HomeWindow: An Augmented Reality Domestic Monitor

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ABSTRACT
Computation is increasingly prevalent in the home: it serves as a way to control the home itself, or it is part of the many digital appliances within it. The question is: how can home inhabitants effectively understand and control the digital home? Our solution lets a person examine and control their home surroundings through a mobile display that serves as a 'magic lens', where the detail shown varies with proximity. In particular, HomeWindow is an augmented reality system that superimposes an interactive graphical interface atop of physical but digital artifacts in the home. One can get an overview of a room's computational state by looking through the display: the basic state of all digital hot spots are shown atop their physical counterparts. As one approaches a particular digital spot, more detailed information as well as a control interface is shown using a semantic zoom. Our current implementation works with two home devices. First, people can examine and remotely control the status of mobile domestic robots. Second, people can discover the power consumption of household appliances, where appliances are surrounded by a colorful aura that reflects its current and historical energy use.

Categories and Subject Descriptors
H.5.2 [Information Interfaces and Presentation]: User Interfaces – Graphical User Interfaces.

General Terms
Design, Economics, Experimentation, Human Factors.

Keywords
Augmented reality, human-robot interaction, energy awareness, domestic computing ubiquitous computing.

1. INTRODUCTION
Our homes are filled with an ever-increasing amount of digital appliances and artifacts. In addition, many households are welcoming robots into their living space, either as toys or as very basic household caretakers. However, most of these entities are standalone devices, not intended to be part of any centrally organized household system. While our portable music players and mobile phones sync with our laptops, and our digital displays are connected to the cable box, these connections and interfaces are complex and require at least some intimate knowledge of the hardware and software behind these devices.

Rather than interacting with each device individually to discover what state it is in, we propose getting a broader picture of the home space. By carrying a special device that interfaces with many other digital devices in the home, we can see information from a very high level, and not restricted to the interface of the device it is coming from.

The HomeWindow is a handheld mobile computer with a small color display and small camera. Users hold the device in front of them as they walk around the home. The HomeWindow detects "artifacts" using special markers; everything from washing machines, domestic robots, televisions, and lights, showing the camera's images on the display. First, a very general visualization uses color auras to alert the user that certain objects are being tracked. Robots have a simple box around them, while for other objects the color of the aura shows the user how much energy this appliance is currently using, cycling through green, yellow, orange, and red hues as usage increases (Figure 1). As the user approaches a specific device and the HomeWindow gets close to it, a semantic zoom is used to show a detailed information overlay about the appliances.

2. RELATED WORK
Rekimoto et al. [1] describes an augmented reality system called NaviCam that is aware of the physical situation the user is in, and uses colored markers to detect the environment and superimpose additional information above physical artifacts.

Figure 1. HomeWindow showing the energy usage of several monitors, displays, and computers with colored auras. Red is high usage while green is low usage.

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Figure 2. The OQO UMPC with an attached webcam can be held in one hand.

3. IMPLEMENTATION

The HomeWindow builds on the mixed reality lens metaphor. This is where elements in the physical world are supplemented with virtual markers or icons. For the lens metaphor to work, the HomeWindow attempts to be "transparent" and show the user what they would normally see with their own eyes. We use ARToolKitPlus to track devices using inexpensive 2D barcodes that can be recognized with an ordinary webcam.

The HomeWindow must be small and light enough to carry by the user around their home, preferably with one hand. We are using the OQO ultra-mobile PC (UMPC) as the main computer that is running our system (Figure 2). The OQO has a large and high resolution display, a stylus sensitive surface, and built-in wireless that allows the HomeWindow to synchronize with other computers.

3.1 Robot Information

We examine a Sony AIBO robotic dog in the home [2]. This is a sociable robot and has a video camera that it can use to collect pictures from the home. Currently, the user can detect the robot with the HomeWindow and control it remotely using buttons on the UMPC. Our vision is to have the AIBO walk around the house, like a pet, collecting images of things it sees or does, and post them on its own blog. The user can then see the images by bringing the HomeWindow close to the AIBO, and these images will appear above the robot one by one in a slideshow.

Different types of robots can be interfaced to the system like the iRobot Roomba vacuum cleaner. Instead of using the HomeWindow to view a blog, the user can see status updates from the Roomba, such as when it has cleaned last, its battery state, and if it must be cleaned.

3.2 Energy Information

As well as tracking robots, we can use the HomeWindow to overlay information on top of other household devices and appliances. Currently, we use the HomeWindow to display energy usage information for devices in the home such as plasma displays or computer stations using a static image.

Electrical consumption will be recorded using devices like the Watts Up Pro, a meter that can upload data to a computer using wireless or USB [3]. This is stored in a database and is liked to the corresponding device. When the HomeWindow tracks a device, it retrieves the corresponding energy consumption and displays this to the user in the following two ways.

A color aura is superimposed above the device showing the current or historical usage. Green means little consumption while red means the device has been using a lot of energy. When the user approaches the device, a semantic zoom begins to show more detailed information, such as a time graph of consumption, maximum electrical usage, etc. This way, the user can quickly see what devices use the most energy, and then get more information when coming closer.

4. FUTURE WORK

We would like to implement more a robust interaction system with robots. Having the AIBO collect pictures of the home to be reviewed by the user later, or to keep accurate statistics of its operation in the case of the Roomba are two possibilities.

