Advanced visualization and interaction applied to virtual scenarios

Doctoral-Meeting initiative

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Virtual TV sets

Mixing two worlds

- The presented research mixes two worlds
  - Computing
  - Communication
- Virtual TV sets mix two worlds
  - Real world
  - Virtual World

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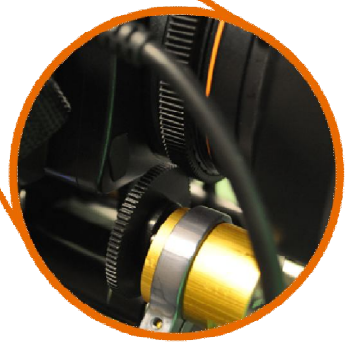
Virtual TV sets

How do they work?



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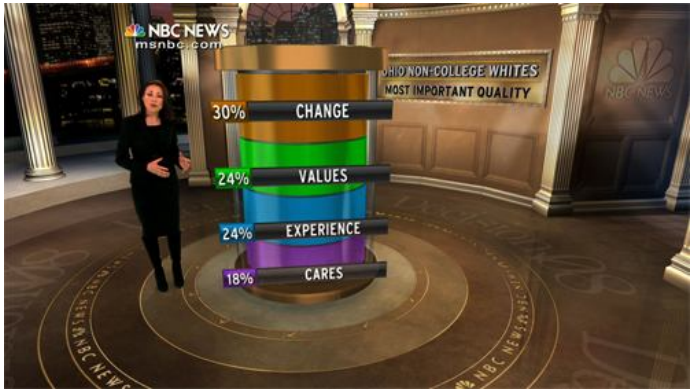
Virtual TV sets

Real time issues

- Live television broadcast
  - Real-time rendering of the scenario
    - Real-time tracking of the cameras
    - Real-time algorithms for realistic rendering
      - Shadows
      - Illumination
  - Actions, and animations fired on the fly
  - Real-time interaction of the presenter with the scenario
    - Occlussions
    - Collisions



Working process

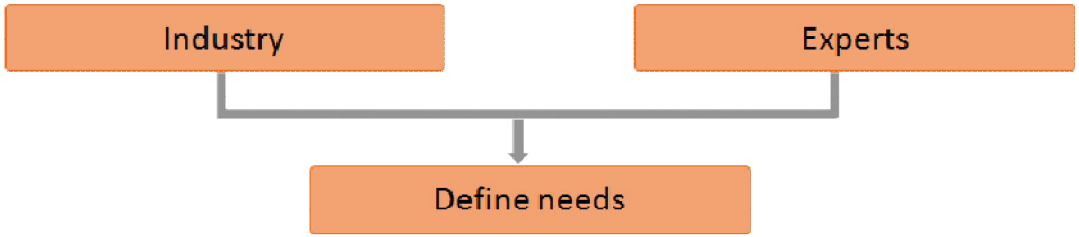
Methodology: Main steps

Industry

Experts

Working process

Methodology: Main steps



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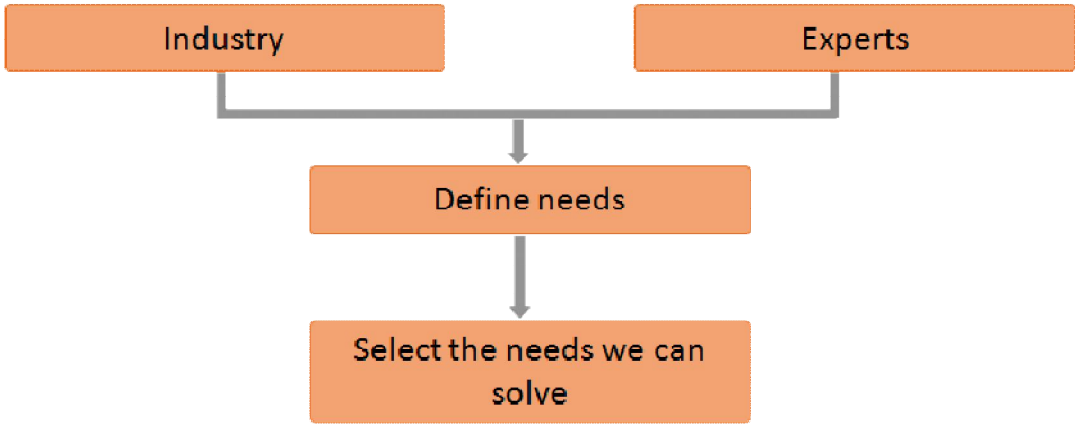

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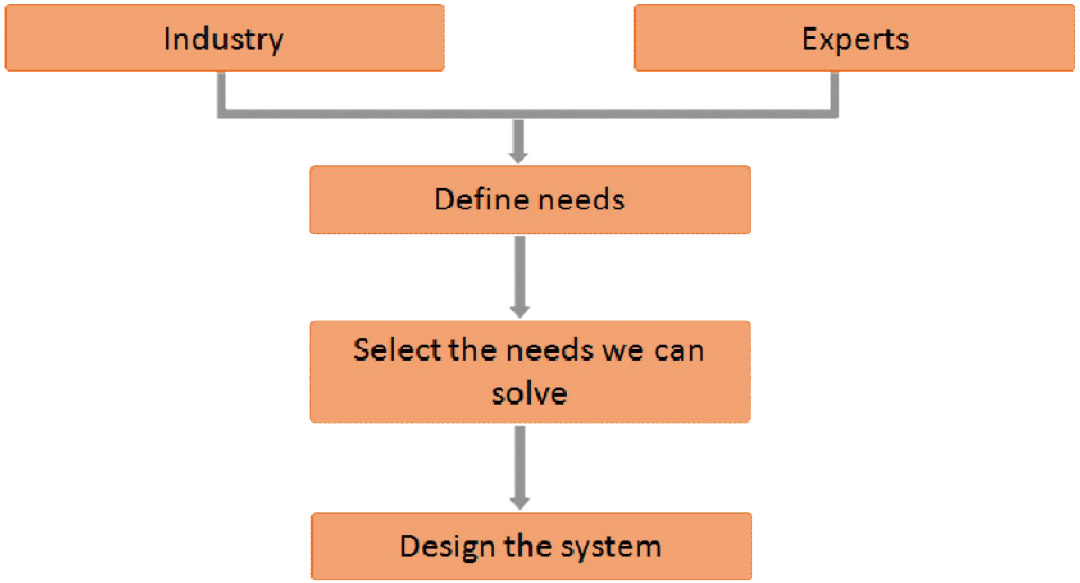

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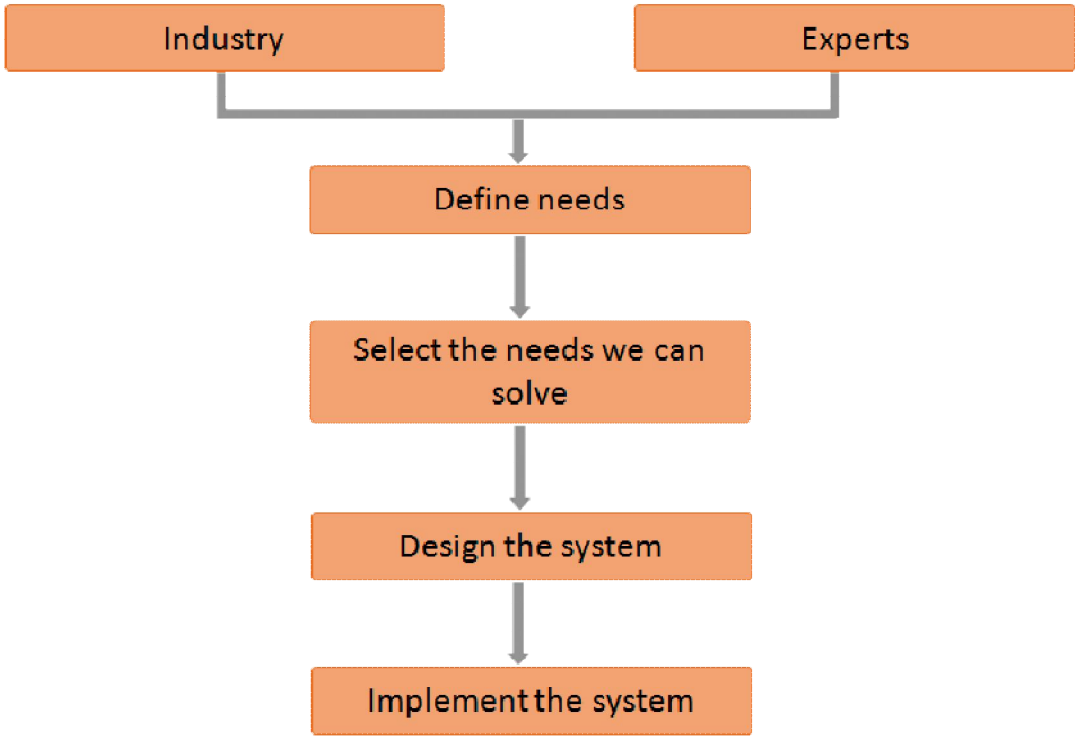

