Beyond Application-Led Research in Pervasive Display Systems

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Abstract. This position paper argues that more research is needed into identifying key abstractions and reference criteria for multi-purpose display systems. This would enable research in this area to go beyond the development of specific applications and move towards enabling infrastructures that could serve the needs of multiple applications.

1 Introduction

The use of large public displays has attracted considerable interest in recent years, and several prototypes have been built that explore many of their potential applications. Still, most research so far has focused on specific applications and their evaluation from an end-user perspective, and not much attention has been given to generic infra-structure support for pervasive display applications. As a consequence, and even though many systems provide similar functionality and address common issues, they are hard to compare and evaluate. In this position paper, we argue that the key issue for this workshop is the definition of an evolutionary path that promotes incremental research in this area. This may include the definition of common terminology, the identification of common abstractions and architectural approaches, the promotion of benchmark tasks that facilitate the comparison between various systems, and ultimately the move away from designs specialized for each particular environment to reusable building blocks that provide common infrastructure support for multi-purpose pervasive display systems. This workshop may build on other early efforts in the same direction [1], as well as on the contributions and experience of the participants to make a decisive step in that direction and move away from the limitations of application-led research [2].

2 Pervasive Display Systems

In this paper we are basically considering general purpose display infrastructures that manage multiple public displays, and which we call Pervasive Display Systems (PDS).

A PDS is made up of public displays, i.e. displays that are not under the control of a single user. This is probably the main conceptual difference between PDS and Distributed Displays Environments (DDE) research, where the focus is on supporting computer systems that present output to more than one physical display.

A PDS is multi-purpose, and thus is not tailored at the needs of any application in particular. It provides generic support to an open-ended set of applications that may require display services. The main function of the PDS is to manage display requests and arbitrate display resources. A direct consequence of being multi-purpose is the need to provide some control interface where the behaviour of the system can be programmed.

Finally, a PDS is assumed to support coordination between multiple displays. Even if individual displays may control their own level of integration with a shared infrastructure, and in some cases be operated in isolation, the assumption is that the system is able to support the integration of multiple displays into an infra-structure that is perceived by users as a single coordinated display system. Furthermore, those multiple displays are potentially dispersed across many sites spanning a vast geographical area and they are typically placed at such a distance from each other that a user is only able to interact with one display at each point in time [3]. Again, this differentiates PDS from Distributed Display Environments where displays are assumed to be co-located.

2.1 A taxonomy of usage models

The central issue when considering multi-purpose display systems is how to identify the potential requirements that an open-ended set of applications may impose on those systems. This may prove to be an unfeasible task given the broad variety of scenarios in which pervasive displays systems have been used, and, since this is an area in which we are just starting to explore its many possibilities, all the new usage types that are yet to be identified. Still, as an incremental step, we can identify at large what are the main usage models and their key requirements. Such categorisation of the main usage models from the perspective of the requirements imposed upon the infrastructure can help us clustering the multiple requirements posed by individual applications, and inform the design of pervasive display systems so that they can be targeted at their main usage. Furthermore, it may also help to guide user expectations on display systems and manage their perceived affordances. From our literature survey, we have grouped existing applications into the following five usage models:

Experience oriented - Experience oriented displays are typically part of a media and sensor rich installation conceived for providing some sort of strong and engaging user experience, e.g. interactive art installations or games. The displays are normally interactive, but all the interactions are directly related with the narrative of the experience itself. A very important point for these systems is the ability of the experience creators to maintain a strong control over the behaviour of the displays so that they can know exactly what the experience is going to be like.

Content oriented - Content oriented displays are focused on the dissemination of content to people passing-by. Content can be controlled centrally in a one-to-many broadcast model, as in the digital signage networks that control most of the displays that we can find today in public places, or created locally, as in the plasma Poster network, in which community shared multimedia content is displayed [4]. In either case, the main role of the system is to arbitrate content presentation by separating it in time or space.

Sign oriented - Sign oriented displays are primarily used as digital replacements for traditional signs, e.g. room numbers or directional signs. Their objective is thus to present specific and short pieces of information concerning things such as directions to some nearby event, the name of the place, the current status of a meeting room, or an occasional location-based announcement. Even if we admit that a sign oriented display may alternate its presentation between a small set of different views, they are not expected to change as often as content oriented systems. An appropriate space model may enable displays to generate dynamic directions that are location and orientation specific as in [5].

Ambient oriented - Ambient oriented displays are mainly used for promoting awareness through the periphery of attention. They are expected to change smoothly, providing a continuous, but distraction-free, output of background information. Examples may include GUI-based approaches such as informative art [6] and InfoCanvas [7], or displays based on light and sound patterns as in the Hello.Wall [8] and AmbientROOM [9].

Personal oriented – Personal oriented displays are mainly designed to support individual access to digital services. An individual may approach the display and use it at its own convenience for the time needed to complete a particular service. They differ from typical information kiosks in that the display is public, and thus visible to other proximate people. If the system is able to support multiple users simultaneously interactions may be longer, otherwise interactions should be short in order to avoid preemption of the display by a single user. Another major concern is handling user data which may be private and thus not shown on the display. Examples of multi-user systems designed for personal services are the Dynamo [10] and BlueBoard [11] systems. More common examples include the store assistance displays in which customers may approach the barcode of a product and obtain further information about that product.

We believe that the categorisation above is comprehensive enough to accommodate the current status of the art in pervasive display systems, but a single system may combine characteristics from more than one usage model and thus these categories should not be seen as isolated. From the perspective of the generalisation of requirements most of these usage models pose requirements that are specific but easy to combine with requirements posed by other usage models. Experience oriented systems are the exception because of their need for sophisticated control, which may lead to design time optimisations and more specific approaches, meaning that their requirements do not lend themselves to generalisation as easily as the other usage models. This contradiction between support for sophisticated control and generalisation is probably the key trade-off in the design of PDS.

3 Situaction Framework

Our own approach for handling the challenges of multi-purpose networks of public displays is the Situaction Framework. We aim to enable the use of situated displays as part of a larger ubiquitous computing infrastructure. Situated applications may be running to support activities associated with that physical space and use presentation services, either pre-programmed, pro-actively, or as a reaction to user input. The Situaction framework is designed around the following key principles:

1. The presented items are mainly situated applications, and not just static content. Situated applications are able to generate dynamic content and negotiate their current utility with the system.
2. The system intermediates user input, separating the process of sensing user input from the problem of reacting to that input.
3. Scheduling is context-aware and is based on the dynamic maximisation of the systems' utility. Our approach is a context-aware scheduling model based on a long-term scheduling that defines the set of activities to be presented together with various context criteria for their presentation, and a short-term scheduling that builds on the current state of the system, environment and applications to select the most relevant application to be presented.

7 Conclusions

The Situaction framework is an attempt at enabling the concept of Pervasive Display System. Other systems have been developed with similar goals, but the current lack of reference criteria for their evaluation makes it very difficult to compare the findings and evaluate the suitability of those systems for specific applications.

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