Beam-Its – Virtual Sticky Notes in the Real World

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Abstract

We present the concept, design, and implementation of Beam-Its, a virtual version of sticky notes, which can be placed in the physical environment. Beam-Its are created on a PDA and placed on objects or surfaces in the environment, where they are currently displayed by a steerable projector. Beam-Its can contain handwritten text and sketches, just as physical Post-Its®, but also photos and sound recordings made on the PDA, thus extending the functionality of physical Post-Its®. They can also appear or disappear depending on context, which enables additional usage scenarios.

1. Introduction

Sticky notes, better known by the brand name Post-Its®, are an important tool for many of us to organize our daily lives. They provide a convenient way of attaching small amounts of information, such as a few words or a sketch, to objects and places in our physical environments. They remind us of duties and appointments and their ubiquity and convenient form factor is hard to match. In keeping with our earlier research [4, 3], we are investigating, how popular concepts from the digital or physical world can be extended into a Ubiquitous Computing setting, where these two worlds mix. This paper discusses what a virtual version of the Post-It® could look like, and which advantages it would have over the physical version. In an environment with appropriate instrumentation, such as electronic wallpapers or a steerable projector, virtual sticky notes can appear or remain invisible in the environment depending on context parameters, such as the time or the identities of people present. They can also contain multimedia content in addition to simple text or sketches. Figure 1 shows a simple scenario demonstrating an obvious advantage in terms of privacy.

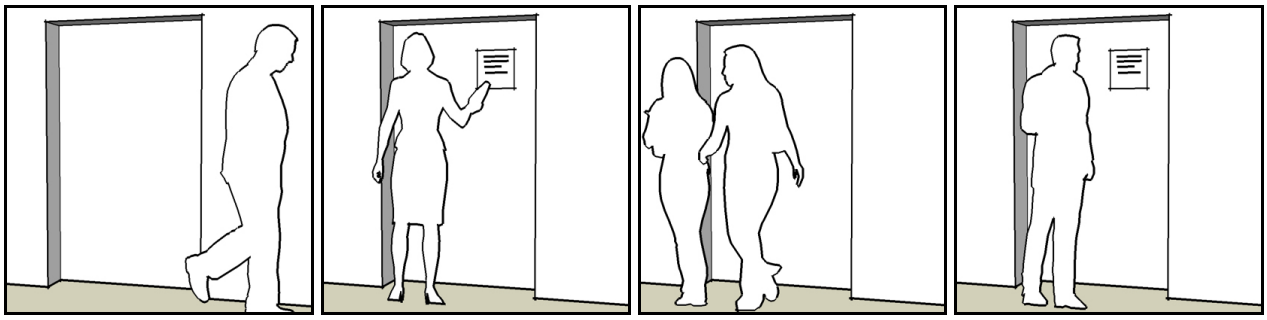

Figure 1. Paul leaves his office to get a cup of coffee. He'll be back in 10 minutes. When Ella arrives to find his door closed, she leaves him a personal sticky note on the door. In the meantime, others pass the door and it appears empty to them, but when Paul returns, he finds the personal note Ella left for him.

We have built a digital version of Post-Its® in our instrumented environment, with which the scenario in Figure 1, but also many other ones become possible. As they are currently displayed by the beam of a steerable projector, we have called them *Beam-Its*.

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2. Related Work

A number of desktop applications implement electronic sticky notes, including Post-it Digital Notes[2], Hott Notes[3], or NoteZilla[4]. They allow users to create digital messages, which closely mimic conventional sticky notes, and to place them on their virtual desktops or attach them to documents or web pages. Some of these digital notes can also contain pictures or alarms, but all of them live purely on virtual desktops, not in the real world. Some of these digital notes can also contain pictures or alarms which remind the user of an upcoming appointment, but all of them live purely on virtual desktops, not in the real world.

