Attention-aware Real-time Computer Graphics

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Motivation for our research

- Successfully predicting visual attention can significantly improve many aspects of computer graphics.
  - scene design
  - interactivity
  - rendering

- Exploit –the never before employed in attention predictions– **scene semantics**.

- Design attention-aware applications.

Attention Modeling - Low Level

Visual perception is currently divided into two major areas of research:

- Low-level vision (bottom-up) deals with the extraction of basic physical properties such as color and depth. [Marr 1982]

Attention Modeling - High Level

High-level vision (top-down) maps visual representations to meaning and semantics. [Henderson 1999]

✓Also includes the interaction of cognition and perception along with short-term memory for visual information scene/object identification amongst others.
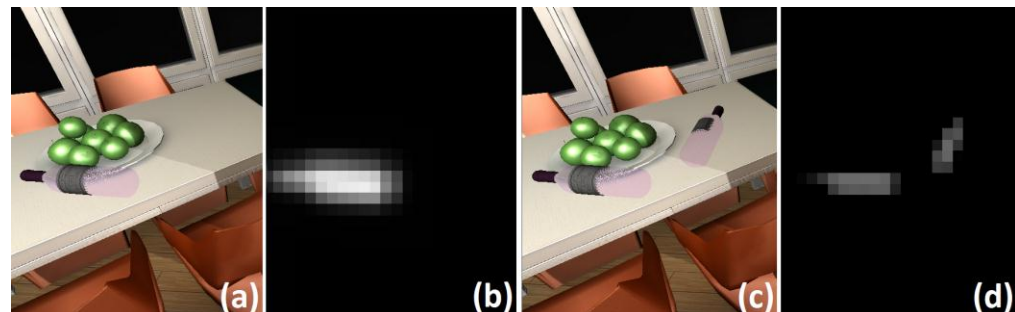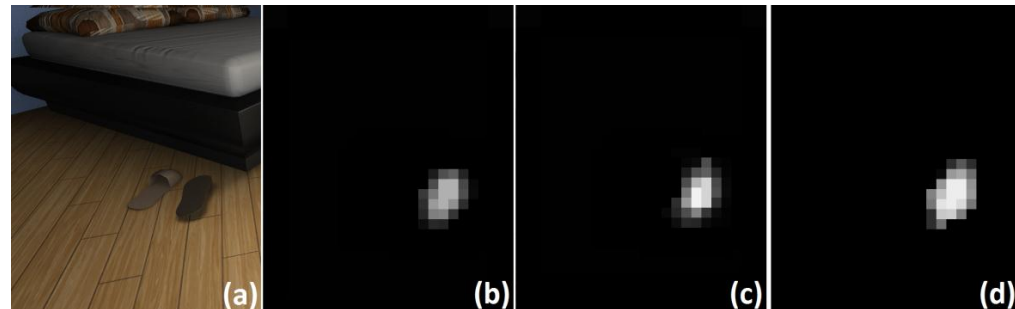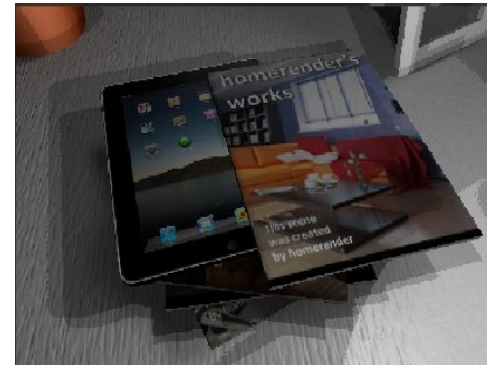
Object-centered Attention (1)

