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# Document-Centric Mixed Reality and Informal Communication in a Brazilian Neurological Institution

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**Abstract**

We present initial designs toward a system facilitating ad hoc communication among staff in a large chronic care hospital for patients with neurological disorders and brain injury. We identify unique characteristics of the hospital and its context, and we discuss potential benefits of employing *document-centric mixed reality* as a means of enhancing the informal communication practices that support hospital workflow.

**Author Keywords**

Mixed reality, natural user interface, health care

**ACM Classification Keywords**

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

**Introduction**

We have recently begun working with a chronic care hospital for persons with neurological disorders in Brazil. This work involves collaboration among several Canadian and Brazilian research groups in HCI and design, with the goal of designing digital services for the hospital that employ a combination of natural user interfaces, visual analytics and ubiquitous infrastructure.

In this position paper, we discuss some qualities of the hospital context that have influenced preliminary ideation and design work on a system to support *ad hoc, in situ* communication surrounding medical documents. These include staff scheduling and meeting communications, policy directives, formal patient records, progress notes and observations, and increasingly audiovisual materials capturing patient behavior. Our current design direction is then presented in light of these somewhat unique contextual factors. We argue that a lightweight document-centric mixed reality approach may provide immediate benefits for the hospital staff.

### **Motivation and Background**

The hospital has a number of interesting characteristics that significantly impact our research agenda. Here we outline those characteristics that are most pertinent to this discussion.

First, the hospital's current workflow is largely *reliant on paper*. Aside from a small number of computers used for orders and invoices, the hospital does not currently use digital information technology. Patient records, daily logs, schedules, lesson plans and reports, administrative plans and policies, all are recorded on paper. Hospital practices surrounding knowledge transfer, shift changes, meetings and policy enforcement revolve around such paper artifacts.

Second, the hospital's *physical characteristics* impose constraints on work practice and technology. The edifice is quite old and walls are very thick. As a result, there is virtually no cellular reception throughout. Many staff don't have a single home base within the hospital, and not every room is reachable by landline telephone.

Further, the institution has a wide, central, north-south hallway, several hundred metres in length, with two intersecting east-west wings, meaning co-workers can be quite a distance apart from each other. For these reasons contacting co-workers can be a challenge, both for informal communication as well as for formal meetings.

Third, some hospital routines are not formally codified. What superficially may be informal communication is thus often a critical part of the day-to-day operation of the hospital. Such routines are learned by observation and through discussion with co-workers.

Finally, the hospital itself is currently undergoing a major shift in emphasis from chronic care to habilitation and (re)integration into society. This requires support for remote monitoring and casual intervention in temporary living spaces where patients can acquire independent or assisted living skills.

### **NUI in a Paper-Based Institution**

Studying and evaluating novel systems involving natural user interfaces<sup>1</sup> (NUIs), visualization and pervasive computing infrastructure within the context of a largely paper-based institution has high research value for (at least) two reasons. First, the relative absence of traditional health information systems allows novel technological approaches to be explored unencumbered by the existing digital infrastructure. Second, it opens up opportunity to explore how these "natural" modes of interaction are informed by and

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<sup>1</sup> Defined here as interfaces involving speech, touch, gesture, and established means of interacting with physical materials.

augment existing, and arguably also “natural”, paper-based practices.

CSCW has long drawn inspiration from paper-based practices. In some cases, such as with Air Traffic Controller flight strips [1], it has been very difficult to replace paper with digital systems, leading to explorations as to how these systems can better integrate with other information artifacts [2]. Other research has considered how groups organize themselves around shared information resources (e.g. whiteboards, engineering drawings, maps [3]), and situate themselves and these resources in a shared workspace [4,5], in order to derive design guidance for pervasive digital interactive systems.

This reflection on existing practice is particularly relevant in the healthcare context. Paper-based forms (e.g. the pain scale) may carry the force of clinical validation, and cannot simply be replaced by a digital facsimile. The choices as to when, where, and how hospital staff share information (and how they do so while respecting the privacy of their patients) are not obvious and require direct study.

### **A case for Document-Centric Mixed Reality**

In this section we outline our current design directions. *Document-centric Mixed Reality* is a form of collaborative system that permits synchronous and asynchronous, remote and collocated forms of cooperative work [6,7]. Documents and individuals have a presence in a virtual world, and this world is grafted onto physical workspaces. Such systems have several key characteristics that appear to map well to our particular hospital context.

*Supporting a gradual transition between physical and*

*logical data storage.* In these systems documents have both a digital and a spatial manifestation; since all documents reside in a 3-D virtual world, traditional spatial practices for organization, manipulation and storage can translate directly from paper to digital. While this very literal mapping from paper to digital is possible, so are more abstracted forms of organization, storage and manipulation, allowing the system to adapt as the hospital staff become more sophisticated digital workers. Despite the opportunities for design offered by the paper-based practices in the institution, supporting the access, manipulation and storage of documents remains a critical design challenge.

*Collapsing space.* Mixed reality collapses space by allowing remote collaborators to work with a group of collocated collaborators through a virtual world mapped onto the collocated group’s work region(s). In the hospital, this has definite potential benefit for communication given the large distances in the building. For example, this would allow a psychiatric doctor to remotely review and discuss documents with an onsite nurse, and to include additional doctors in the discussion. The transition houses also seem to be ideal locations to support virtual monitoring and presence of remote caregivers. Design questions include how to effectively map multiple physical spaces to a virtual document space, and how to deploy such systems while respecting the privacy and individual rights of the patients and staff.

*Capturing the context surrounding document use.*

Document-centric mixed reality offers the potential to capture context as well as document actions. For example, the arrival, departure and relative locations of individual collaborators, the temporal sequence of document changes, and verbal communication can all be

stored for later retrieval in such a system. Doing so may help to formally codify existing practice surrounding the paper documents in the hospital, and also be used as a way to illustrate new practices.

### **Current Work**

We are currently designing a lightweight tablet-based interface as a generic client for document-centric mixed reality for the hospital. The form factor of tablets resembles paper and they have been successfully adopted in health care facilities. We are also experimenting with environmental sensing to augment the tablet interface by increasing a sense of co-presence when communicating with colleagues at other locations in the hospital.

The tablet serves as a proxy for documents when held horizontally. Documents are retrieved using keyword search, which is supported by 3-D data visualizations that can help to find related materials. The nurse stations and certain other areas of the hospital are augmented with vision-based tracking, which is used to create a virtual fused workspace. Hospital staff can “see” others in this space by holding their tablet vertically, and see notes and activity traces left by others. They can “engage” with co-workers using this interface, and return to the horizontal view to begin collaborating over shared documents.

Our ultimate research goal is to understand ways that digital systems can permit the practices revolving around verbal communication and paper documentation to continue in the hospital, and still introduce the benefits of digital communication and information technology. We argue that document-centric mixed reality is worthy of exploration in this space.

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