Chapter 8.9
Ambient Intelligence on the Dance Floor

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ABSTRACT

With the evolution of intelligent devices, sensors, and ambient intelligent systems, it is not surprising to see many research projects starting to explore the design of intelligent artifacts in the area of art and technology; these projects take the form of art exhibits, interactive performances, and multi-media installations. In this paper, we seek to propose a new architecture for an ambient intelligent dance performance space. Dance is an art form that seeks to explore the use of gesture and body as means of artistic expression. This paper proposes an extension to the medium of expression currently used in dance—we seek to explore the use of the dance environment itself, including the stage lighting and music, as a medium for artistic reflection and expression. To materialize this vision, the performance space will be augmented with several sensors: physiological sensors worn by the dancers, as well as pressure sensor mats installed on the floor to track dancers' movements. Data from these sensors will be passed into a three layered architecture: a layer analyzes sensor data collected from physiological and pressure sensors. Another layer intelligently adapts the lighting and music to portray the dancer's physiological state given artistic patterns authored through specifically developed tools; and, lastly, a layer for presenting the music and lighting changes in the physical dance environment. [Article copies are available for purchase from InfoSci-on-Demand.com]

INTRODUCTION

Ambient Intelligence (AmI) integrates concepts ranging from ubiquitous computing to Artificial Intelligence (AI) with the vision that technology will become invisible, embedded in our natural surroundings, present whenever we need it, attuned to the users' senses, and adaptive to users. In an Ambient Intelligent environment , people are surrounded with networks of embedded intelligent devices that can sense their state, anticipate, and

perhaps adapt to their needs. One can imagine the implementation of such a vision within a dance environment where lighting, scenery, and audio change dynamically in the performance to reflect the dancers' movements and state. In this paper, we address such a vision. Particularly, we aim to address the design of a new ambient intelligent dance environment.

The project explores the visual depiction of the self and body in the light of the rising new technologies and media. The focus is the graphic representation of the dancer's creative expression in time. The artificial representation of the dancer is generated by transforming actual physiological signals from a dancer's body into visual and audio forms. Since the resulting form will represent the individual whose biological signals generate and sustain it, it will be a personal signature of that individual in digital space. The dance space will envelop its user via stage lighting and sound. By offering a new way of exploring the relationship between the dancer and her artificial reflection through the dance environment, this project will provoke profound and lasting aesthetic and reflective responses from its users/audience. The pursuit of this project is expected to establish a new area of creative inquiry in dance with several potential spin-offs and artistic collaborations.

To realize this vision, dancers will wear wireless physiological sensors that measure three functions: 1) skin conductance, 2) cardiac activity, and 3) body temperature. In addition, pressure sensors will be installed in the physical dance floor. Data from the sensors will be processed through two interface systems; one extracts physiological data, normalizes the signal, and interpolates any missing data, while the other collects pressure signals from all pressure mats and computes light IDs for lights affecting the dancer. These Light IDs and the physiological data will then be fed to two intelligent subsystems: an intelligent on-stage lighting system and an intelligent music system. These systems will adapt the lighting and music to reflect the dancer's movements and physiological state.

As with any artistic performance giving artists a language to identify the style and manner with which the intelligent systems can reflect dancer's state and movements is of utter importance. For this purpose, we have developed two tools: lighting and music tool. Both tools allow artists to identify the style and manner of reflection at a high level. The lighting tool allows designers to set several constraints; for example, she can set constraints indicating the shift of warmth of color in specific regions or level of contrast and shift in contrast between different regions as a function of the physiological state. Similar to the lighting tool, the intelligent music tool will allow artists to author constraints and patterns of music movements and shifts as a function of dancer's movements and physiological state.

The lighting and music intelligent systems use these artistic settings as constraints to adapt the lighting and music in real-time based on the given dancer's physiological state and movements. The intelligent lighting system uses non-constraint optimization to adjust each on-stage light color and angle reflecting the dancers' physiological state and movements while maintaining desired artistic style and patterns. The intelligent music system uses a rule-based system to dynamically and unobtrusively adapt the music to the dancer's physiological state given authored constraints and music patterns.

There have been numerous projects that integrated virtual imagery in performance, examples include (Crow & Csuri, 1985); Gruen, 1983; (Meador, Rogers, O'Neal, Kurt, & Cunningham, 2004). However, there is very little work that allows adaptation of on-stage lighting and music as an extension of the dancers' cognitive space. The area of Cognitive Informatics (Wang, 2006, 2007) fits our area of inquiry. In particular this is a field studies the mechanisms and process of natural processing and intelligence, includ-