- Global context representations termed memory/scene schemata. [Bartlett 1932]
  - integrate pre-existing knowledge with recently acquired from attentional processing
  - a scene is comprised by consistent objects, i.e. objects expected to be found in a specific context and inconsistent objects, i.e. objects that are not normally existent in a given scene and thus salient
- Attention on singleton objects.
  [Theeuwes and Godijn 2002]
  - singletons ordinarily capture attention
- Attention on violations of canonical form.
  [Becker 2007]
  - violations of canonical form are detected peripherally, are semantically salient and can affect the likelihood of fixating on an item
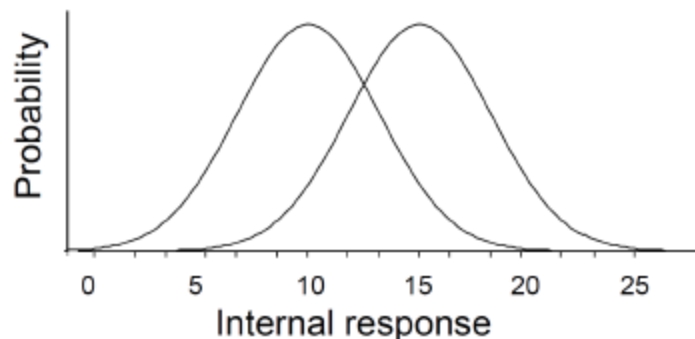
Object-centered Attention (2)

- Objects belonging in a set are contextually compound.
  [Koffka 1935]
  - An object positioned in-between a set of similar objects but dissimilar from those in the set, is hypothesized to pop out even when not salient in terms of e.g. color

- Recurring fixations are generated for objects inconsistent with the context or in a non-canonical form. [Henderson 1999]
  - temporal context

- A single salient feature in an image pops-out more intensely than when several salient features exist. [Frintrop 2010]
  - feature uniqueness

(a) (b) (c) (d)

(a) (b) (c) (d)

Object-centered Attention

- High level semantics have a strong influence on:
  - eye movements over the scene by guiding attention
  - fixation time on objects
- Eyes are mostly drown to important parts of the scene.
  - parts with higher entropy/informativeness

- Differential Weighting Model (DWM) [Eckstein 1998]

$$LR_{j,x,y,f} = \frac{l_{j,x,y,f}(\lambda_{j,x,y,f}|s)}{l_{j,x,y,f}(\lambda_{j,x,y,f}|n)} = exp\left(\frac{\lambda_{j,x,y,f}d'_j - 0.5d'^2_j}{\sigma^2}\right)$$
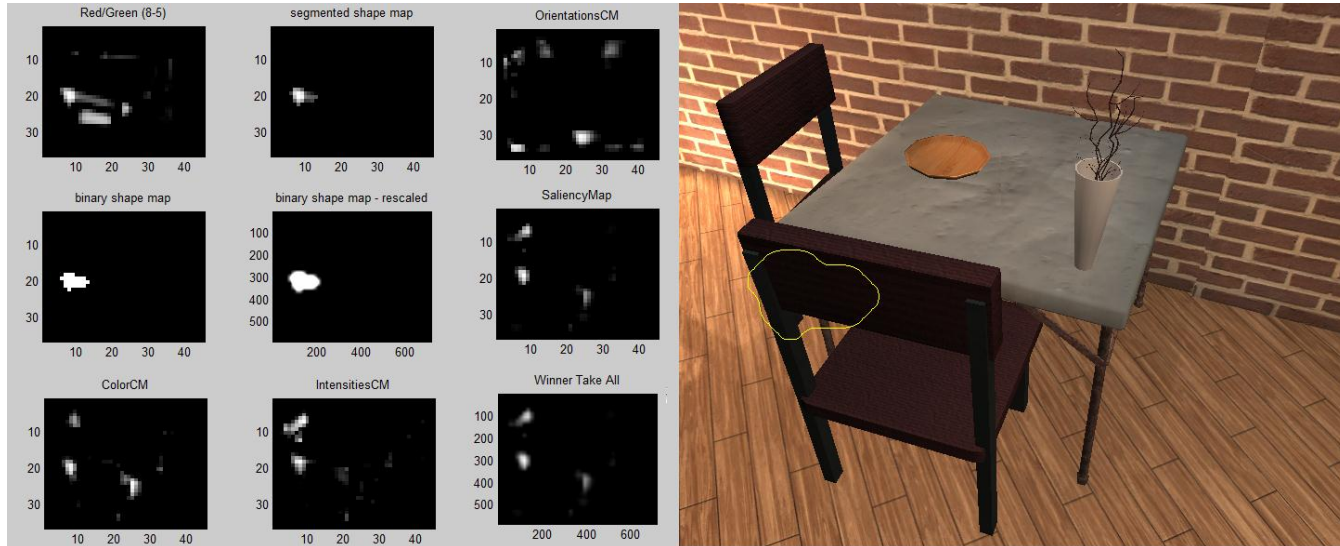

Parameters for the model obtained via multiple perceptual experiments.

