OCCUPANT-AWARE, COGNITIVE ILLUMINATED ENVIRONMENTS

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Where I'm from

+ NYSERDA, 24 industrial partners

LESA – Making Lighting More Useful

- Thought Leadership in advanced lighting system **applications**

- Deep understanding in a wide range of core and applied lighting technologies

- Eager to work collaboratively with industry to open new markets

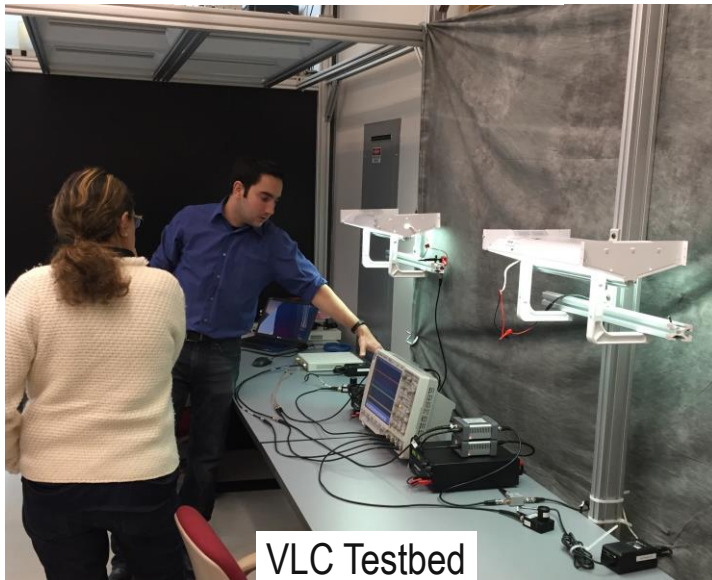- Leverage Federal and State funding to accelerate progress

Communications

Cognition

Healthcare

Efficient Buildings

Plant Science
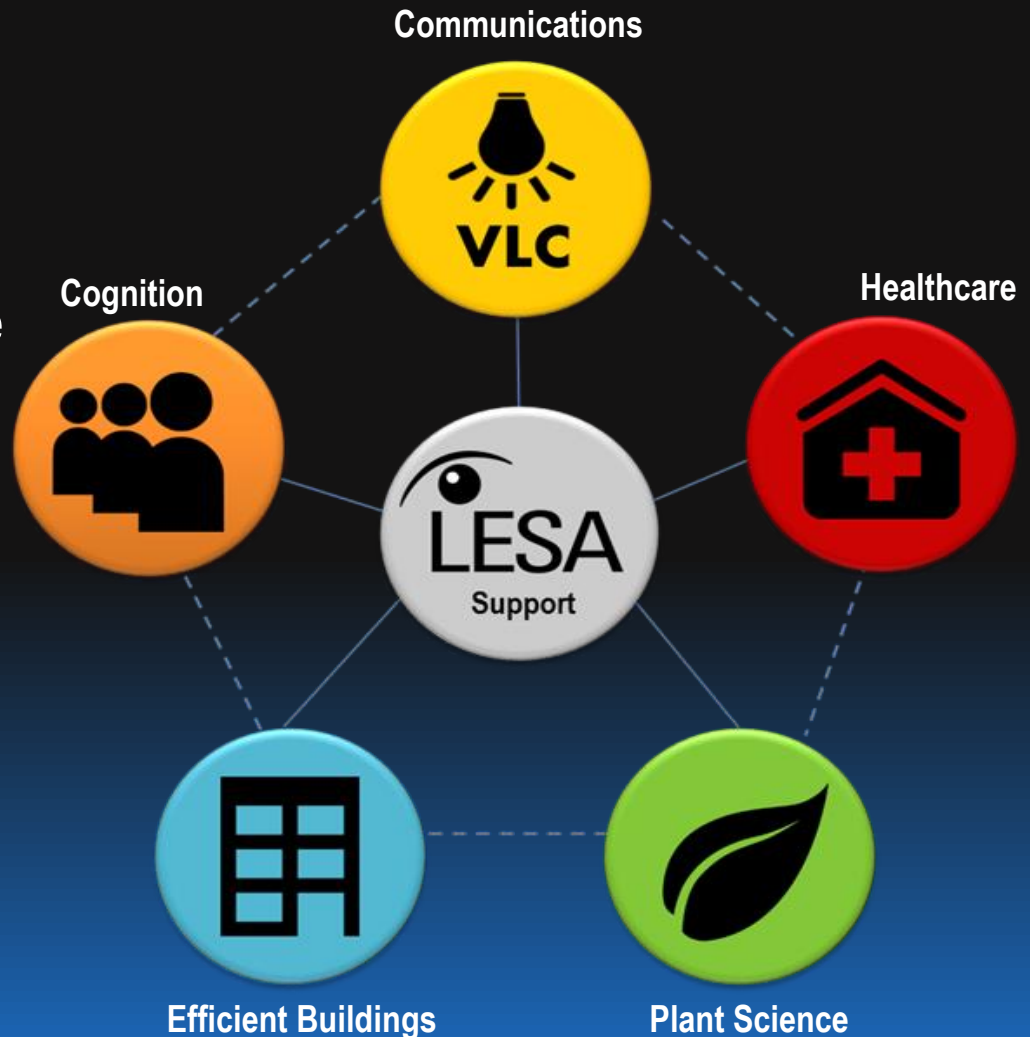
LESA systems-level testbeds
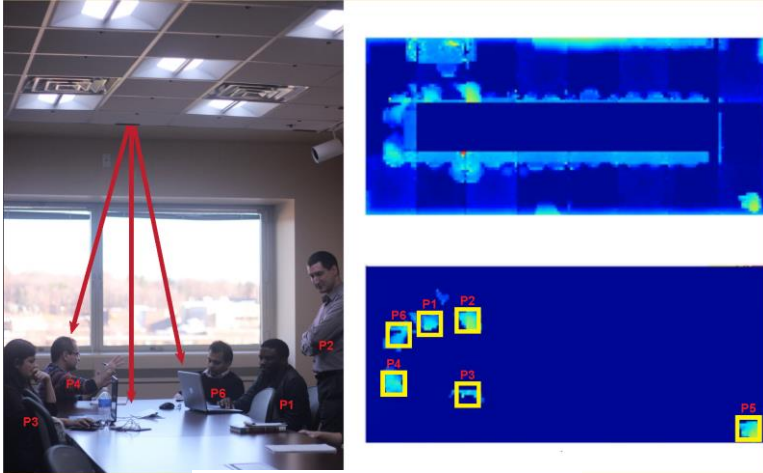
Smart Conference Room