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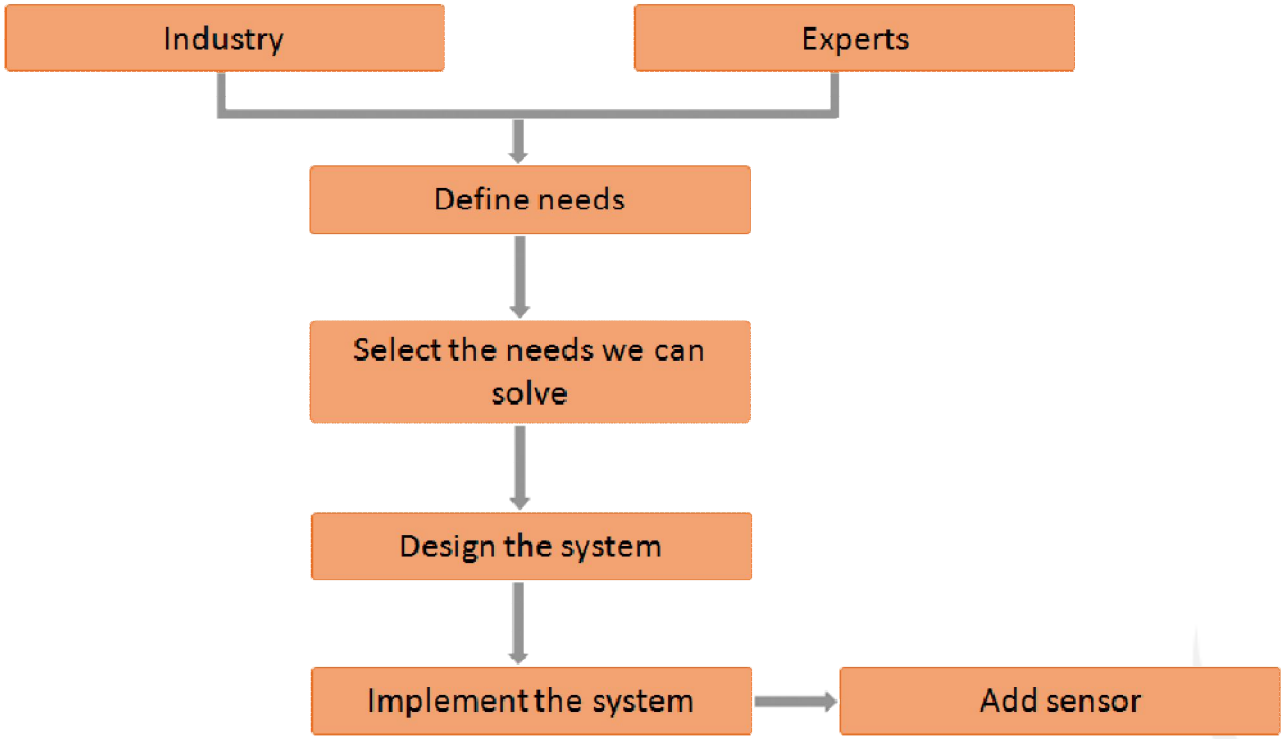

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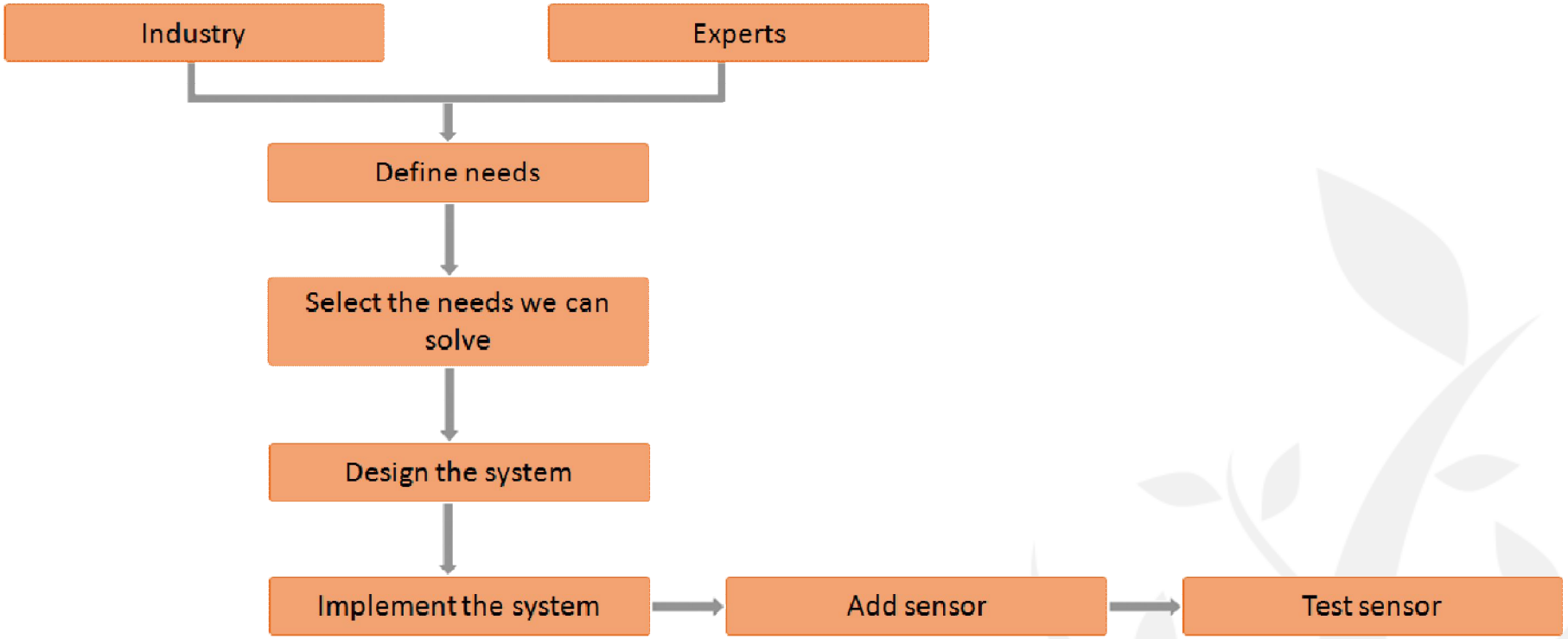