Obtaining Model Parameters
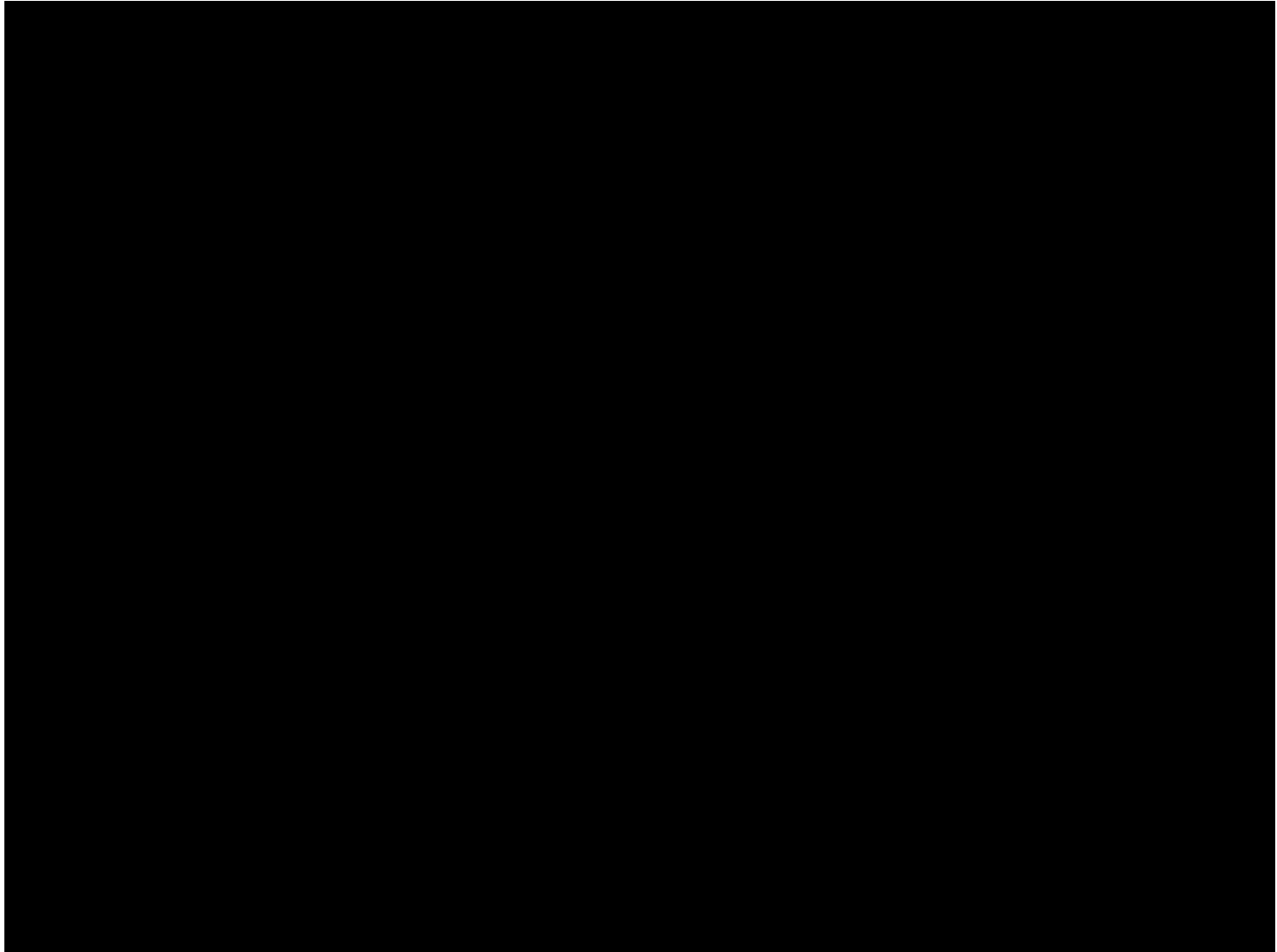
Low-level vs High Level Saliency

Attention in Games

- Object-centered attention can be observed in gaming contexts.

- Schema effects are expected in ecologically valid spaces.