Hospital Room Testbed

VLC Testbed

Plant Research Laboratory

The Smart Conference Room

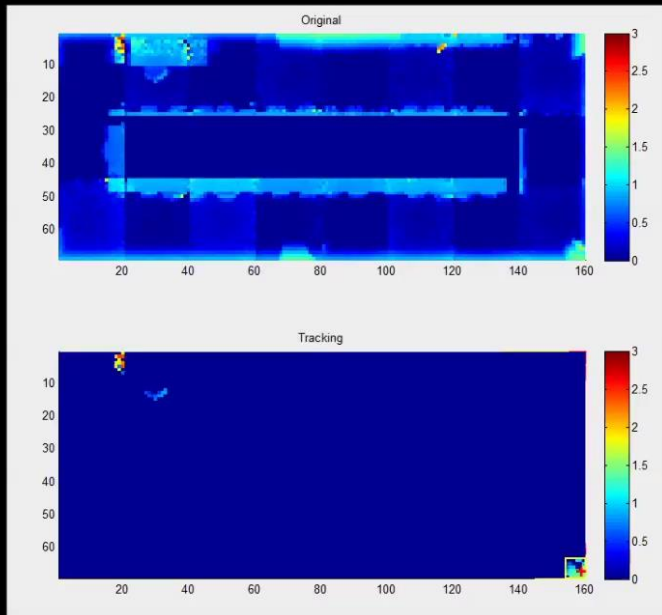Center for Lighting Enabled Systems & Applications

The Smart Conference Room

Afshari, Woodstock, Imam, Mishra, Sanderson, Radke, *Buildsys 2015*

Occupancy tracking using time-of-flight sensors

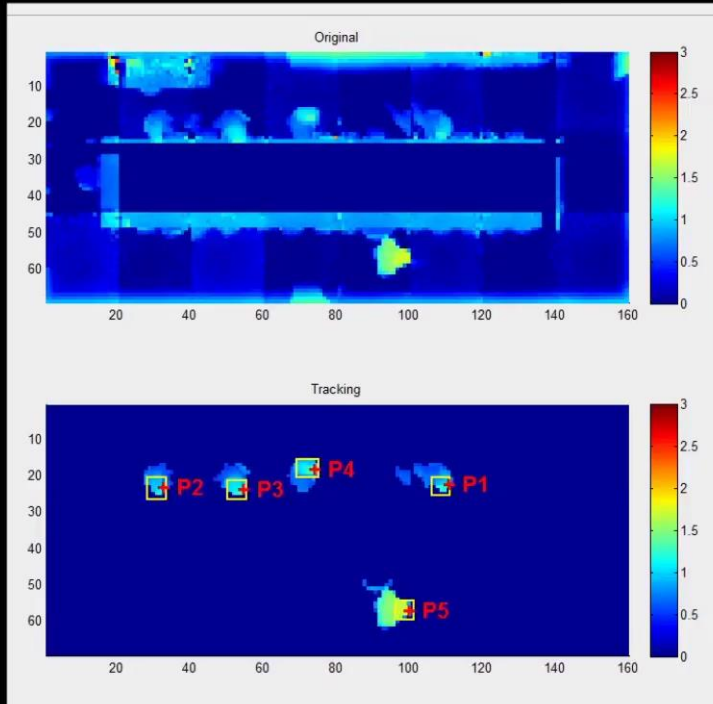Center for Lighting Enabled Systems & Applications

Occupant-aware lighting using ToF tracking
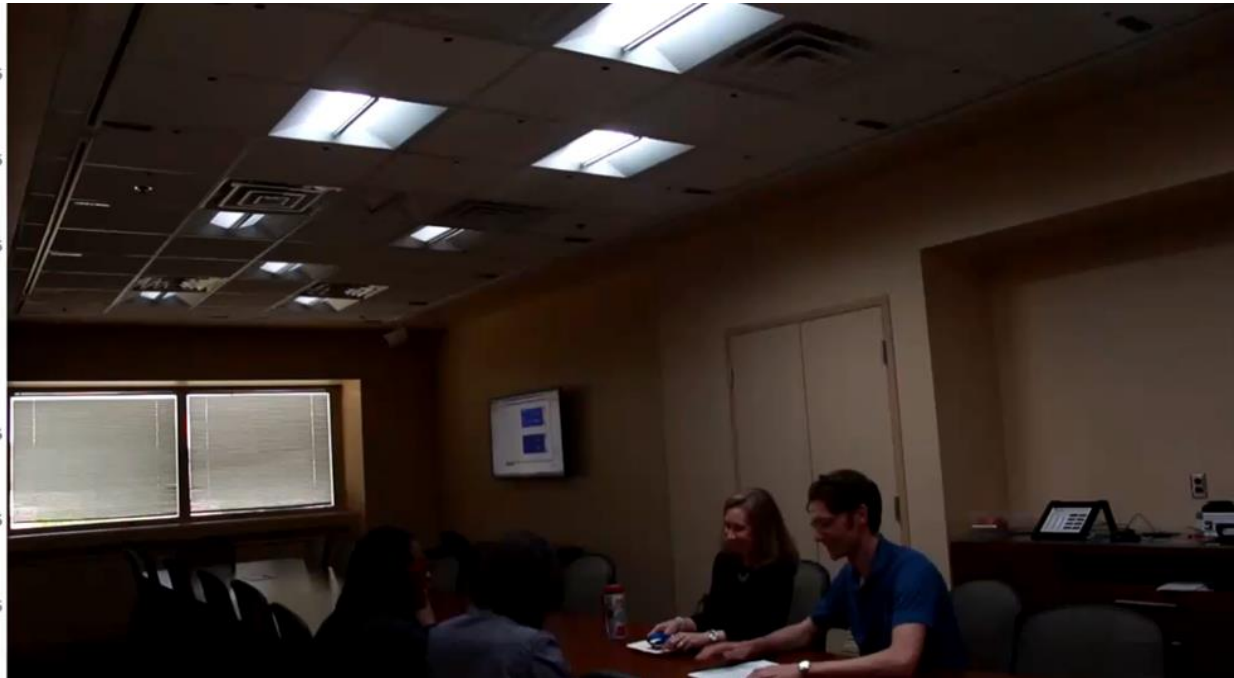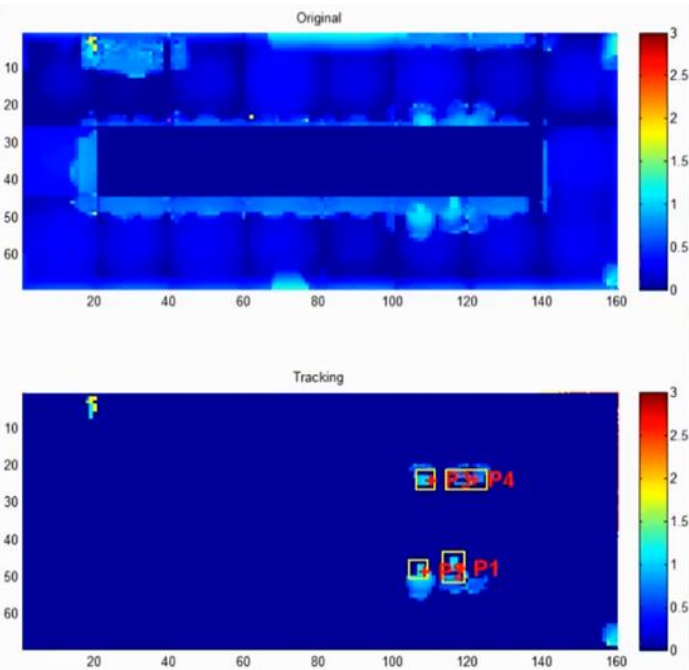
Woodstock, Radke, Sanderson, *FUSION 2016*