Two recent approaches to virtual messages in the real world are the Digital Graffitti Service[5] and the Place-Its application [8] by which users can leave digital messages anywhere in the environment using their mobile phones. With the former, tourists can mark interesting locations and share their experiences with others visiting the same place, and with the latter, users can place reminders for themselves at predefined locations (e.g. home, work) so that they receive these messages when they arrive at these particular places. A user study conducted with the Place-It application shows that location-based reminders are in general considered useful and enjoyable, although some of the participants asked for time-constrained reminders which were not offered by the application. These results encourage us in our belief that virtual messages that can be location- as well as time- and user-dependent might be an enrichment for people's daily lives. In contrast to the approaches described above, in our work, we are trying to seamlessly augment the physical environment to the bare eyes of the user.

The Everywhere Displays projector [6] pointed the way to such a seamless augmentation. Two recent projects use handheld projectors to augment the environment. In Beardsley at al. [1], users interact with projected web browsers and object augmentations and select regions of interest in the environment using a technique called hold-and-drag. In Cao et al. [5], users can define virtual spaces by a pen tracked in 3D, and then interact with these spaces using widgets and projector movements. One possible application of this is the creation of messages and object annotations. We are aiming for an overall much more lightweight approach, leaving at least the reader of our notes barehanded.

3. Visual Design of the Beam-Its

When we first designed the Beam-Its, we considered a visual appearance very close to physical Post-Its®, i.e., a clearly marked yellow square with black or colored pen strokes. In preliminary tests, this design exhibited considerable disadvantages for projection. The brightness of the typical Post-Its® yellow reduces the usable contrast range for the projected ink strokes and the design also interfered with physical objects onto which the notes were projected. We therefore decided to implement a very simple background-less design, which maximizes usable contrast and minimizes graphical elements (see Figure 2). Slight modifications, such as individual pen colors or borders, could also be used to identify authors or other properties of a note, such as priority. If future versions were to use a different base technology, such as electronic wall paper, these design decisions would have to be reconsidered.

[2] http://www.3m.com/us/office/postit/digital/digital_notes.html
[3] http://www.hottnotes.com
[4] http://www.conceptworld.com/NoteZilla
[5] https://www.ct.siemens.com/en/technologies/se/beispiele/graffitis.html

4. Interaction Concept and Implementation

In our prototype implementation, users create virtual sticky notes with a tracked PDA, using the stylus and a specific note-taking application (Figure 2 left). Instead of tearing a paper note from the pad, they then tap a ”Beam-It” button, and the message appears as a projected note (displayed by the Fluid Beam projector [9]) on a surface or object in front of them (Figure 2 right). In our current implementation, the user position is detected by means of an indoor location system using active RFID tags and infrared beacons [2, 7] and his or her current orientation is determined by an electronic compass that can be either attached to the user's PDA or integrated into his or her clothes. The currently used location system offers an accuracy of about 2m and a highly precise detection of the user orientation, which allows only a rough determination of the final Beam-It position. This accuracy turned out to be mostly sufficient for our purposes and we expect it to be even improved by further development of the indoor location system.

Beside the PDA-based option of creating virtual messages, we consider to also offer a web-interface that would allow users to create Beam-Its at remote locations. This interface can for example show a 3D model of the environment in which the Beam-It should be placed [12, 10]. In this way, it is not necessary for users to be physically present at the place where they want to leave a message but they can browse through the environment and place messages at arbitrary remote locations.

After it is placed in the environment, the Beam-It virtually ”sticks” to this location or object and will be displayed there or hidden as appropriate, depending on the situation. This basic interaction scheme closely mimics the physical Post-Its® as we know them, which allows the transfer of a widely familiar mental model and makes the application easily understandable.