- Real-life and fictitious objects are abundant and affecting attention.

- In the following slides screenshots from the games
  - Hitman Absolution
  - Heavy Rain
  - Alternativa

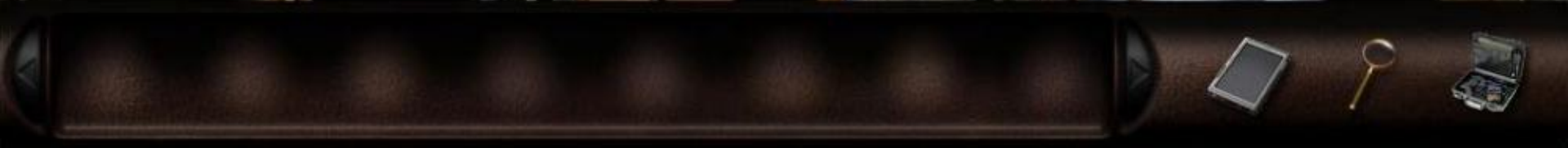 are presented, showing the aforementioned attentional phenomena in context.

Scene Schema: Library
Violations of canonical form
can be found.

Scene Schema: kitchen
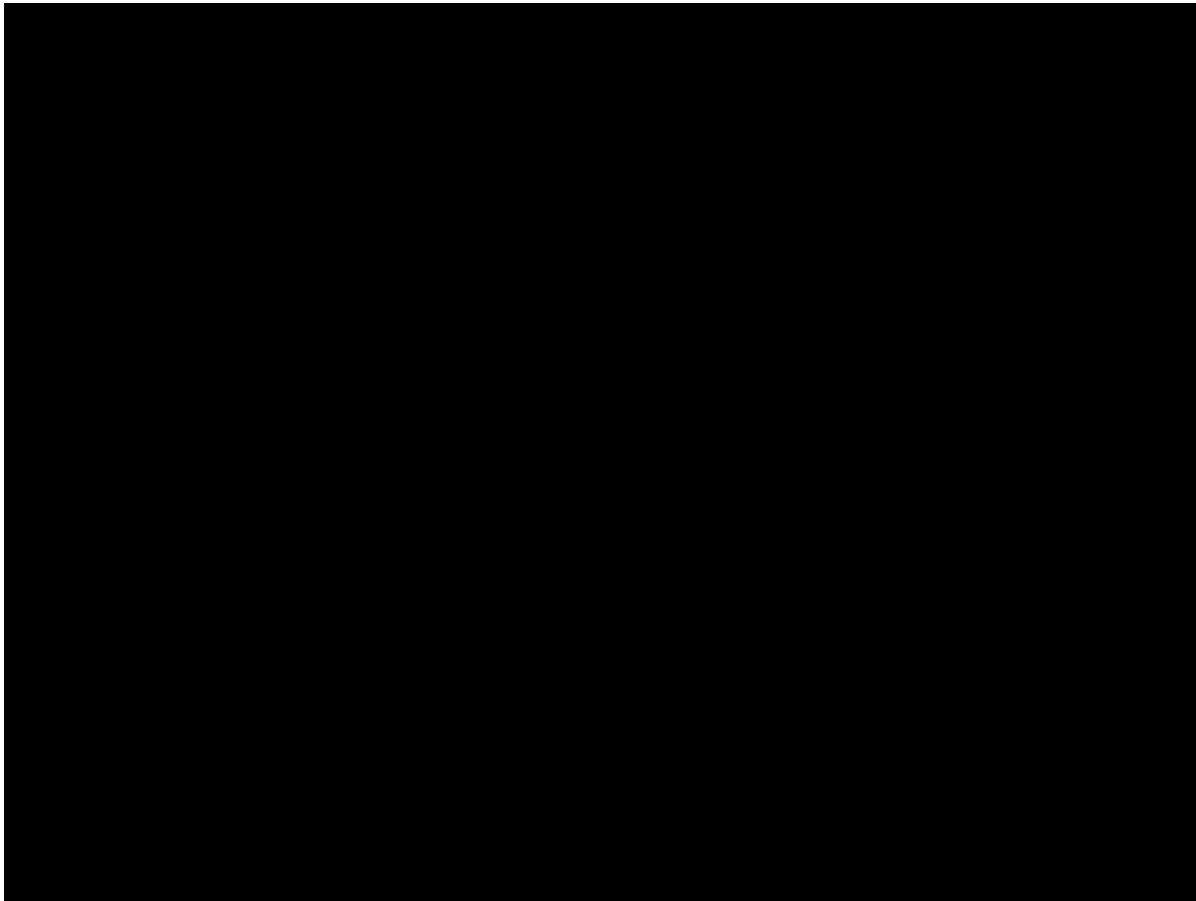Inconsistent whiteboard.

