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SmartSink: Context-Aware Work Surface

Leonardo Bonanni, Chia-Hsun Lee, Sam Sarcia, Jon Wetzel
MIT Media Laboratory
20 Ames Street
Cambridge, MA 02139 USA
amerigo@media.mit.edu, jackylee@media.mit.edu, ssarcia@mit.edu, jwwetzel@mit.edu

We have become accustomed to a digital desktop that is customizable and anticipates our needs. What if our physical work surfaces could interact with us in the same way? We have recently completed a working prototype of a work surface that automatically adjusts to individual users and anticipates their needs. The work surface is a large sink and counter suitable for installation in multi-user environments where hygiene and ergonomics are important, such as hospitals and commercial or residential kitchens. Vision-based sensing allows the fixture to adjust to your height automatically, to choose when to dispense water and to adjust the temperature of the water based on your needs. The water and work surfaces act as graphical interfaces to inform the user of the sink's status. The work surface is made from soft, strong materials that absorb noise and minimize breakage of delicate objects. As a context-aware appliance, SmartSink allows the user to remain concentrated on the task at hand, only offering information in an informative, unobtrusive manner.

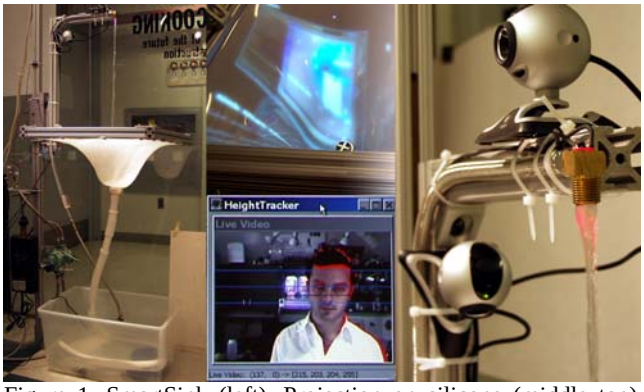

Figure 1. SmartSink (left), Projection on silicone (middle top), HeightTracker (middle bottom), and HeatSink (right).

Automatic Height Adjustment
Work surfaces like the sink are so commonly used that their height can have great impact on the comfort and safety of the user. Comfortable work surface heights vary extremely between tall standing users and children or handicapped/seated users. SmartSink is mounted on a track that allows a vertical adjustment from 28" (71cm) to 48" (122cm) high. A CCD camera mounted on a fixed chassis observes the approaching user and measures their height through a HeightTracker algorithm running on a PC. This program continuously compares video frames from the CCD camera to adjacent frames to detect a user's approach. When it has established the location of highest (y-axis) movement, the program drives the motorized lift mechanism through a PIC-based microcomputer. A stepper motor carries the entire assembly, including flexible supply and drain lines, along an aluminum extrusion fitted with a gear rack.
Automatic Water Flow and Temperature Adjustment
While a sink serves many purposes, water flow and temperature require only limited control for most: on/off and cold/warm/hot respectively. We designed a system to automatically turn on the right temperature of water when something is presented to the sink. A CCD camera mounted on the moving chassis observes the contents of the sink and classifies them through color-recognition and shape-recognition algorithms running on a PC. When a user presents vegetables, the program interprets their green color and dispenses cold water for washing them. When a user presents their palms, the computer recognizes the color of flesh and dispenses warm water for washing hands. When a user presents pots and pans, the computer recognizes the black (iron) and white (glare) and dispenses hot water for washing pots. A user can also train the program through a neural network by specifying the object and the desired water temperature. A PIC-based microcomputer actuates two electric water valves in the tap and an instantanous heater on the supply line to control water flow and temperature.
Display
Although SmartSink is hands-free, users can maintain a sense of control if they are provided with limited information: the temperature of the water and the status of the image-recognition systems. We project images of the camera views and a text describing the sink contents onto the translucent surface of the sink through a multimedia projector mounted above the sink [1]. We have adopted a display system called HeatSink [2] that illuminates the water stream with red or blue light depending on the temperature of the water. The system works by a solid-state sensor that informs a PIC microcontroller, in turn driving LED's installed at the nozzle inside the stream of water. The color carries the length of the stream, projecting a colored spot where the water impacts and where the user's eyes are focused.
Noise-Reduction and Breakage Protection
Traditional sinks are noisy and prone to dish breakage. To counteract this, SmartSink was made with a resilient material that resists bacterial growth and high temperature in addition to noise and breakage. The shell of the sink was cast from platinum-cure silicone in several layers with a two-dimensionally flexible mesh fabric incorporated between the layers to increase tear resistance. The translucent material is suitable as a projection surface and can even be backlit for added task lighting. The silicone is biologically inert and resists up to 700^{o}F (370^{o}C).

Multi-User work surfaces can benefit from the same kind of accommodation that we have grown accustomed to in computer desktops. We will conduct user tests of SmartSink to determine how to augment our physical environment with the same kind of customized, highly responsive interfaces we expect from the digital world.

REFERENCES

1.Lee, Chia-Hsun and Bonanni, Leonardo. *The Kitchen as a Graphical User Inteface*. Accepted to ArtPapers at Siggraph 2004.
2.Arroyo, E. Bonanni, L. Selker, T. *Waterbot:* A Persuasive Technology to Motivate Water Conservation. Submitted to Papers at UIST 2004.