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SenseStage: Low Cost Open Source Wireless Sensor Infrastructure for Live Performance and Interactive Real Time Environments

SenseStage is a research-creation project to develop small, low cost and low power wireless sensor hardware together with software infrastructure specifically for use in live theater, dance and music performance as well as for the design of interactive, real-time environments involving distributed, heterogeneous sensing modalities.
The project consists of three components:

- a series of small, battery powered wireless PCBs that can acquire and transmit input from a range of analog and digital sensors.
- an open source software environment that enables the real-time sharing of such sensor data among designers and
- plug in modules that enable the analysis of such sensor data streams in order to provide building blocks for the generation of complex dynamics for output media.

The project emerged from a desire to address a novel, emerging research field: distributed, wireless sensing networks for real-time composition using many forms of output media including sound, video, lighting, mechatronic and actuation devices and similar. The design of interactive environments using diverse output media increasingly involves the mapping of many channels of real-time sensor data to control the temporal behavior of such media. Standard mapping techniques with sensors that have been derived from the ”instrument building” paradigm, usually address only small numbers of sensors or participants and may not scale well to larger spaces. Systems involv-

ing large numbers of sensors and participants are rare, custom-designed, and expensive.

Furthermore, while wireless sensors and wireless sensor networks (WSNs) are being increasingly deployed daily in areas such as health care, defense, seismology and home security, there are scant examples of such technologies in artistic projects simply due to the lack of available hardware/software infrastructure for artists to use. Most work in sensor networks has been in areas of applied technology development without artistic aims or is restricted to lab settings. Based on these factors, SenseStage has developed a fully integrated hardware and software infrastructure that is intuitive to use by artists and designers, is scaleable to many nodes and performs data acquisition, transmission, conditioning, sharing and compositional tasks all within the same system.

Three specific factors have motivated the SenseStage project:

1) Economic and technical constraints of live performance:

While there is increasing interest in the use of sensing technologies in live performance contexts (particularly theater, dance and music-theater), the economic and cultural constraints of live performance make the integration and use of such experimental technologies difficult. Long rehearsal periods and proper technical infrastructure necessary to test and use sensing systems are prohibitively expensive for artists and cultural institutions. This is particularly evident in the extremely short technical integration periods ("tech week" or "technical rehearsals") that are customary for theater, dance and music. Thus, the use of many sensing devices and software tools needs to be conditioned by flexibility, minimal preshow setup time, quick deployment and use within a variety of stage or exhibition conditions.

2) Lack of tools for artistic use:

As previously stated, SenseStage emerged from a desire to address the emerging research field of ubiquitous computing within the artistic, real-time context of live performance and interactive environments. Although many groups are currently researching and developing WSNs, design decisions are normally motivated by engineering innovations thus leading to efficient yet, prohibitively expensive and complex systems out of the reach of artists. Furthermore, as will be detailed below, despite the high number of research initiatives currently taking place, there are disappointingly few wireless sensing platforms that are actually available for real world use or that are cost effective. In addition, there is a lack of software tools for interacting easily with the large amount of data produced by such distributed wireless systems, especially tools implemented in lingua franca programming languages and environments used by musicians, sound and media artists such as Processing, Max/MSP/Jitter, Supercollider, PureData and other environments supporting OpenSoundControl (OSC). SenseStage seeks to develop a technological framework that eases the exchange of data between many diverse programming environments used for interactive sound and media projects in order that artists and designers with diverse practices can work efficiently

on complex interactive projects in both development (i.e., rehearsal) and performance stages.

3) Real world testing scenarios:

Much of the research agenda for the project was driven by many years of artistic work and technological development of tools to facilitate the creation of interactive performances and installations with distributed sensing and which used mapping of such input data to complex parameter spaces for the control of sound and other media in real-time. A key design element of the SenseStage project is thus to deploy SenseStage technologies into real world, professionally driven testing environments to see how such tools function “in the wild” and outside of the standard lab, demo-driven mode normally given to the presentation of new technologies.