# DigiScope: An Invisible Worlds Window

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**ABSTRACT**

Smart appliances, i.e. wirelessly networked mobile information devices have started to populate the "real world" with "hidden" or "invisible" services, thus building up an "invisible world" of services associated with real world objects. With the embedding of invisible technology into everyday things, however, also the intuitive perception of "invisible services" disappears. In this video we present how we can support the perception of smart appliance services via novel interactive visual experiences. We have developed and built a see-through based visual perception system for "invisible worlds" to support interactive theatre experience in mixed reality spaces, which we call DigiScope. In the video we shown how e.g. the "invisible services" of our SmartCase, an Internet enabled suitcase, can be visualized via graphical hyperlink annotations

**Keywords**
Computational Perception, Smart Appliances, MR.

**SMART THINGS**

"The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it" was Mark Weiser's central statement in his seminal paper [8] in 1991. His conjecture, that "we are trying to conceive a new way of thinking about computers in the world, one that takes into account the natural human environment and allows the computers themselves to vanish into the background" has fertilized not only the embedding of ubiquitous computing technology into a natural human environment which responds to people's needs and actions in a contextual manner, but has also caused "hidden" functionality and services volatilize out of sight of humans. "Smart Things" functionality is characterized by the autonomy of their programmed behaviour, the dynamicity and context-awareness of services and applications they offer, the ad-hoc interoperability of services and the different modes of user interaction upon those services. Since many of these objects are able to communicate and interact with global networks and with each other, the vision of "context-aware" [1] smart appliances and smart spaces – where dynamically configured systems of mobile entities by exploiting the available infrastructure and processing power of the environment – has become a reality.

**DIGISCOPE**

With our work we aim at supporting "human to ubiquitous computer interaction" processes by bringing back visual clues to the user on how to interact. Once computers have disappeared from desks, hiding in the background, their services will most likely still be there. New artefacts and smart appliances [7] are evolving that "carry" invisible services, such that manipulating the appliance controls a service. Even if the service is not integrated into the artefact but merely "linked" to a background system [5], the manipulation of the physical object can manipulate their virtual representative on that background system respectively. To this end it is necessary to link the physical world with the virtual world [2], i.e. the linking of physical objects with their "virtual counterparts" [6]. Tangible interface research [4] has contributed to this issue of physical-virtual linkage by considering physical artefacts as representations and controls for digital information. A physical object thus represents information while at the same time acts a control for directly manipulating that information or underlying associations.

This video presents the use of DigiScope, a 6DOF visual see-through tablet we have developed to support an intuitive "invisible service" – or more generally: "invisible world" – inspection: the invisible services of the smart appliance "SmartCase" – which has been developed as a demonstrator for a contextware framework [2] [3] – are inspected. We exploit the metaphor of digital annotations for real world objects, and display these annotations along the line of sight to real world objects that are seen through a holographic display. The user gets the ability to interact with the virtual object and its digital information by viewing the corresponding real (physical) artefact. With DigiScope, the user is handling a holographic display tablet just like a 6 DOF window that opens a view into the virtual world. The tablet is an optical see-though display which allows for a very natural viewing and scene inspection. To implement correct views into the scene, the angle and perspective of the DigiScope is being tracked, instead of tracking the position and orientation of the user. Thus the user is freed from any system hardware obstacles like HMDs, stereoscopic glasses, trackers, sensors, markers, tags, pointers and the such. To support free navigation in the scene, the DigiScope can be fully tilt and rotated in space by hand. The projecting beamer is fixed in the right projecting angle within a 6DOF mounting frame, and is

used to project the computer generated image encoding the scene annotation onto a holographic display. The DigiScope software architecture is based on standard building blocks for AR application frameworks: (i) a 6 DOF tracking library for position and orientation tracking of the DigiScope frame, (ii) Java and Java3D for 3D scene modelling, rendering and implementing user interaction, and (iii) ARToolkit for visual object tracking and scene recognition.

## INSPECTING SMARTCASE

In previous work we have developed SmartCase [2], a context aware smart appliance [3]. The hardware for the SmartCase demonstration prototype uses an embedded single board computer integrated into an off-the-shelf suitcase, which executes a standard TCP/IP stack and HTTP server, accepting requests wirelessly over an integrated IEEE802.11b WLAN adaptor. A miniaturized RFID reader is connected to the serial port of the server machine, an RFID antenna is integrated in the frame of the suitcase so as to enable the server to sense RFID tags contained in the SmartCase. A vast of 125KHz and 13,56 MHz magnetic coupled transponders are used to tag real world objects (like shirts, keys, PDAs or even printed paper) to be potentially carried (and sensed) by the suitcase. In addition, the SmartCase is equipped with optical markers so as to enable visual recognition and tracking with the ARToolkit framework.

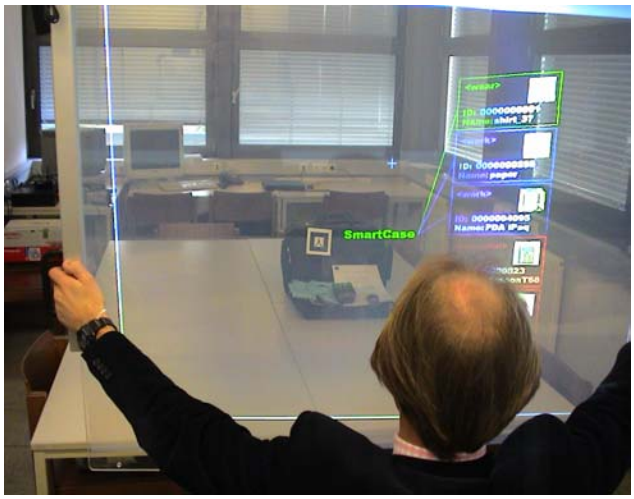


**Figure 1:** The DigiScope

A unique ID associated with every real world object is the ID encoded in its RFID tag. It is sensed by an RFID reader which triggers a script to update the state information on the embedded Web server. Considering now the inventory of the SmartCase as an "invisible" service, then, once an object (e.g. shirt) has been put into the SmartCase, this service can be queried to check whether the shirt is in the case or not. A straightforward way to access this information would be via a classical http interface to the embedded web-server. Observed via the DigiSpace however, changes to the SmartCase inventory are displayed as a graphical annotation of the real world.

## CONCLUSIONS

This video presents DigiScope, a 6DOF visual see-through inspection tablet, as an approach towards emerging problem of developing intuitive interfaces for the perception and inspection of environments populated with an increasing number of smart appliances in the pervasive and ubiquitous computing landscape. DigiScope envisions a new type of MR interface with two main features: (i) a new exploration experience of the physical world seamlessly merged with its digital annotations via a non-obtrusive MR interface, and (ii) an integration of ubiquitous context-awareness and physical hyperlinking at the user interface level. The DigiScope is demonstrated in operation.

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