Presentation mode

Vision: Meeting Facilitation and Summarization

spatio-acoustic person tracking
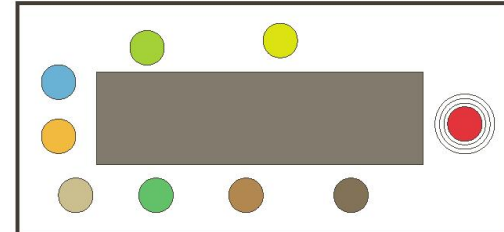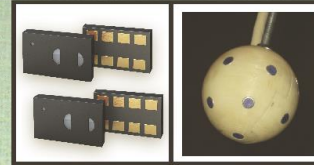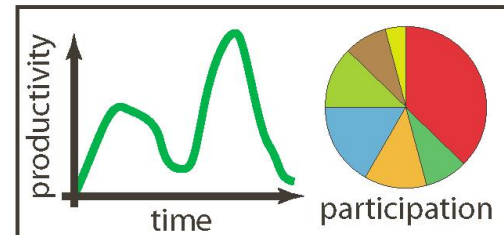
"**Indrani**, do you have the results of **that test** yet?"

"No, I'll have it ready for **next time**."

natural language understanding

meeting analysis and facilitation

Active meeting facilitation

Smart room as active meeting participant

Active decision support

Type of Sensor	Detects	Spatially pinpoints people	Distinguishes many people	Economically feasible	Suited for sensitive environments
Passive Infrared	Changes in body temp.	No	No	Yes	Yes
Video Cameras	Image	Yes	Yes	Yes	No
Ultrasound	Motion	No	No	Yes	No
High resolution ToF	Depth map	Yes	Yes	No	No
Low resolution ToF	Sparse depth map	Yes	Yes	Yes	Yes
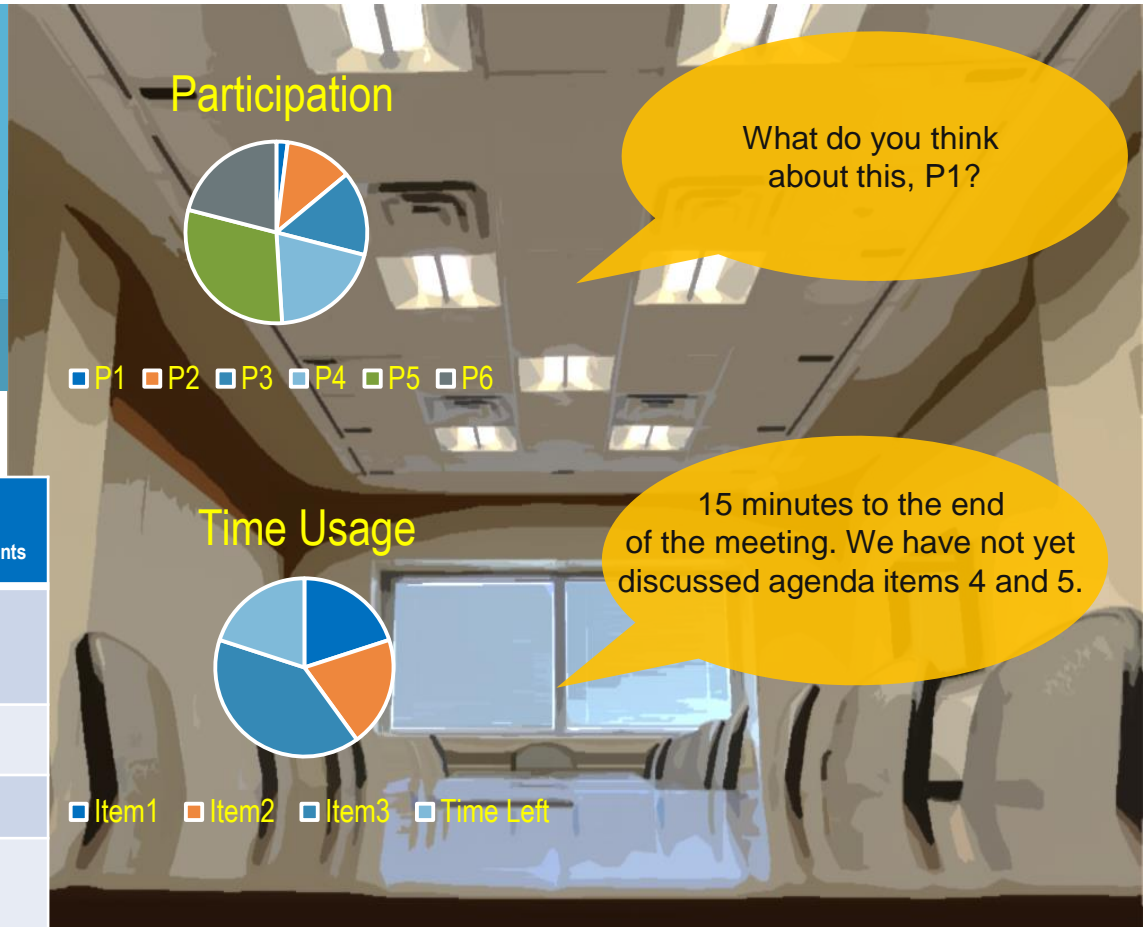
Framework