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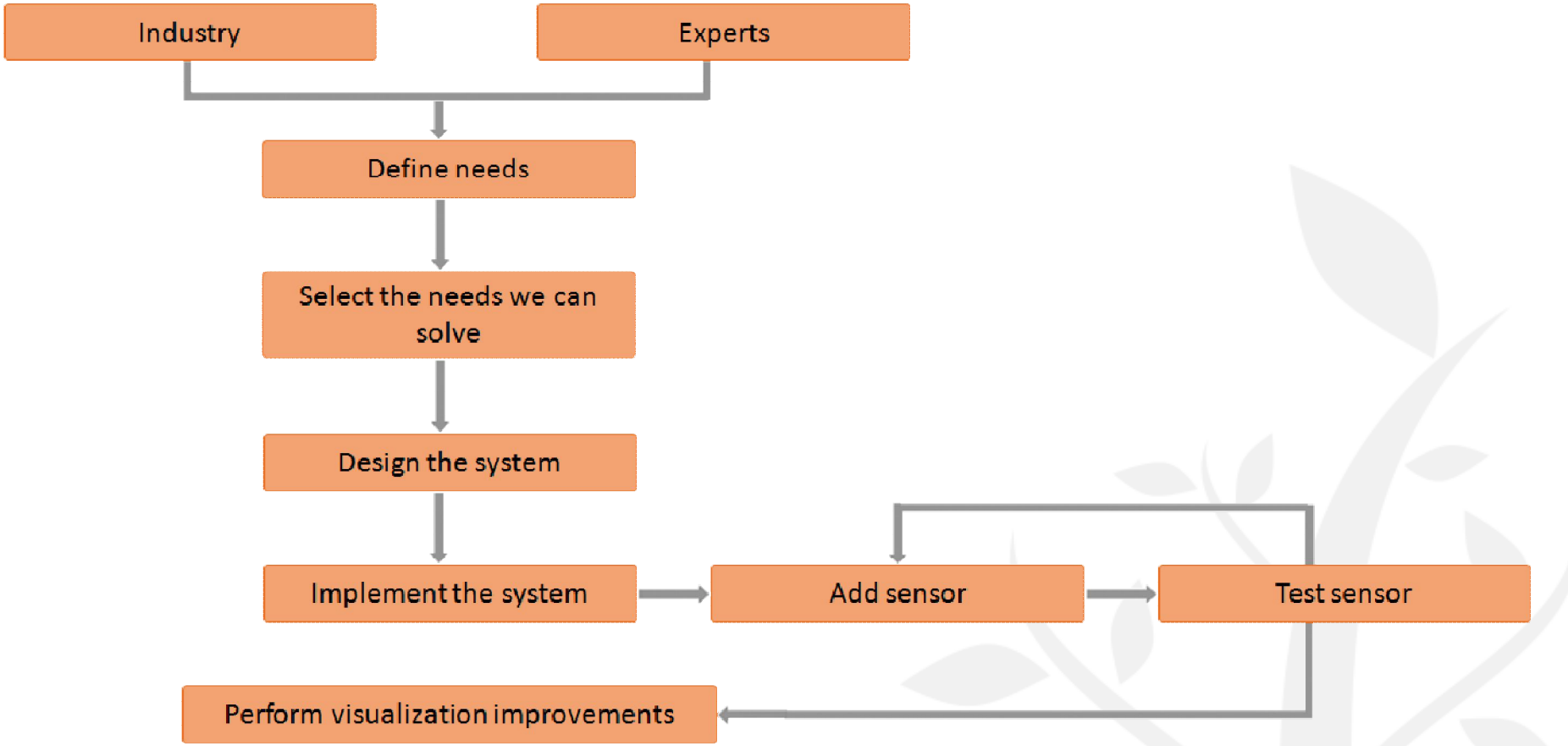

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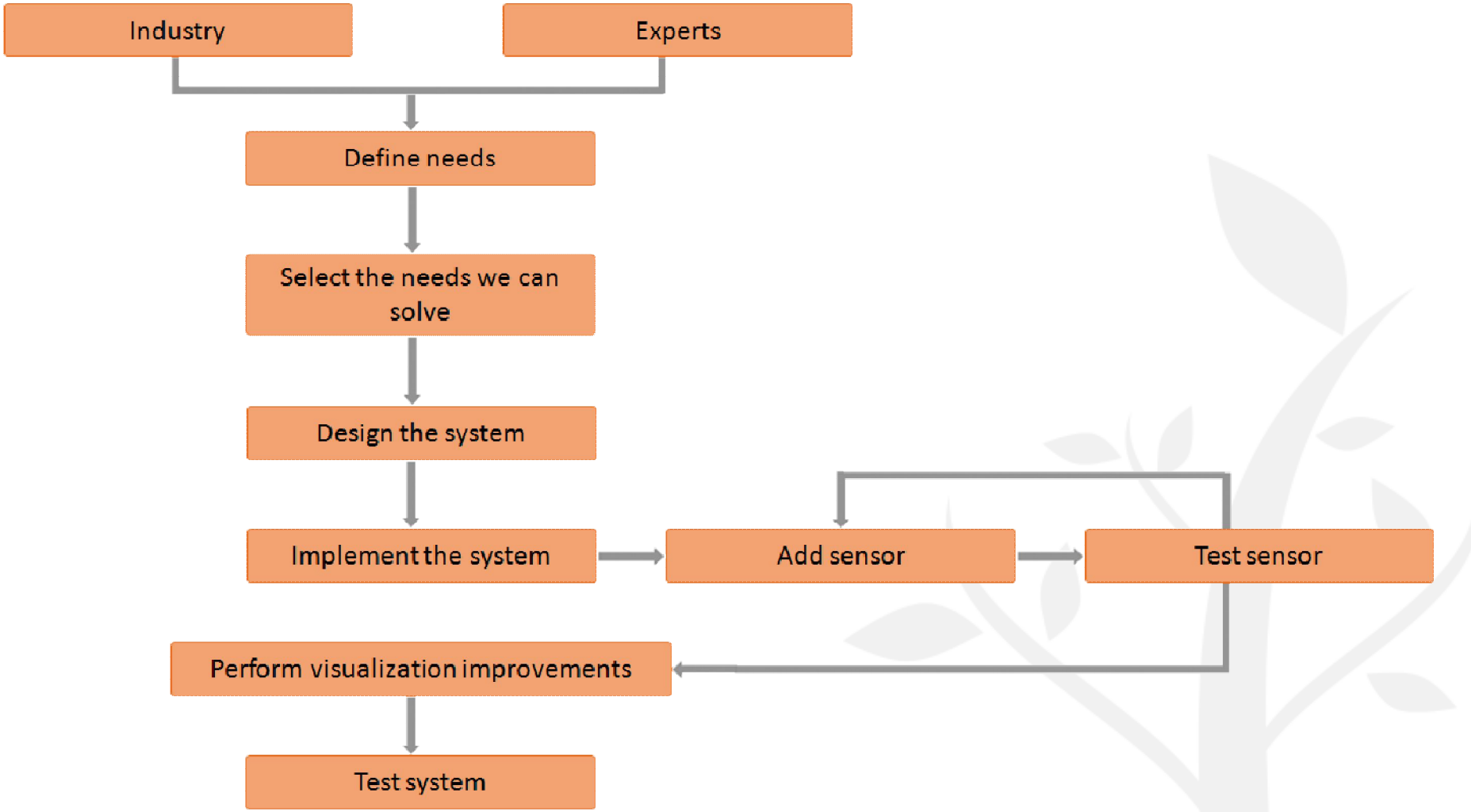

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Virtual TV sets

Present and future

Drawbacks of virtual TV sets nowadays

- Very conservative industry
  - Expensive camera tracking systems
    - Optical
    - Mechanical
  - Unrealistic rendering
  - Every interaction is hand controlled
    - Oclussions
    - Actions

Our proposal to solve these problems

- Use low cost tracking systems
- Combine different tracking systems to achieve different types of interaction
- Use these tracking systems to automate the presenter interactions
- Use advanced real time rendering techniques to improve the visual outcome

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System definition

Main interests and problems of the industry

- Free camera tracking
- Presenter tracking
- Presenter interaction
- Realistic visualization

- First step
  - Scalable system
    - Allow to easily add new sensors
    - Allow to easily substitute old sensors
    - Transparent for the final user

