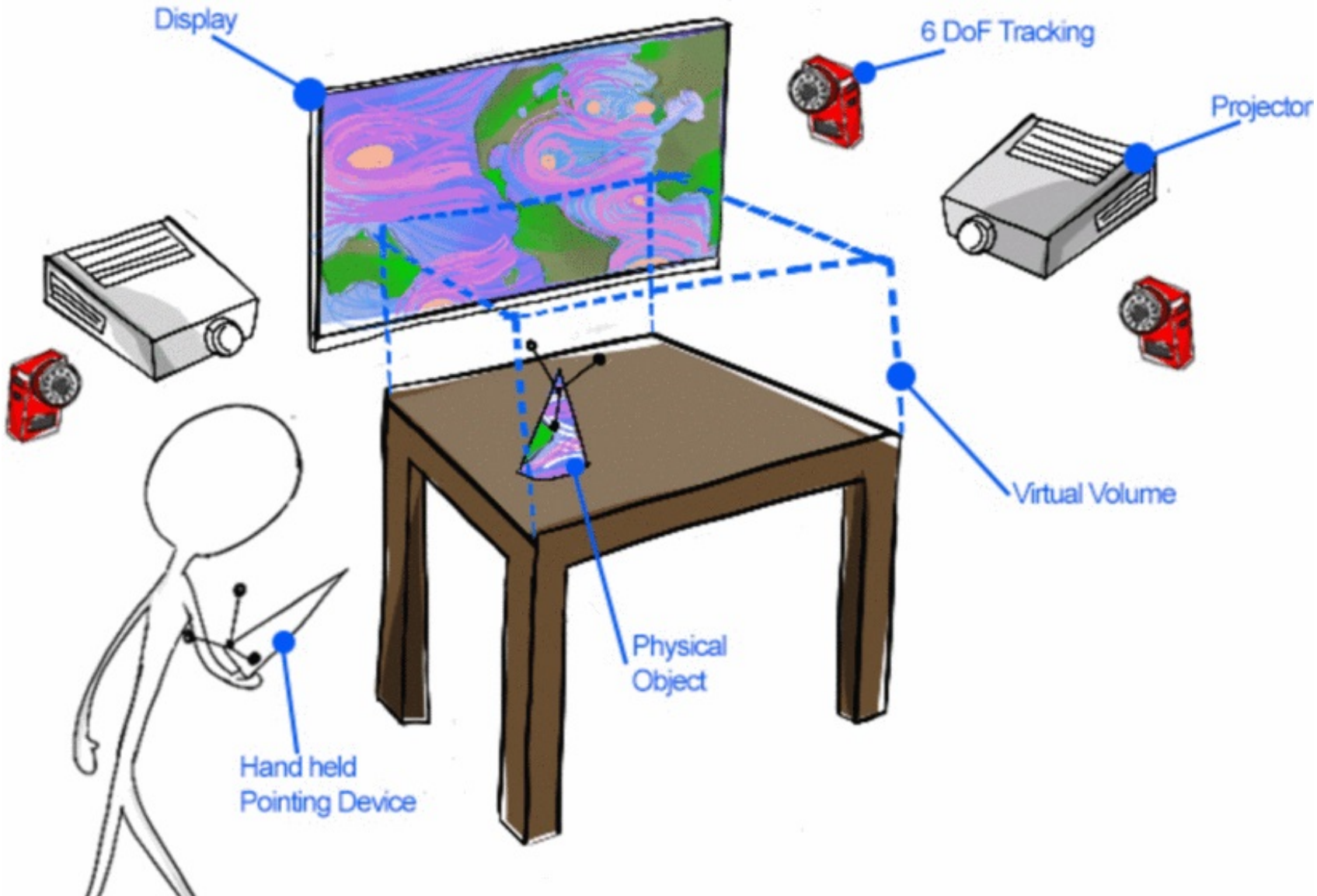
Applications that use spatial augmented reality for 3D data visualization