Integrated Smart Service System

Smart Conference Room Testbed

CRAIVE-Lab Testbed

Computing, Sensing, and Information Technology

Time-of-Flight Tracking

Acoustical Beamforming

Meeting Understanding

Speech to Text

Knowledge Extraction

Rensselaer and IBM
ORGANIZATION
researchers are building
PERSON
two new smart service
CARDINAL
testbeds in August 2016.
DATE

Meeting Facilitation
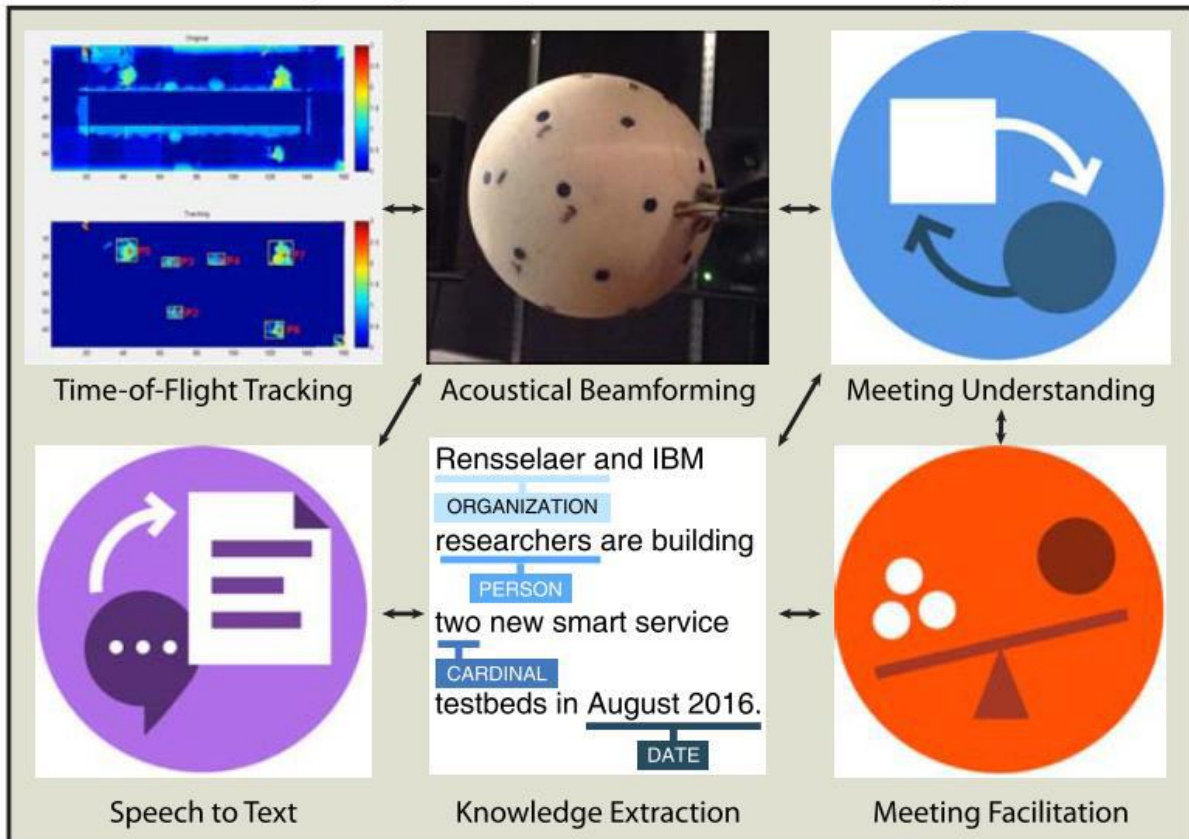
Collaborations with audio processing, natural language understanding, and social science experts from RPI and Northeastern; supported by NSF
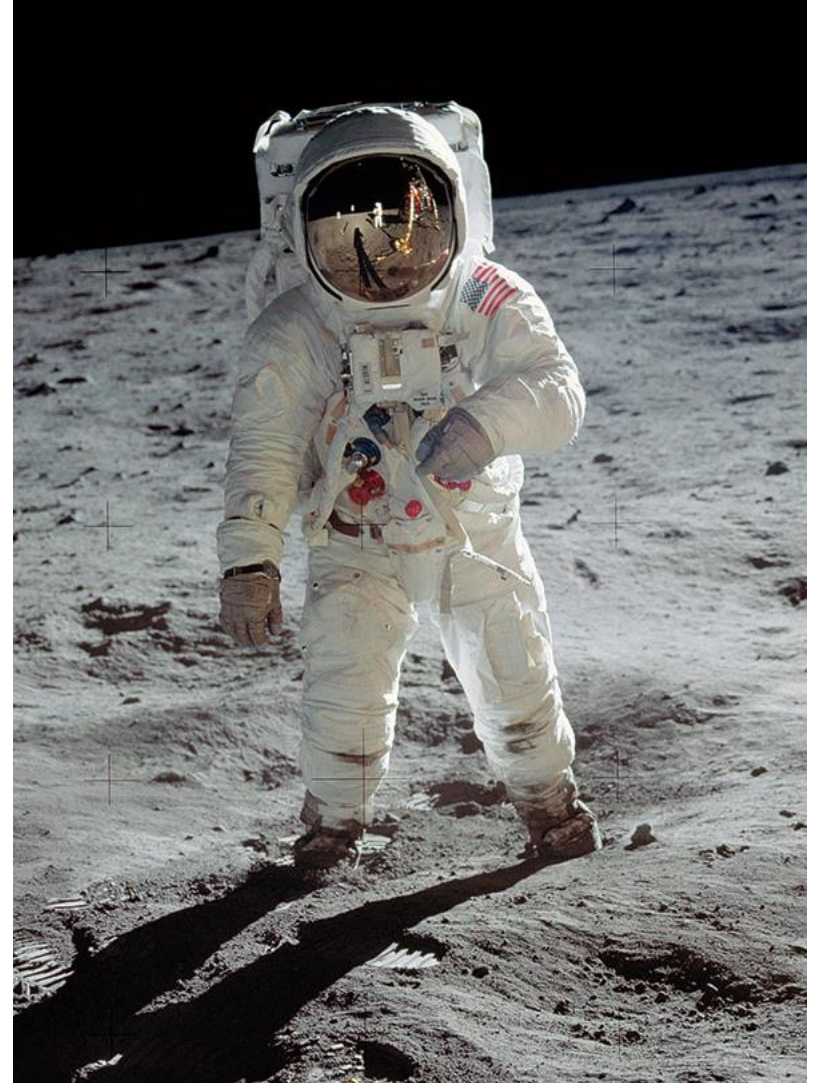
The Lunar Survival Task

| Items	Step 1 (Individual Ranking)	Step 2 (Group Ranking)
Box of matches		
Food concentrate		
50 feet of nylon rope		
Parachute silk		
Portable heating unit		
Two .45 caliber pistols		
One case of dehydrated milk		
Two 100-pound tanks of oxygen		
Stellar map (of the moon's constellation)		
Life raft		
Magnetic compass		
5 gallons of water		
Signal flares		
First aid kit containing injection needles		
Solar-powered FM receiver transmitter		

The post-task questionnaire

- How well did you know each of your group members before today?