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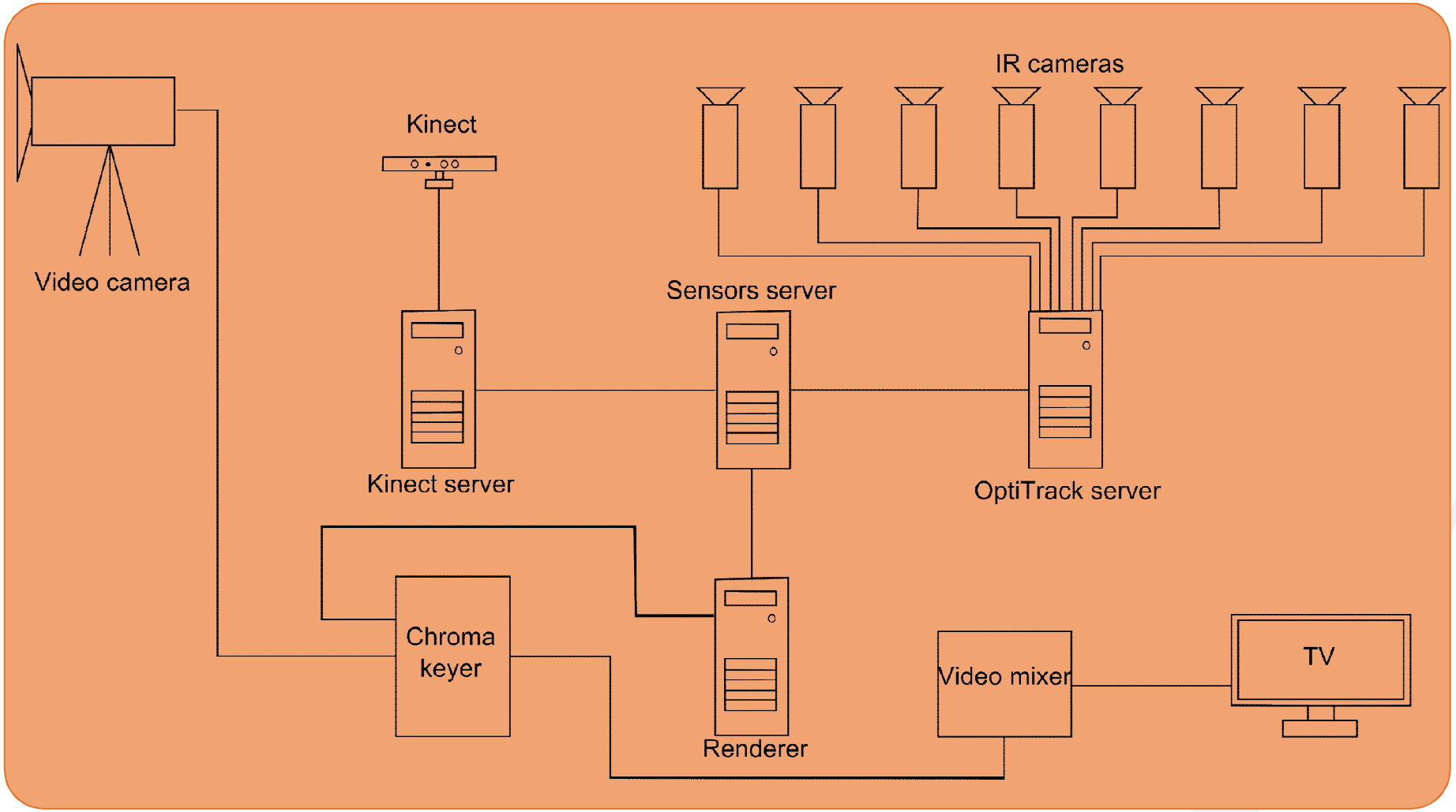
System design

Scalable sensor system for TV sets



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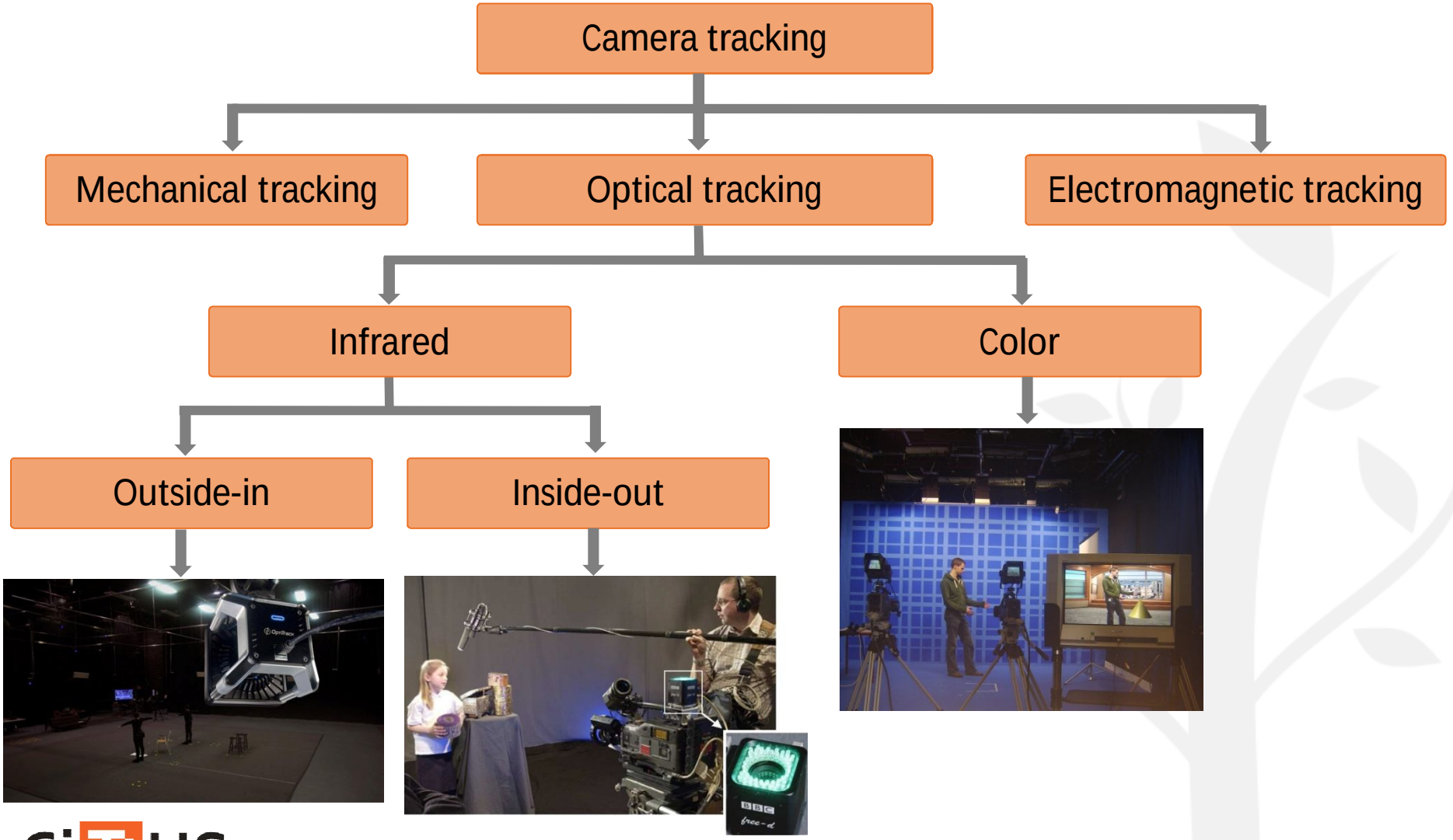
System implementation

Camera tracking sensors



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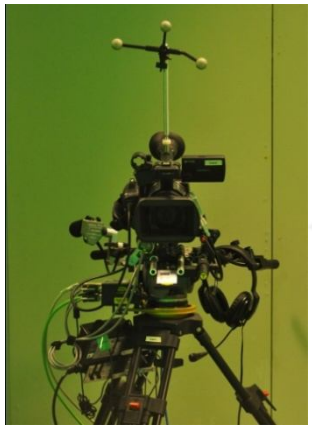
System implementation

Motion capture systems by OptiTrack

- Outside-in OptiTrack camera systems
  - Same precission and lag as the inside-out systems
  - More flexible to include new cameras and objects to track
  - Cheaper
- Our system
  - 8 V:100 R2 cameras
  - Tracking Tools Software