Scene Schema: living room
Violations of canonical form can be found.
Inconsistent objects: bat on the couch.

Game Balancing

- We designed a game level editor that automatically adjusts game level difficulty based on object saliency.

Level-of-Detail (1)

- C-LOD allows complex shaders to run on mobile devices.
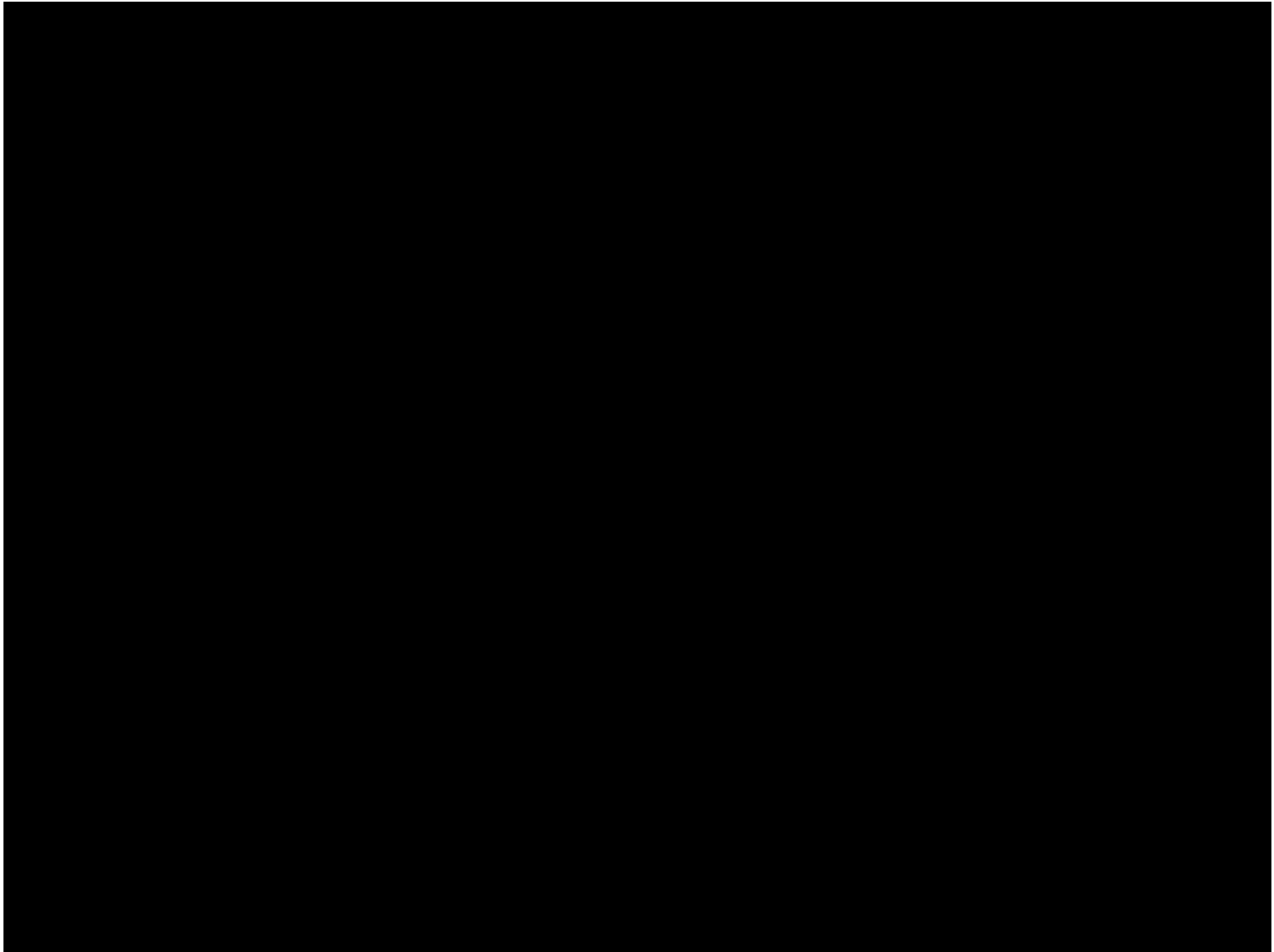