- To what extent did the following group members contribute to the discussion?

- To what extend did the following group members act as a group leader?

- Was the discussion engaging/boring, comfortable/awkward, etc.?

- Age/gender

Experimental setup

Time-of-Flight sensors

Lapel microphones
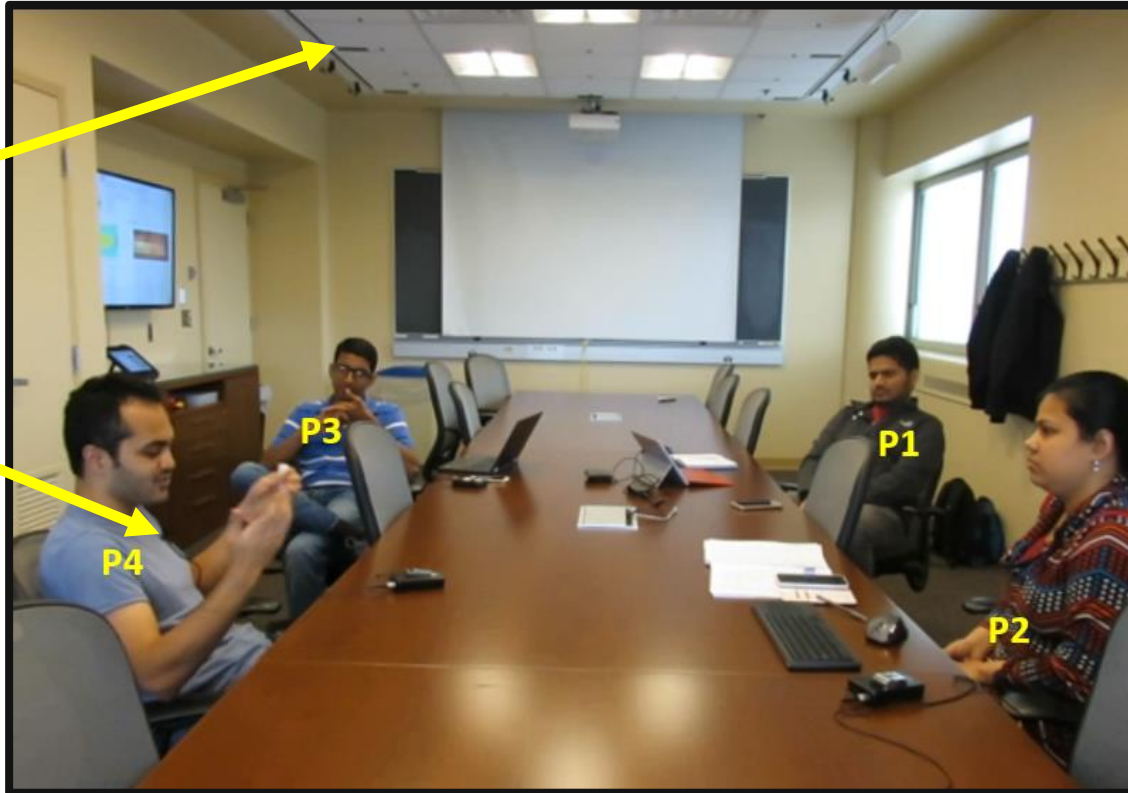
Dataset : 22 lunar survival tasks, with group size varying from 3 to 5
Collected in SCR in October 2017

Multi-modal analysis of group meetings

Spatial understanding:
- Location
- Pose
- Body orientation
- Head pose
- Body posture
- Gestures

Non-verbal audio analysis:
- Speaker segmentation
- Interruptions
- Speaking overlap
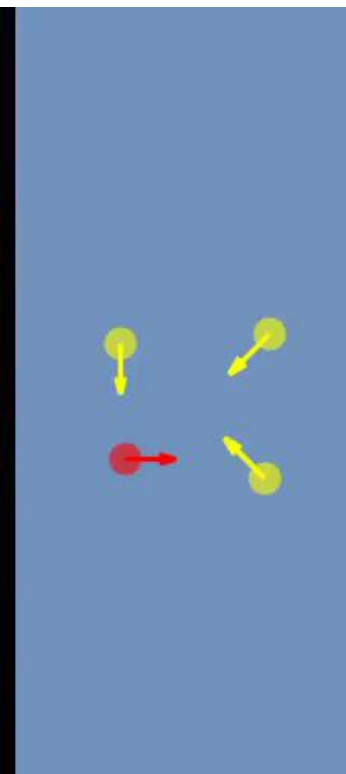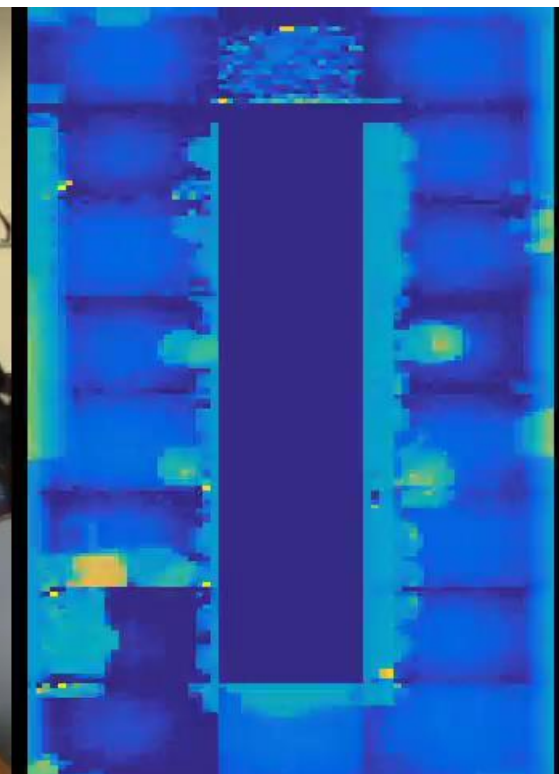- Tone, prosody, laughter

Speech analysis:
- Generate automated summaries
- What items are being talked about and how much?
- What are the different phases in the meeting?