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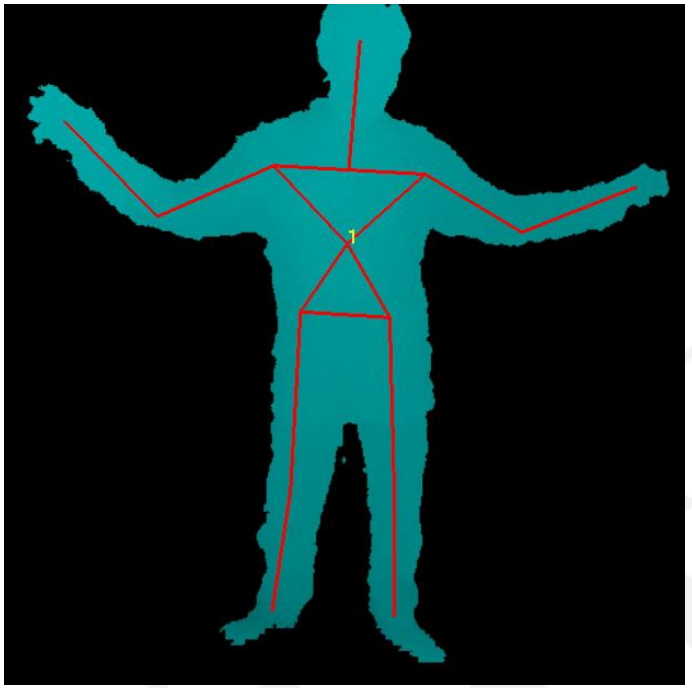
System implementation

Presenter tracking

- PrimeSense sensors
  - Microsoft Kinect
  - Asus Xtion Pro
- Technical characteristics
  - Range between 50cm and 5m
  - Precision between 1.5mm and 5 cm
  - Frame-rate of 30/60 fps
  - Price around 130 dollars



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System implementation

Adding Leap Motion sensor

- Hand tracking system
- Technical characteristics
  - Range between 3cm and 70 cm
  - Frame-rate of 300 fps
  - Precission at the optimum distance (that can be configured) is claimed to be around 0.01 mm
  - The price is 80 dollars
- Advantages
  - Great precission
  - Good for gesture tracking
  - Easy interaction for the user
  - Less probability of oclussions between users
- Disadvantages
  - Small capture volume
  - Just for the hands

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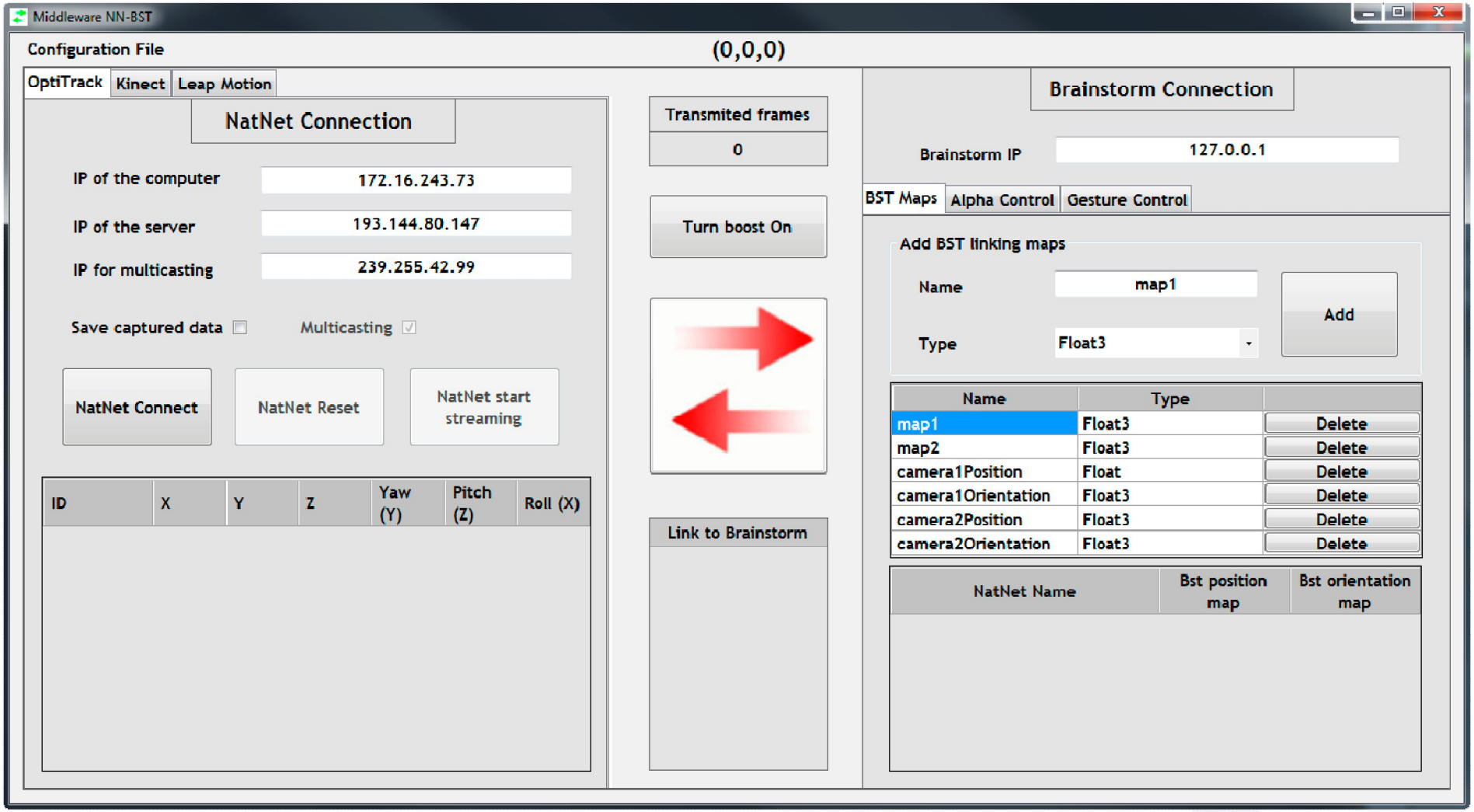
Final software implementation

The main application



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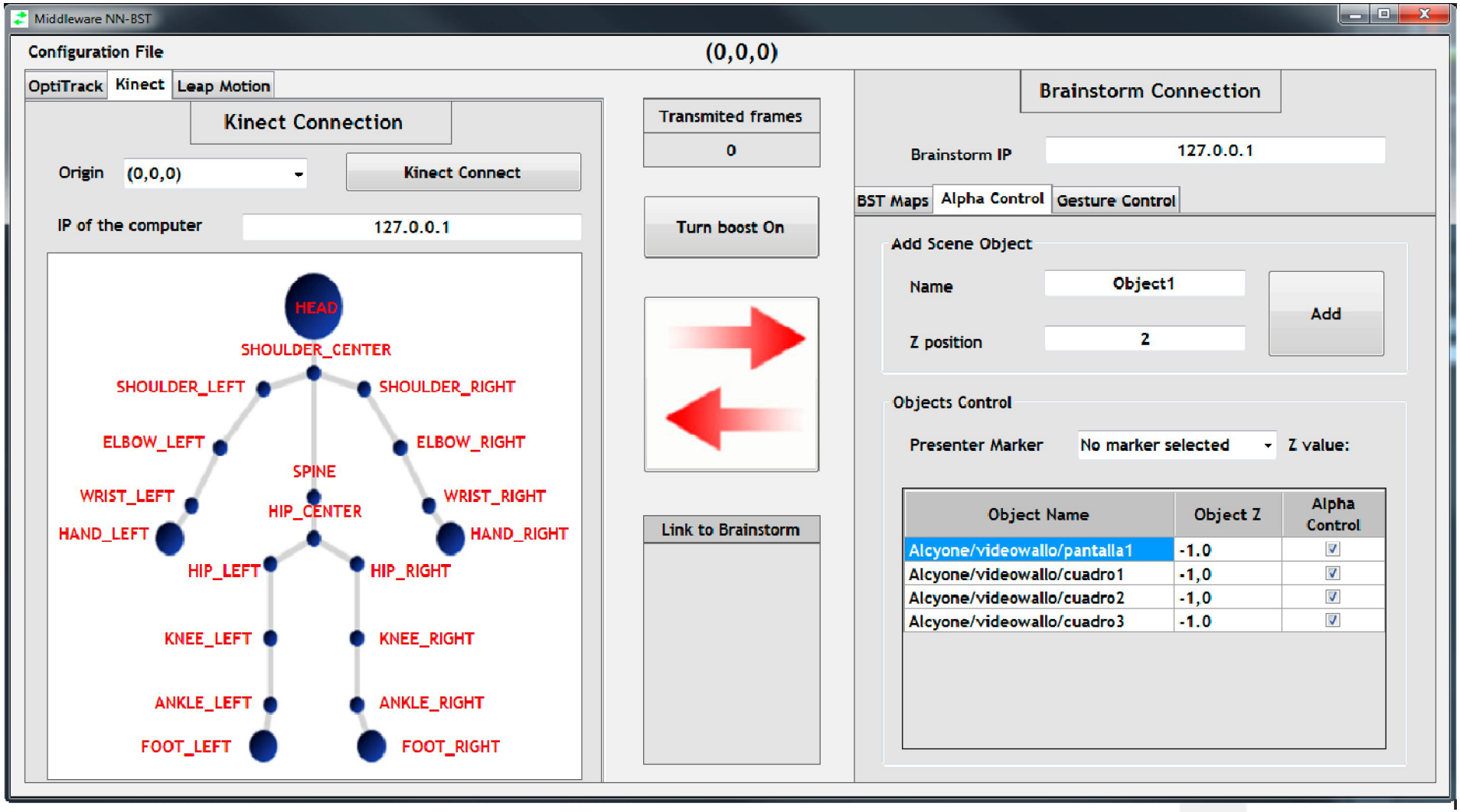