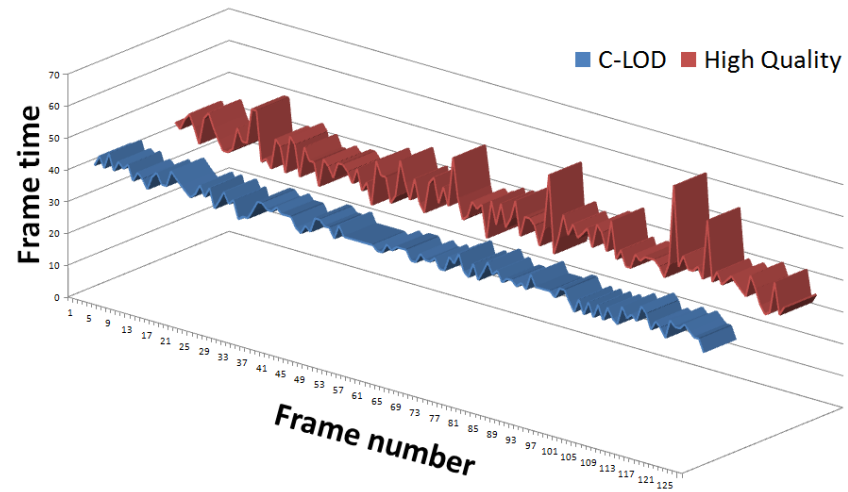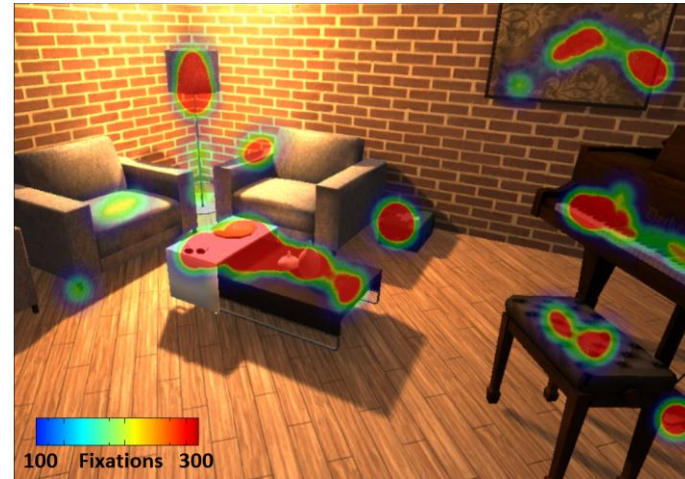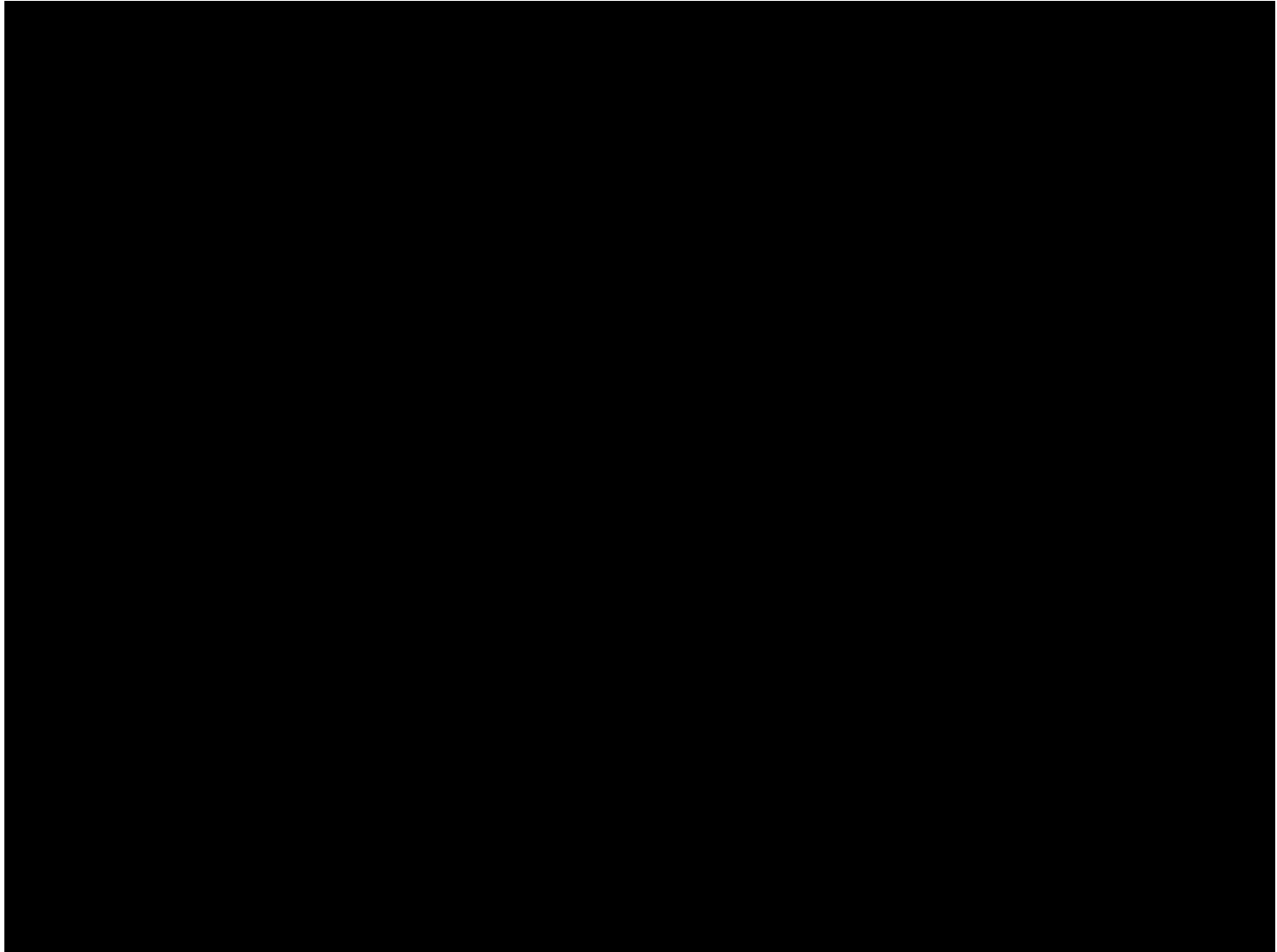| subsurface scattering |
| tessellation |
| dirt/aging |
| Gabor noise |
| particle effects |
| complex/procedural materials |