Body orientation from sparse ToF data

Body orientation from sparse ToF data

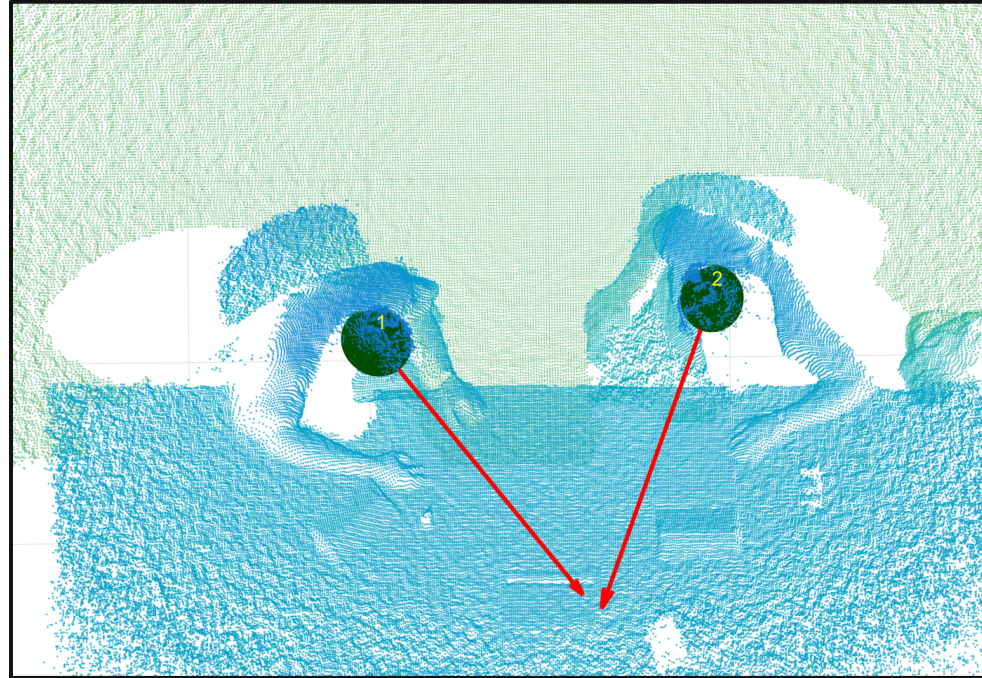Center for Lighting Enabled Systems & Applications
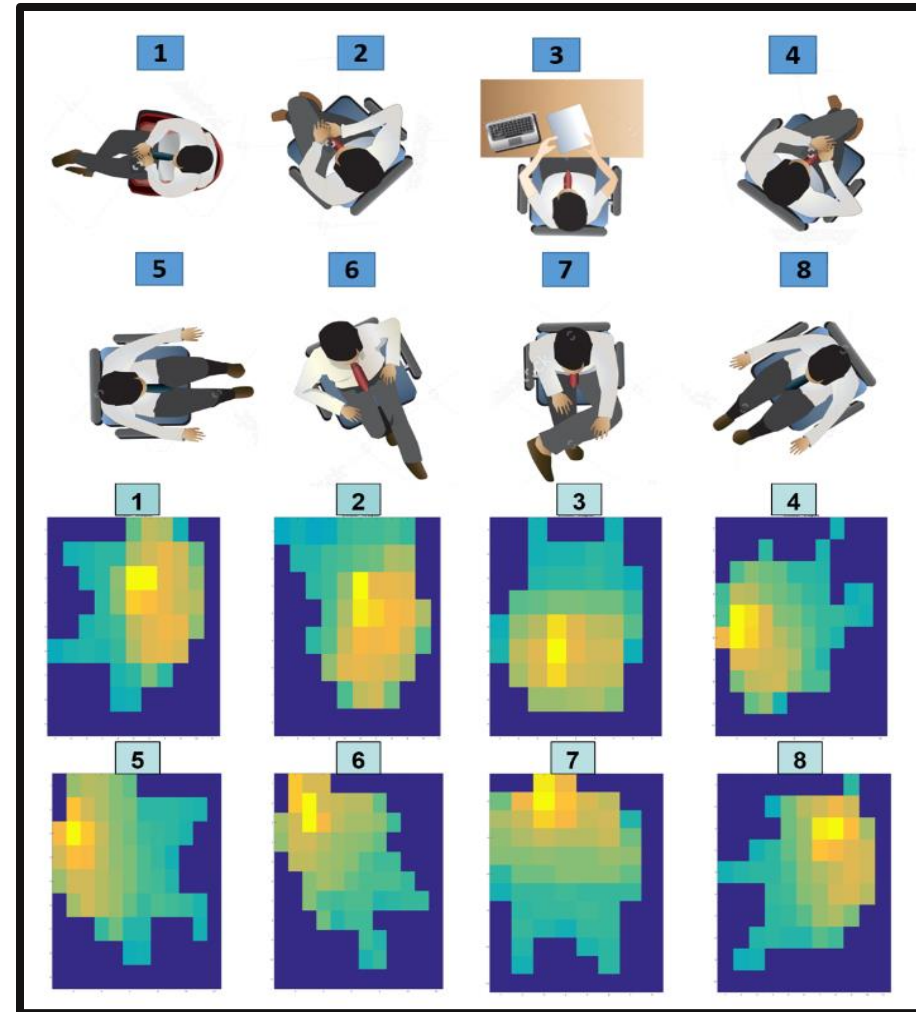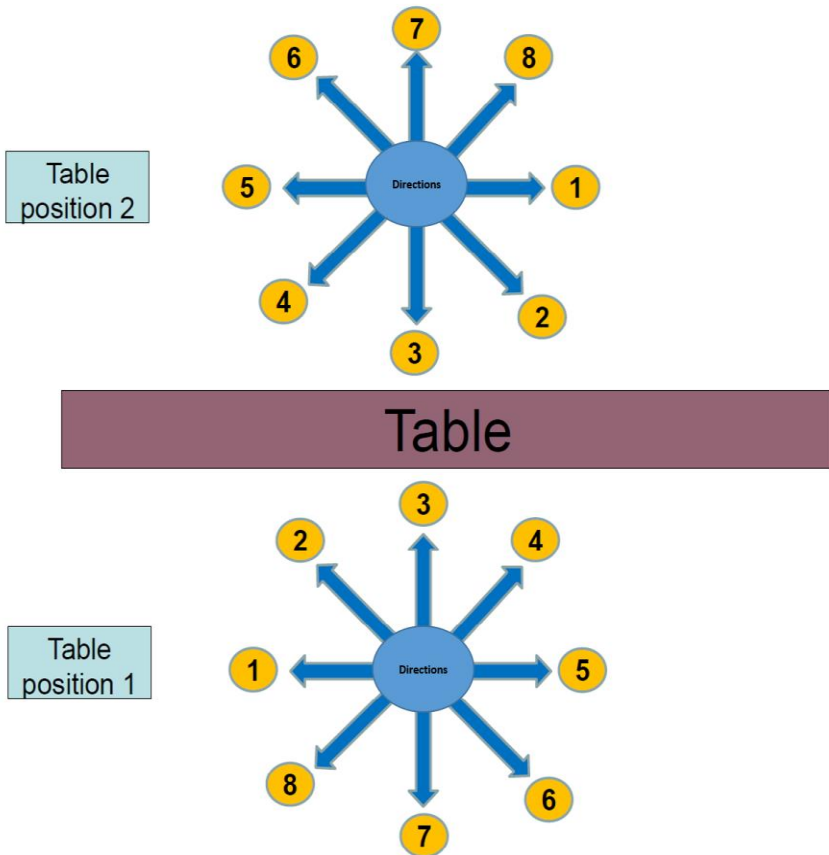