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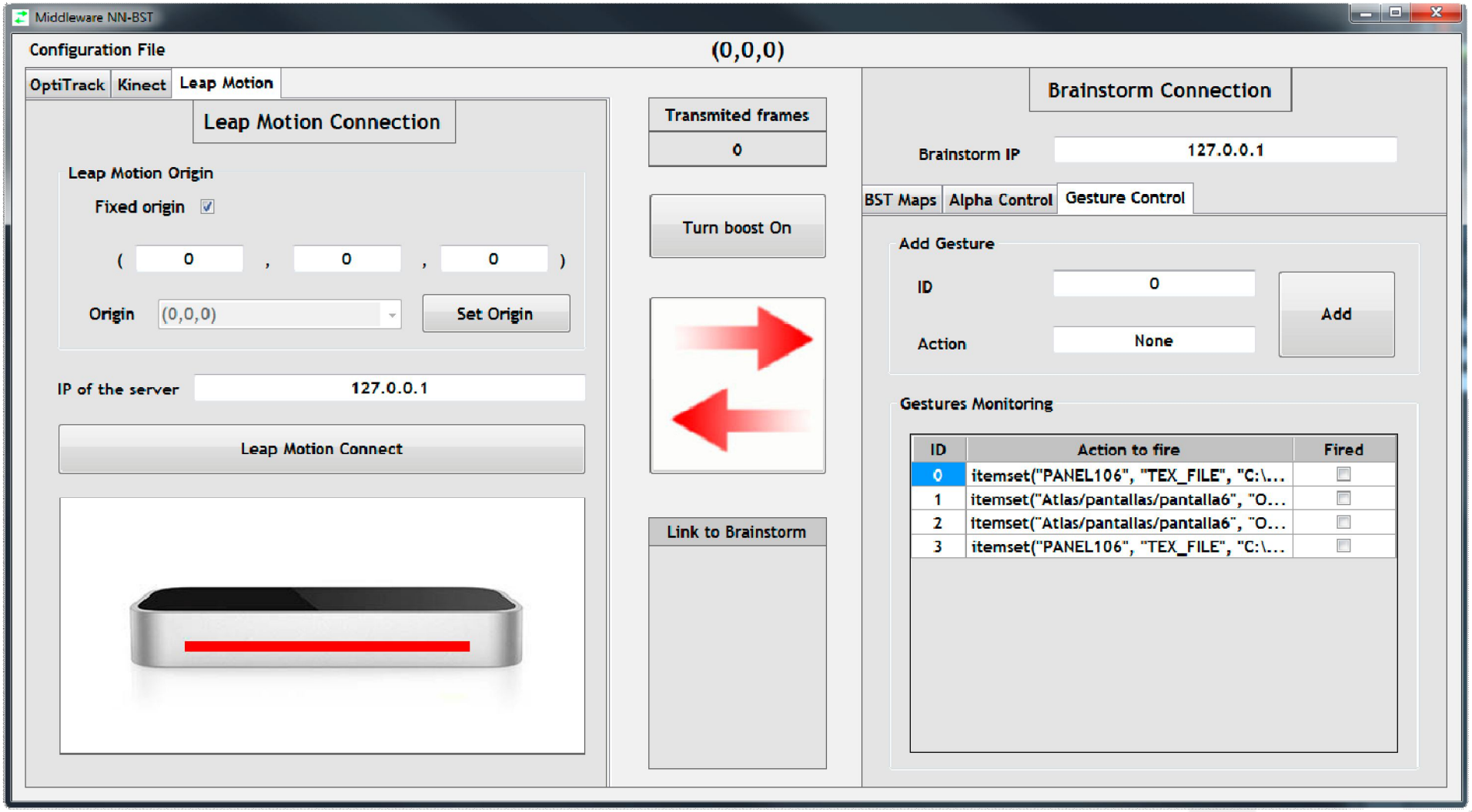


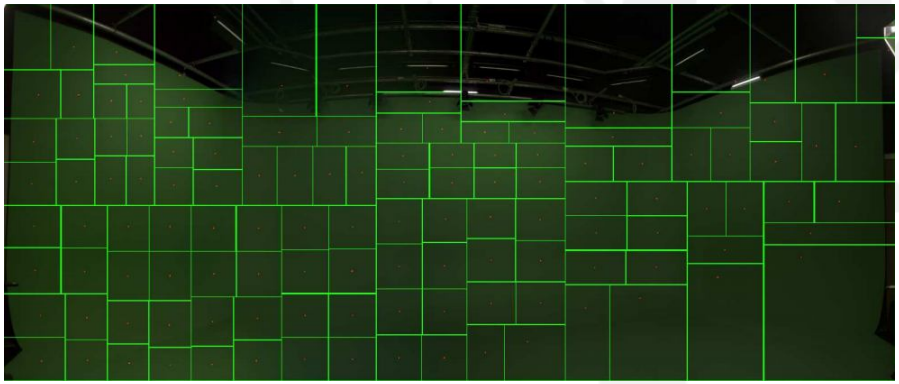
Advanced visualization

Illumination analysis

- Median cut sampling algorithm
  - Obtain a light probe of the scenario
  - Compute its luminance image

$$Y = 0.2125R + 0.7154G + 0.0721\,B$$

  - Perform the algorithm to get the desired sampling density
    - Start defining one region that includes the whole image
    - Divide this region in two regions of equal luminance
    - Repeat computation for each new region until we get the desired number of samples
    - Compute centroid of the region and color for this centroid