In addition, we would like to use real data for the energy system. This can be collected by a retail device called the Watts-Up Pro that will publish energy consumption to a shared dictionary, which the HomeWindow can access. Graphs of current and historical usage will be shown to the user, instead of the current static image.

5. REFERENCES

[1] Rekimoto, J., and Nagao, K. 1995. The World through the Computer: Computer Augmented Interaction with Real World Environments. UIST '95.

[2] Sony AIBO, http://support.sony-europe.com/aibo/

[3] Watts Up Pro, https://www.wattsupmeters.com/secure/index.php

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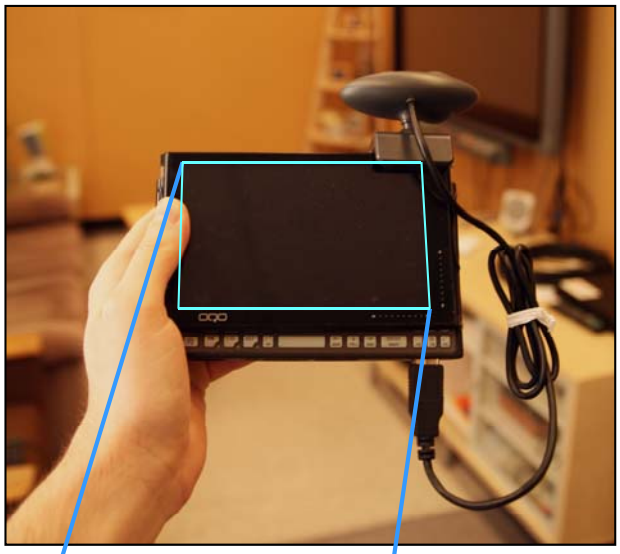
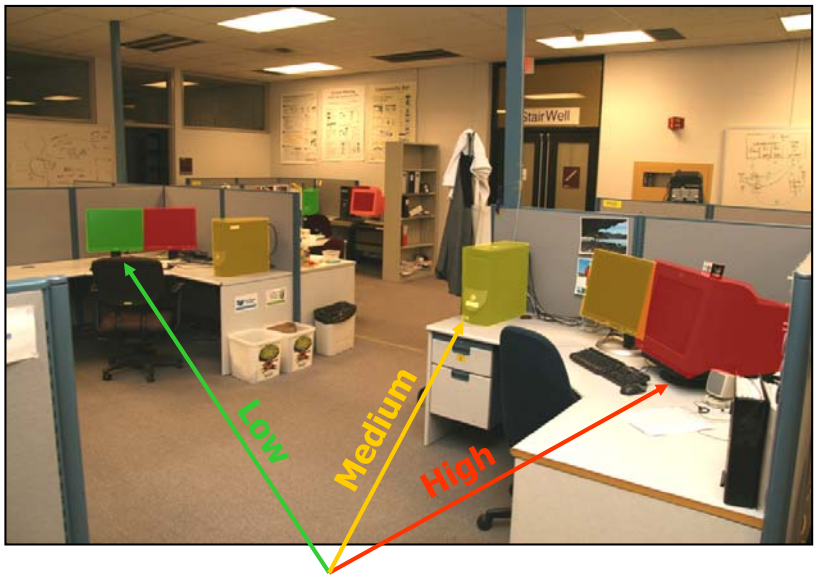
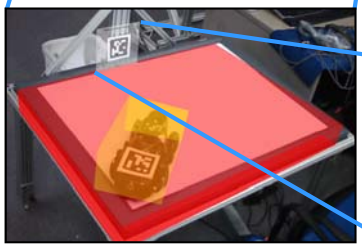
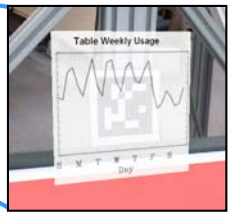




Energy consumption is shown with a colorful aura overtop of devices

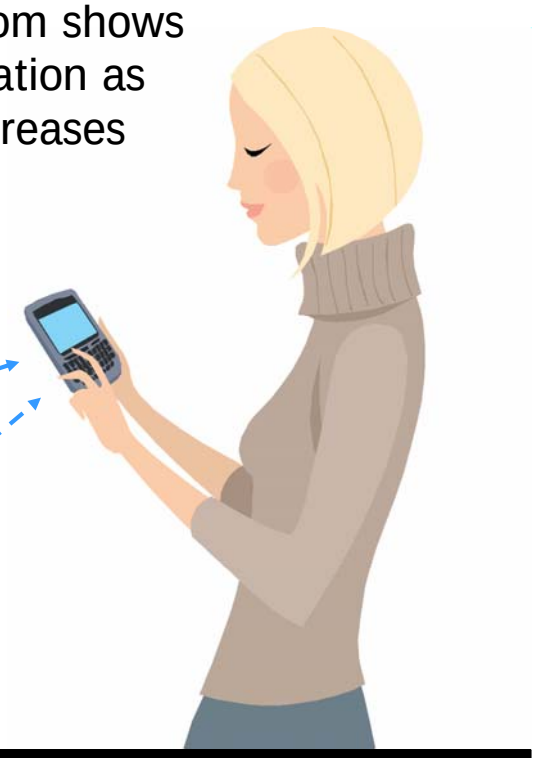




Users view their homes with a 'magic lens' mobile display

Semantic zoom shows more information as proximity increases

Robots are controlled or monitored, broadcasting their status or other attributes



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