

# Ubiquitous Displays Via a Distributed Framework of Projector-Camera Systems

Aditi Majumder

Department of Computer Science, University of California, Irvine

**Vision:** We envision a new display paradigm where displays are not mere carriers of information, but active members of the workspace interacting with data, user, environment and other displays. The goal is to integrate such active displays seamlessly with the environment making them ubiquitous to multiple users and data. Such ubiquitous display can be a critical component of the future collaborative workspace.

**Goals:** For this purpose, we are exploring a active display unit made of a projector augmented with sensors, and an embedded computation and communication unit as active display. We call these active displays plug-and-play projectors (PPP). We are also exploring for the first time, the challenges and capabilities resulting from instrumenting a workspace with a distributed network of such PPPs to achieve ubiquitous displays.

We are developing novel distributed methodologies to (a) cover the existing surfaces (e.g. walls, floors), that can deviate considerably from planar, white and Lambertian, with multiple active displays; (b) provide scalability and reconfigurability (in terms of scale, resolution and form factor) of displays; (c) provide a framework for shared viewing and interaction modalities for multiple users.

**Research Objectives:** To achieve the above goals, we plan to develop distributed methodologies to interact with the environment, data and user. For interaction with environment, we plan to develop methodologies that register imagery globally with the underlying display surface via multiple local corrections. For interaction with the user, we plan to develop distributed methodologies for gesture-tracking and use it to design a gesture-based shared interaction modality for large-scale data visualization and modification. For interaction with the data, we will develop an application-independent distributed windows management middleware called overloaded windows. The developed methodologies for interaction with user and data will be used to provide a novel application of distributed data mobilizer for scanning, storing and interacting with life-size image-like artifacts. The developed methodologies will be evaluated using the developed infrastructure and the Environment to Environment Communication (E2E) project with National University of Singapore (NUS).

**Current State of the Project:** Initial explorations for this project was supported by an NSF SGER grant from 2007-2008. Recently we have been funded for this project by NSF CAREER 2009. We are just starting to build the infra-structure to instrument ubiquitous display in a large laboratory setting with 15 projector-camera pairs mounted on rails/pan-tilt units controlled by 15 PCs.

While this is in progress, in our current large area display lab that hosts a 9 projector planar display and an 8 projector cylindrical display, we have started some early explorations towards the above objectives. This has led to a considerable body of literature. We have developed the first prototype of a distributed framework of PPPs on planar displays and distributed methodologies for identifying the PPP configuration and registering them geometrically [1]. To enable use of uncalibrated devices, we have explored photometric self-calibration of PPPs [2]. Considering the fact, that for ubiquitous displays most of the time the underlying surfaces will be extruded surfaces, we have submitted two manuscripts on auto-registration of projectors on such surfaces [2,3,4]. Since we plan to use inexpensive projectors that show considerable color variation, we have explored novel color calibration techniques [5]. We have also realized the first prototype of data handling displays using a distributed gesture tracking mechanisms [6].

## References

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