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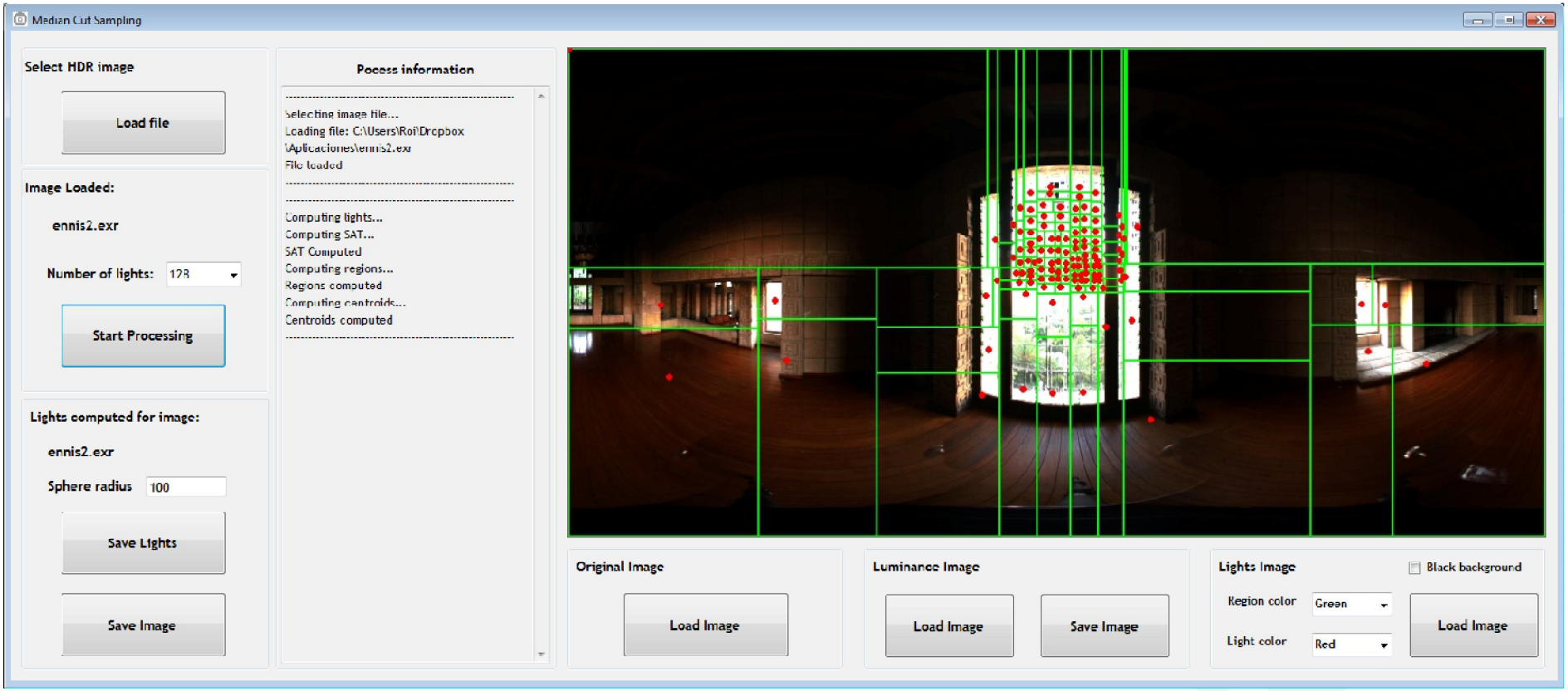
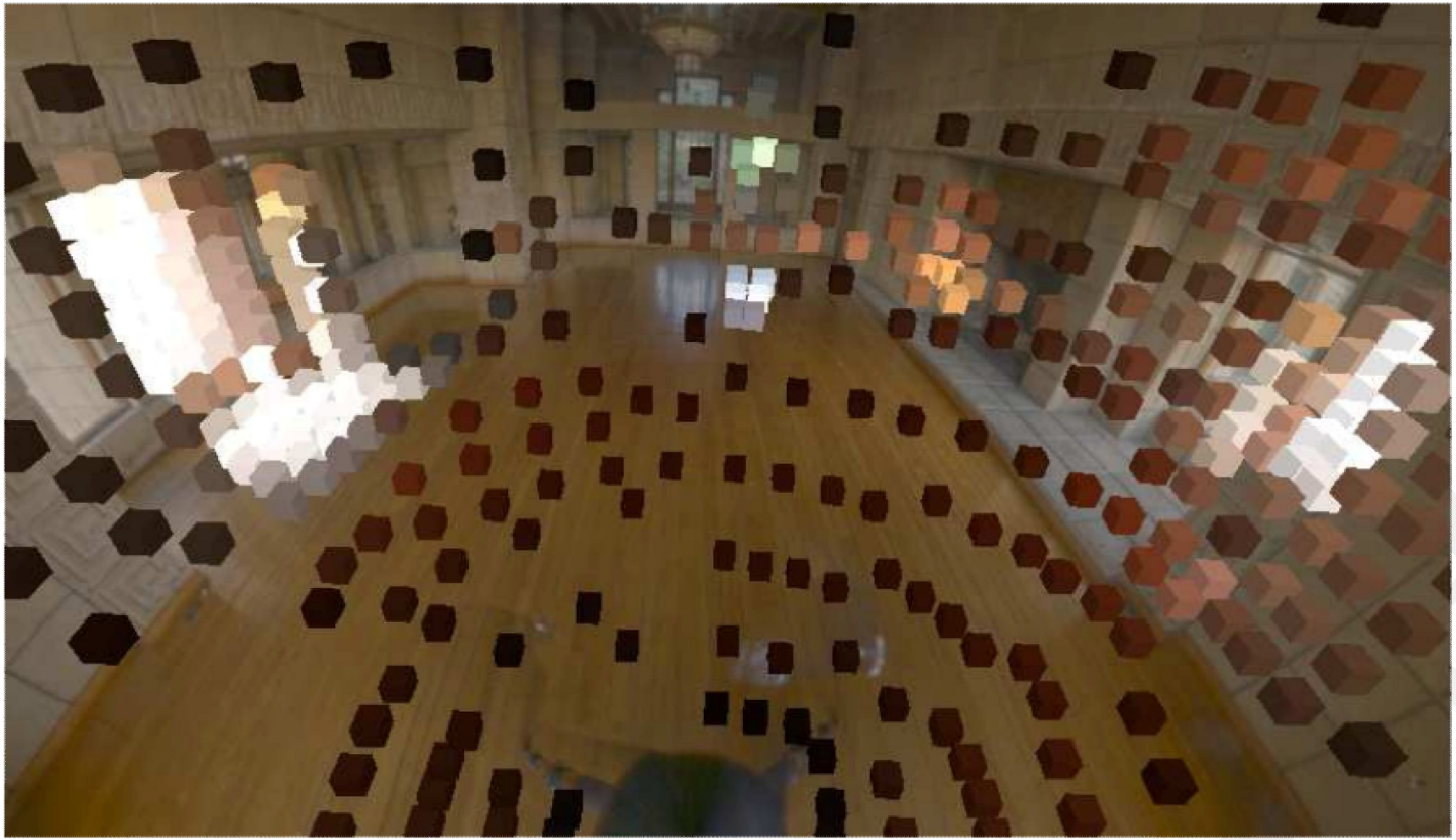
Advanced visualization

Illumination analysis application



Advanced visualization

Illumination analysis output



Advanced visualization

Including shadows

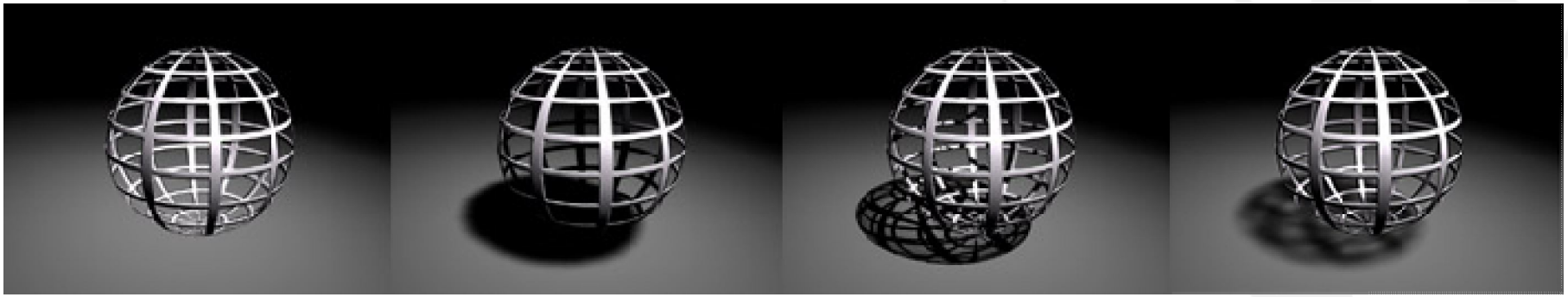
Main characteristics of the TV set illumination