Level-of-Detail (2)

Validation (1)

Validation (2)

Publications

- **Koulieris, G.A.**, Drettakis, G., Cunningham, D., Mania, K. (2014). An Automated High Level Saliency Predictor for Smart Game Balancing. ACM Transactions on Applied Perception (TAP)
- **Koulieris, G.A.**, Drettakis, G., Cunningham, D., Mania, K. (to appear 2014). C-LOD: Context-aware Material Level Of Detail for Mobile Graphics. Computer Graphics Forum (Proceedings of the Eurographics Symposium on Rendering) 2014, Lyon, France
- McNamara, A., Mania, K., **Koulieris, G.A.**, Itti, L. (to appear 2014). Attention-Aware Rendering, Mobile Graphics and Games. Half-day course, ACM Siggraph 2014, Vancouver, Canada
- **Koulieris, G.A.**, Drettakis, G., Cunningham, D., Mania, K. (to appear 2014). High Level Saliency Prediction for Smart Game Balancing. Talk, ACM Siggraph 2014, Vancouver, Canada
- **Koulieris, G.A.**, Drettakis, G., Cunningham, D., Sidorakis, N., Mania, K. (to appear 2014). Context-aware Material Selective Rendering for Mobile Graphics. Poster, ACM Siggraph 2014, Vancouver, Canada

thank you

radiosity rendering by CHIRANTH KUMAR