Responsive Sensate Environments: Past and Future Directions
Designing Space as an Interface with Socio-Spatial Information

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Abstract: This paper looks at ways in which recent developments in sensing technologies and gestural control of data in 3D space provide opportunities to interact with information. Social and spatial data, the utilisation of space, flows of people and dense abstract data lend themselves to visual and auditory representation to enhance our understanding of socio-spatial patterns. Mapping information to visualisation and sonification leads to gestural interaction with information representation, dissolving the visibility and tangibility of traditional computational interfaces and hardware. The purpose of this integration of new technologies is to blur boundaries between computational and spatial interaction and to transform building spaces into responsive, intelligent interfaces for display and information access.

1 INTRODUCTION

Rather than the traditional computer aided architectural design and information communication technology (ICT) integration into architecture, this paper looks designing computer-aided architecture, i.e. spaces and structures enhanced by embedded sensor technologies and responsive (computational) building intelligence. Architecture’s responsibility to society could be viewed as designing a sympathetic environment for human experience and interaction. Emerging sensing technologies and intelligence research illuminate interesting opportunities for designing this experience.

2 RESPONSIVE ENVIRONMENTS

Responsive environments include sensate spaces, enabled by spatially- and socially- triggered devices, intelligent and smart houses (utilising video tracking and data capture), networked sensor environments, pervasive mobile computing solutions and ambient visual and auditory displays. This paper briefly reviews the benefits of extant responsive technologies that have developed since last century until the
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present time in order to clarify potential for future directions. Future architectural
design requires a re-thinking of the way in which we design spaces that seamlessly
integrate people, architectural structures, sensing and interface technologies to
dissolve the distinction between human interaction with buildings and computer
interaction. Current research mapping human spatial and social behaviour to
generative sonification and visualisation for ambient display leads to a second
capability of sensate environments: capturing interaction to observe emergent
human activity. This goal utilises active and passive sensing technologies to learn
more about human interaction, flow and flocking patterns in transitional and social
building spaces. Such observant systems can be applied to new spaces to increase
the building’s awareness.

2.1 Active and Passive Sensing

Active sensors require conscious, deliberate interaction. These include bend, motion,
gyroscopic and velocity sensors attached to limbs, pointer devices, 6-degree-of-
freedom mice (computer mice or pointers that convey 3D directional movement,
rotation and velocity), haptic (i.e. tactile) interfaces, stereo 3D vision or gesture
tracking. In an art installation context, these sensors are performative interface
devices. Gestural controllers (discussed later) are active sensors and triggers that
enable direct spatial human interaction with information representation. For
example, gesture controllers allow a person to manipulate, twist, relocate, and
transform visual and auditory data using arm and hand gestures. In contrast,
inconspicuous, unobtrusive, embedded or passive sensing captures data without the
user needing to change behaviour or consciously interact with the space, e.g.
pressure sensitive floor mats, video tracking, infra-red sensors, temperature,
proximity and ultra-sonic sensors. Passive sensing is optimal for sensate
environments or intelligent buildings in which people should continue their
everyday tasks with the additional advantage of smart feedback, an environment
capable of learning (with Artificial Intelligence) and reflexive ambient display.

The difference between active and passive systems lies in the awareness by the user. Commands are extracted from the data stream in exactly the same way for the
aforementioned tactile active or passive devices. In contrast, gesture recognition and
‘interpretative’ command extraction is more complex in the case of non-tangible
capture technologies such as gesture walls and video tracking. The technical
mechanism of command extraction is not the focus of this paper, rather the concern
here is the implication of socio-spatial behaviour mapping in sensate spaces that can
be both informative and responsive.

2.2 Responsive Environment Design Using Sensors

The methodologies for implementation here are examples from the Key Centre of
Design Computing and Cognition (University of Sydney) Sentient Lab design studio
(Figure 1). Projects use embedded sensors, Teleo modules to convert digital and
analogue signals for computation using the visual object-oriented programming