Preseters body position and pose

Real presenter casts shadows on virtual objects

Simple image shadow

Complex diffuse shadows



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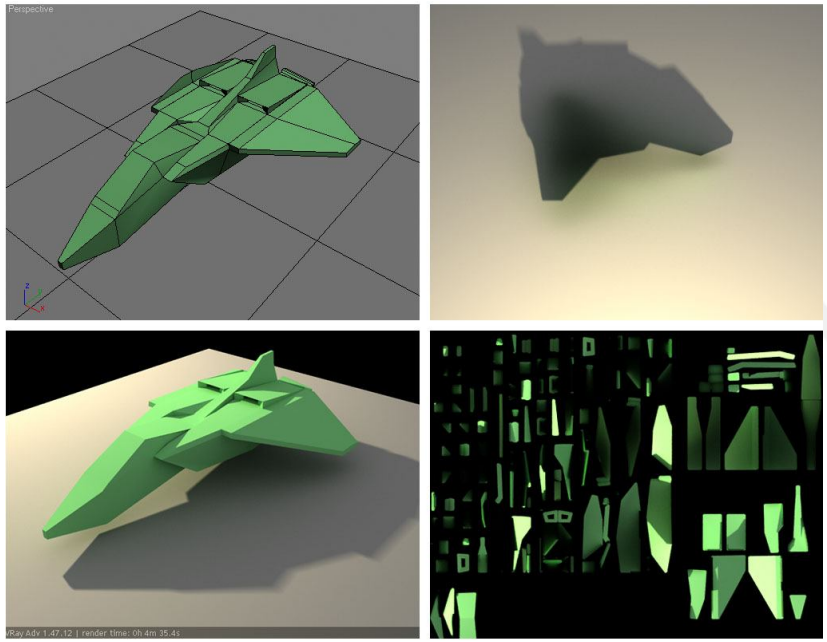
Advanced visualization

Texture baking

- Introducing in the 3D model textures illumination information
  - Realistic illumination without any performance cost
  - Some drawbacks
    - Constant illumination
    - It is not able to simulate every type of light (spot lights)
    - Should come with realistic presenter shadows



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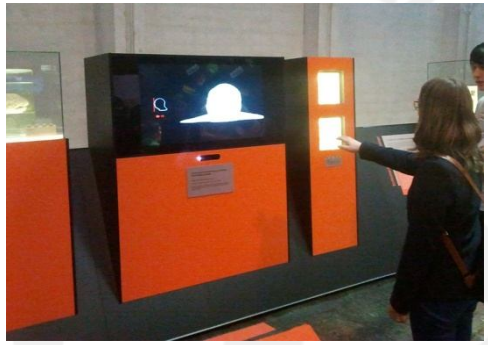
Other applications

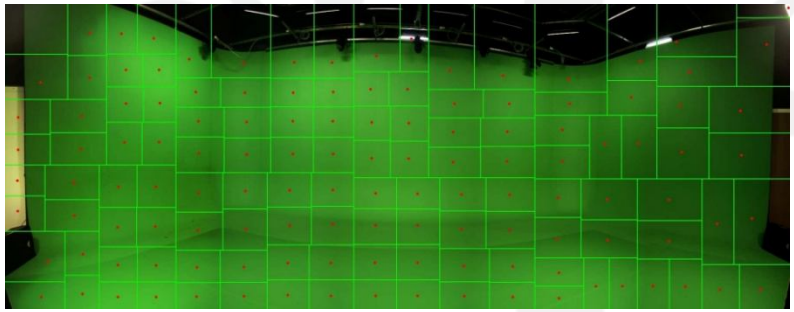
Applying the developed tools to different goals

- The Instruments of the Pórtico de la Gloria
  - Separated application/sensor architecture
  - AR-Toolkit and webcam
  - Exhibited in the crypt of the Pórtico de la Gloria

- Brain explorer
  - Separated application/sensor architecture
  - Kinect sensor
  - Test with leap motion in one day
  - Exhibited in the DOMUS museum



- Illumination analysis
  - Test the uniformity of the USC TV set cyclorama illumination



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Publications

- “Exploración en tiempo real de la reconstrucción virtual de los instrumentos del Pórtico de la Gloria”, Méndez, R., Otero, A., Jarque, S., Flores, J., Arqueológica 2.0, Sevilla, Junio de 2011.

- “The virtual instruments of the *Pórtico de la Gloria*”, Méndez, R., Otero, A., Flores, J. Computer applications and quantitative methods in Archeology 2012, Southampton, marzo 2012.

- “Diseño de un sistema escalable para la sensorización de platós virtuales de televisión con emisiones en directo”, Méndez, R., Sanmartín, G., Mera, D., Flores, J., Castelló, E., CEIG (Congreso Español de Informática gráfica), Jaén, Septiembre de 2012.

- “Exploración en tiempo real de la reconstrucción virtual de los instrumentos del Pórtico de la Gloria”, Méndez, R., Otero, A., Jarque, S., Flores, J., Revista Científica VAR, Virtual Archaeology Review Volumen 3. Número 06 - Noviembre 2012.

Conclusions

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- We have successfully integrated two sensors in the system: Optitrack Cameras and Microsoft Kinect.
- We have developed a tool that allows the virtual TV set designer to know how the illumination of the real TV set will be, so that he can light the model consecuently

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Future work

- Add shadows to the presenter in eStudio
  - Simple shadows
  - Analize the use of complex soft shadows

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  - Open system for new sensors that could appear

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- Test the system in a live broadcast program

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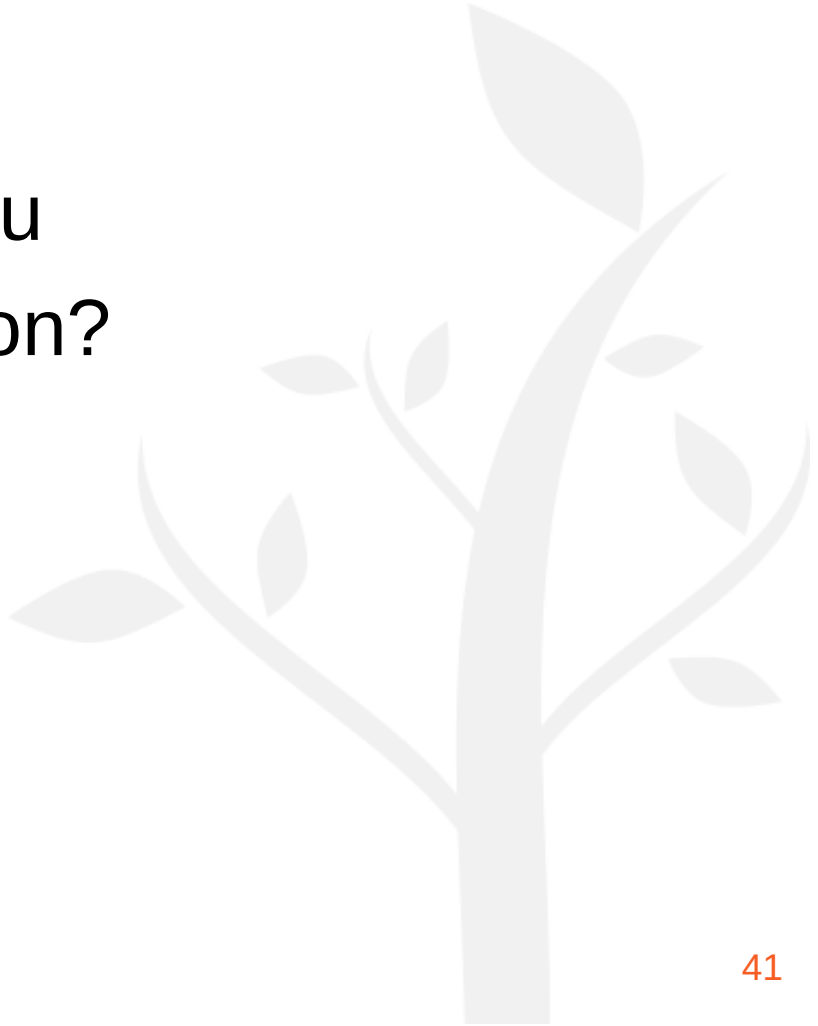
Thank you

Any question?



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