Head pose estimation from denser ToF data (Kinect)
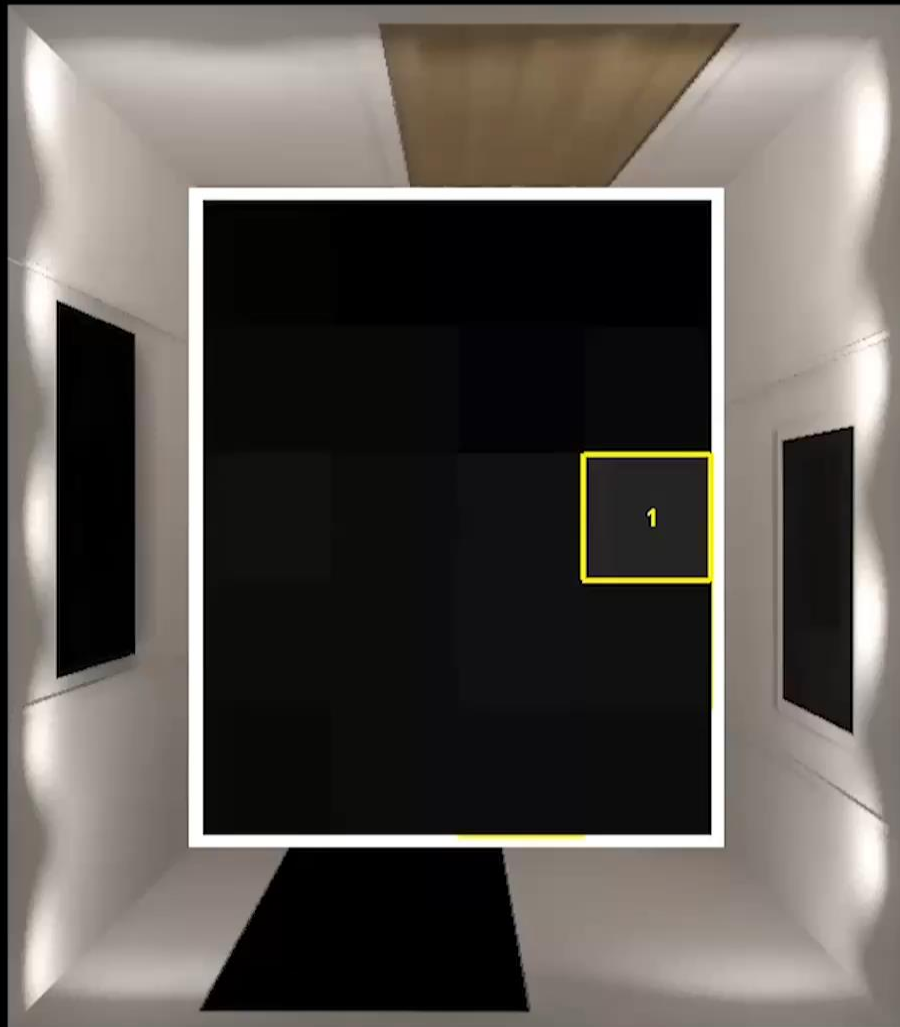
Head pose estimation initial results
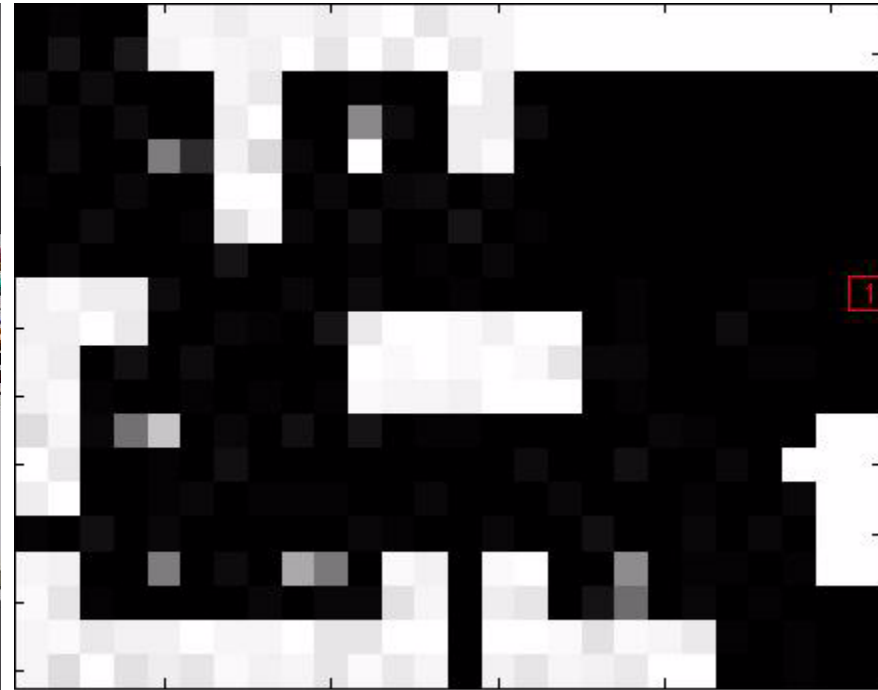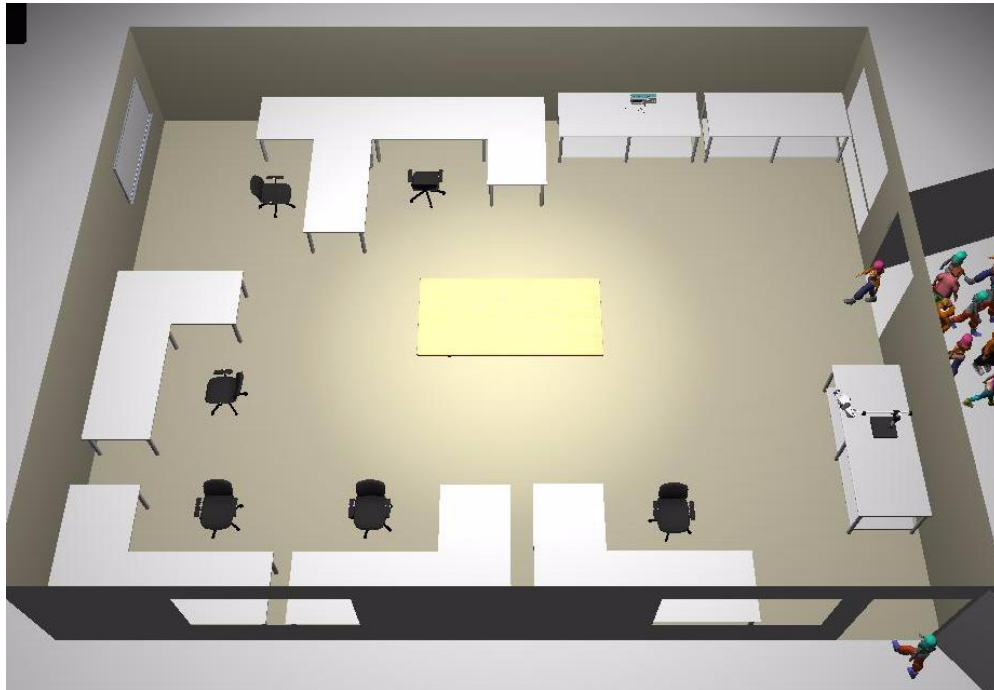

