Semantic Light: Building Blocks

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Abstract

The concept of Semantic Light is simply that lighting systems can be aware of what they are lighting. This offers a number of potential advantages over conventional lighting in quality and efficiency. Semantic Light requires fine grained control of the output of many lights and requires sensors to take in information about what is being lit. It uses this information to co trol the output lighting in great detail.

By running various algorithms, Semantic Light can provide useful information to the user and has a number of applications, including augmented reality.

Principles

Semantic Light offers many interesting possibilities for human machine interaction and in servicing people in a way never before possible. While we do not implement all of these suggestions, we have a system that aims to enable them.

Enhanced Perception

There are a number of lighting effects can help in task-related areas. Semantic Light has a number of potential advantages over conventional lighting in these ares. Possible applications include:

- Changing color temperature to point out details
- Dynamic lighting on specific objects
- Increasing uniformity of light

Information Overlay

Information can be projected directly onto the surface from which the computer is taking input. This allows users to interface to computers in an interesting way, similar to TUI.[1] There are number of new tools that could come from this, including:

- Highlighting text on a page
- Printing text near entities describing them
- A digital ruler that can measure the distance between two points arbitrarily

Human Comfort

Because Semantic Light can be aware of what the task is and who is using it, the system can optimize the colors and quantity of light for the person who is using it. Some ways the system can help improve the user experience are by:

- Adjusting color temperature to contrast room temperature
- Dimming lights when not needed
- Brightening fine features to reduce eye strain