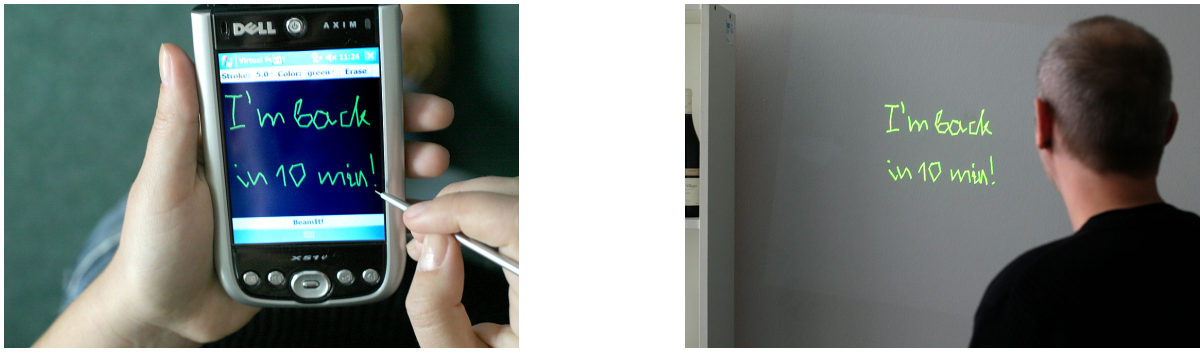

Figure 2. A Beam-It as it is written on the PDA (left) and displayed on the wall (right).

In contrast to conventional paper sticky notes, Beam-Its can exhibit certain additional properties. They can be *time-dependent*, *object-bound*, and/or *personal*. On a technical level, the display of the Beam-It message is controlled by events, such as the detection of the presence of a particular person, the approach of a given point in time, or user interaction with the object, to which the Beam-It sticks.

Time-dependent Beam-Its act as reminders by appearing at a predefined time. In an office environment, this can be used to remind oneself or others of meetings or other events.

Object-bound Beam-Its stick to objects, such as shopping merchandise, furniture or books. Users can interact with them by manipulating the associated object, which obviously needs to be tracked. Using the Beam-Its infrastructure, we have implemented the so-called Product Associated Displays

(PADs) [11]. These are projected displays which appear in an instrumented shopping shelf when the corresponding products are taken out of it, and they show explanatory information about the products.

Personal Beam-Its are specifically addressed to a certain person or group and provide a privacy mechanism which is impossible to achieve with physical sticky notes. The personal Beam-It is only displayed when the respective person is present. In order to detect this presence, users are tracked using an indoor location system [2, 7] in our prototype implementation.

5. Extensions Beyond Pen Strokes

The simple Beam-Its described so far just contain electronic ink (i.e., polygonal lines) and could therefore be implemented with minimal network traffic, resulting in a very good interactive behavior. We have also experimented with a number of extensions using different types of data, such as photos taken by the PDA's camera and sound recordings using the built-in microphone. As these data types create much higher volumes of data to be transmitted, they slow down the overall interaction speed and thereby considerably compromise the interaction experience. We are currently working on improved transmission schemes to deal with this issue.

In theory, the PDA's built-in character recognition could also be used to create character-based text messages instead of handwritten notes. While this would drastically decrease data transmission, it would also strongly impoverish the richness of the medium, as it would become much more difficult and less fluent to mix sketches or drawings with text. We therefore didn't follow up with this idea.

6. Summary and Next Steps

We have presented the concept, design and implementation of our Beam-Its system which allows the placement of virtual sticky notes in the physical environment. These virtual messages offer several features that can not be realized with traditional sticky notes, e.g., they can be made visible only for particular people or they can be made to appear at a predefined point in time, thus serving as reminders, as then they are catching the user's attention. Moreover the proposed approach offers the opportunity to place virtual messages at remote locations, which is obviously not possible with physical sticky notes.

While we think that Beam-Its create an effective human-to-human and machine-to-human messaging system using projected displays, we have not yet formally evaluated their understandability and effectiveness. As we are currently installing additional steerable projectors in additional parts of our group's lab space, this will provide the basis for a larger scale use of the Beam-Its system in a day-to-day lab setting. We expect to gain valuable insights from such a daily use and will continue to explore other forms of virtual augmentation, annotation and functional extension of our physical environment.

We would also like to stress, that steerable projection is but the vehicle for these augmentations, and that they may be achieved in technologically very different ways, such as electronic wall papers, one day. We maintain that our design and interaction concepts are general enough, however, to remain valid under such changed conditions.

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