IR image from overhead Kinect

Top-down view of reconstructed 3D point cloud with fitted ellipsoid and head pose

Single-pixel ToF tracking prototype

Single-pixel ToF tracking simulation

> ▶ Same 2' x 2' spacing as actual deployment in testbed

> ▶ Further investigation under ARPA-E project

C e n t e r   f o r   L i g h t i n g   E n a b l e d   S y s t e m s   &   A p p l i c a t i o n s

The CRAIVE Lab

(Collaborative-Research Augmented Immersive Virtual Environment)

Large-scale cognitive immersive environments
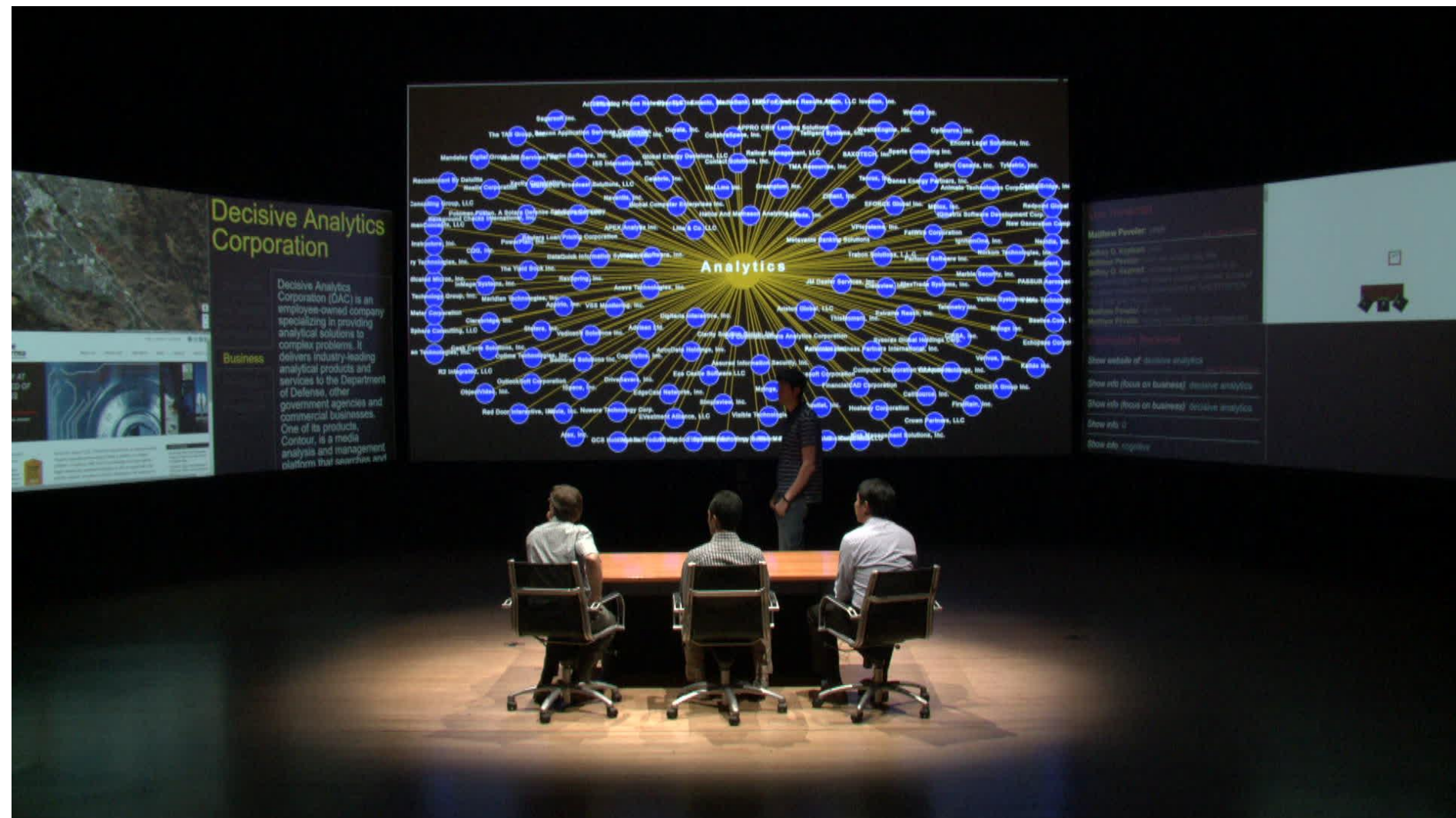
Person and pose tracking

C e n t e r   f o r   L i g h t i n g   E n a b l e d   S y s t e m s   &   A p p l i c a t i o n s

Thanks to…

- Indrani Bhattacharya (Rensselaer)
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- TKae Woodstock

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- Christoph Riedl
- Michael Foley

Making Lighting More Useful
lesa.rpi.edu

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Plant Science