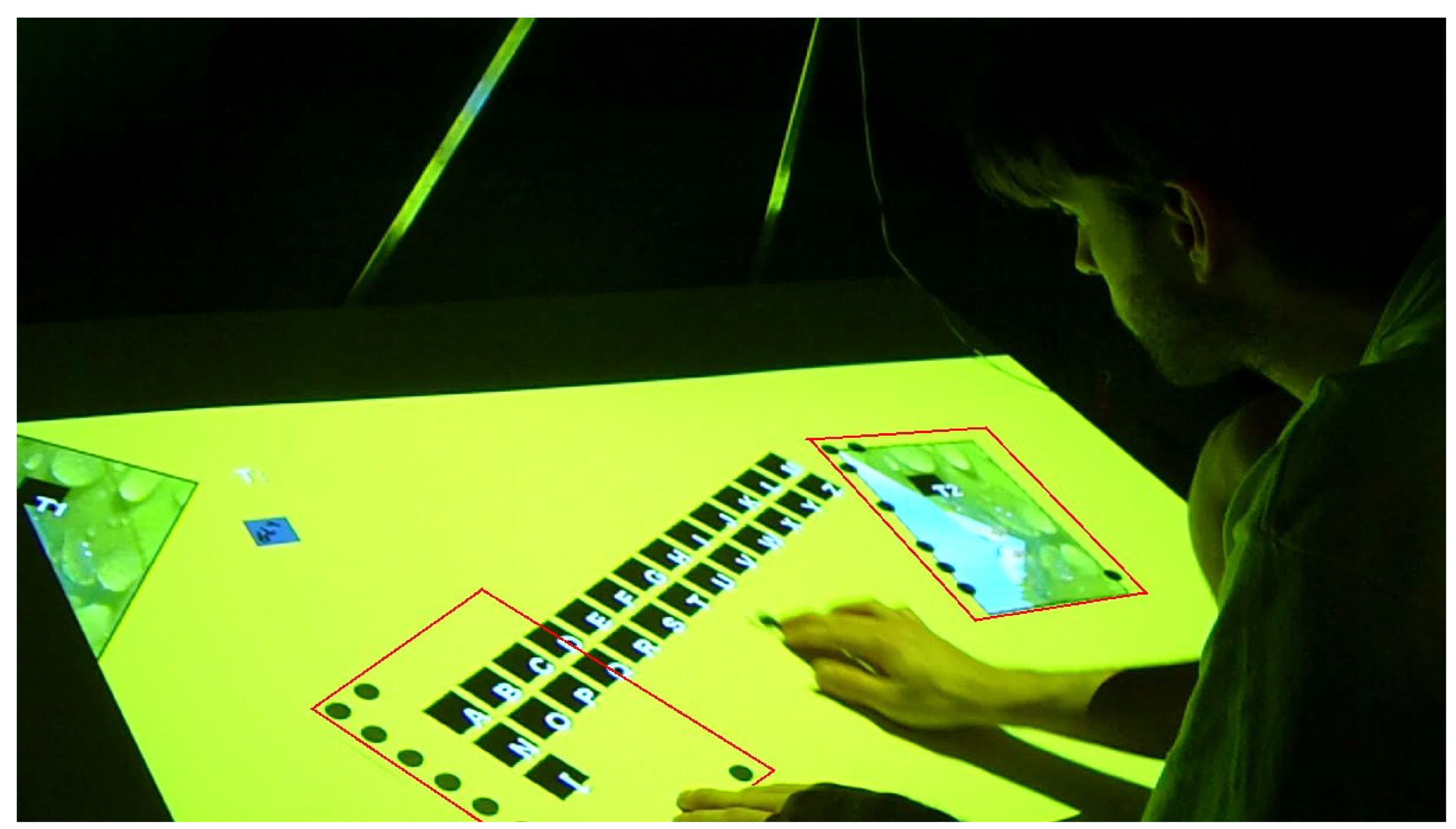
CENTER FOR CONVERGENT DESIGN

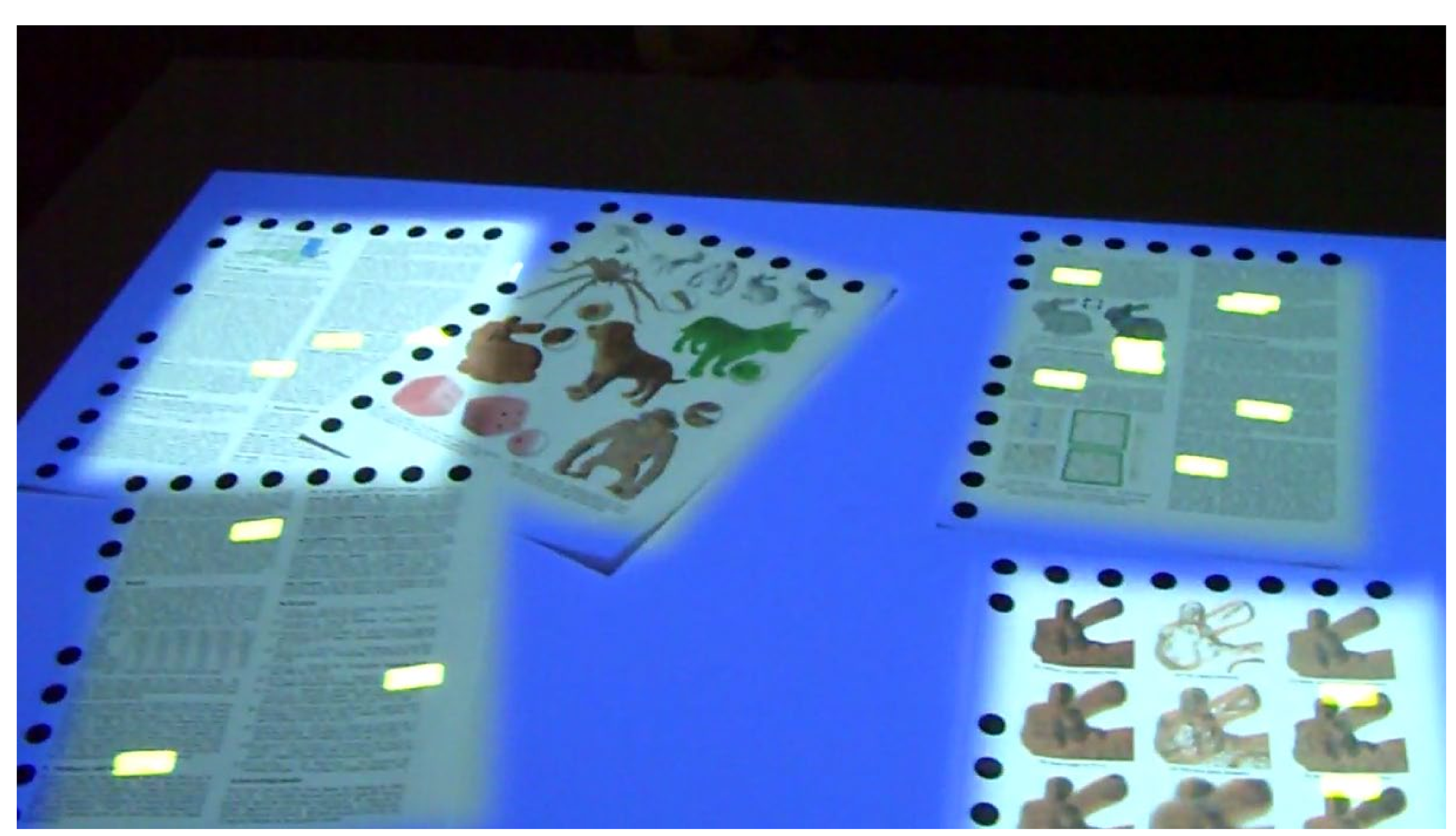
Our Implementation

We use fiducials on pieces of paper to allow the user to interface to the system. We use a camera that detects the locations and other properties of these pieces of paper. By lighting the scene with infrared light and using an infrared camera, the system can clearly see the fiducials regardless of varying or no visible lighting.

We chose to use a DLP projector as an output device. This enabled us to print text onto the surface and produce interesting lighting at great detail. The user can move fiducials around. They can also interact with individual fiduciary dots which can act as pointers interacting with the user interface. The user interface takes advantage of many of the additional properties of our fiducials. For instance, our "windows" are attached to fiducials. They have rotation as a property and do not require on-screen controls to move them around.

Our implementation was written in a manner which allows us to interact in real time with the user on consumer hardware. Many previous systems, such as several FTIR projects, require manual calibration of the viewing area.[2]