- Table-Top
- CAVE

Table-Top

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

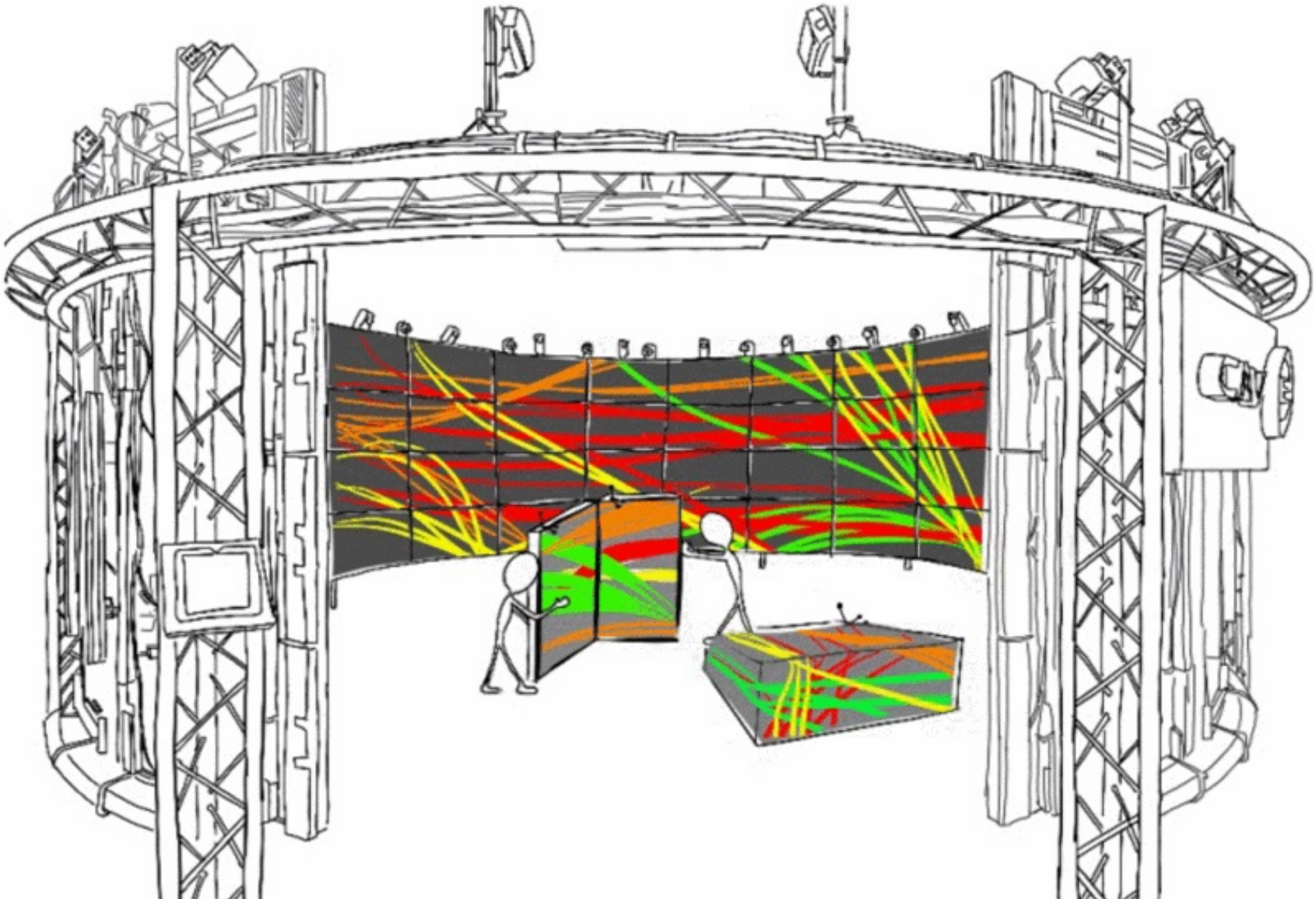
Table-Top


Display
6 DoF Tracking
Projector
Virtual Volume
Physical
Object
Hand held
Pointing Device

CAVE

- Larger area than the table-top method
- Increase in collaborators/viewers
- Similar interactions as the table-top method

CAVE



Limitations

- Strength of the projectors
- Needing a controlled environment
- Solutions

Outline

Conclusions

Bringing the two approaches together will:

- Benefit transportation and education
- added redundancy when using both projectors and displays

Thanks!

Thank you for your time and attention!

Contact:

- yadea003@morris.umn.edu

Any Questions?