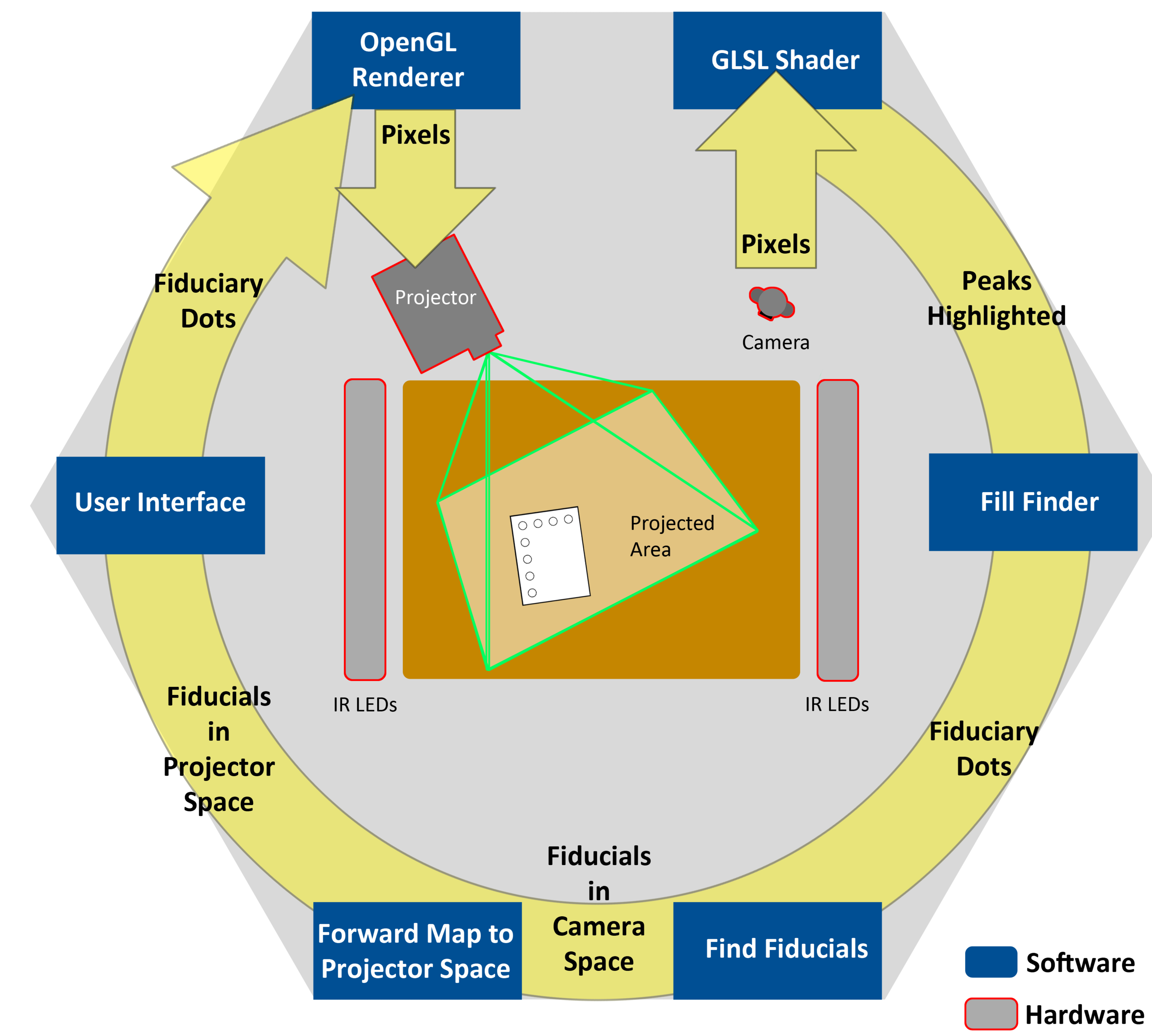




Top: System red outlines are superimposed to indicate where actual sheets of paper are. Bottom: System highlights all cases of a word in a document.

Our system does not require this since it is capable of calibrating itself in an earlier phase of operation. Our system is implemented as a concise, yet modular application in OpenGL. It is clearly segmented into several sections. OpenGL is used heavily in both the GLSL Shader step (used for identifying areas that may be fiduciary dots) and the rendering of the final user interface.

Because our system is modular, it is possible to use the system as a basis for future systems that implement unique user interfaces that could vary greatly from what we demonstrate here.



Conclusion

Our system demonstrates a practical implementation of a specialized Semantic Light system. We demonstrate an example application for Semantic Light and show its potential.

Our implementation has low latency, is intuitive, is simple to implement, is robust, and can be implemented using only minor modifications to consumer hardware.

We only offer a small glimpse of what the field of Semantic Light could offer. With new related technologies, such as more advanced LEDs, better cameras, and more pervasive access to the internet, there is no limit to what Semantic Light may be able to do.

(1) Bencina, Ross; Kaltenbrunner, Martin, 2005 *The Design and Evolution of Fiducials for the reacTIVision System* Music Technology Group, Audiovisual Institute; Universitat Pompeu Fabra, Barcelona, Spain

(2) Han, J. Y. 2005 *Low-Cost Multi-Touch Sensing through Frustrated Total Internal Reflection*. In Proceedings of the 18th Annual ACM Symposium on User Interface Software and Technology