
Move-It: Interactive Sticky Notes Actuated by Shape Memory Alloys

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Abstract

A lot of people still rely on pen and paper for taking short notes. Post-Its® are still the most popular paper media for informal note taking. In this paper, we present the design and implementation of Move-It, a system that combines the affordances of note taking on paper with the capabilities of computer systems. Furthermore, we present how common Post-It® notes can be actuated by shape memory alloys, thus become interactive sticky notes giving active physical feedback.

Keywords

pen-and-paper, sticky notes, digital pen, informal note taking, shape memory alloys.

ACM Classification Keywords

H5.2 [Information interfaces and presentation]: Input devices and strategies; Interaction styles; Natural language.

General Terms

Design, Human Factors

Introduction

Although we are already surrounded by many mobile devices such as tablet PCs, netbooks, and smartphones, paper still remains a ubiquitous means

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for informal note taking in professional [10] as well as private context. Whether it is the to-do list stuck to the monitor, contact information jotted down during a telephone call, a sudden idea while riding on a train, or a short message attached to a pile of documents passed over to a co-worker, paper is often the means of choice. Informal notes thereby can be used for a variety of purposes including temporary storage, cognitive support and reminding.

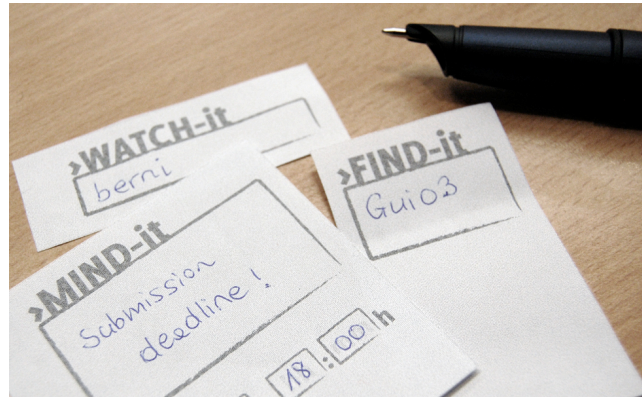


figure 1. A Move-It note combines the affordances of traditional paper and digital interfaces and extends it with active feedback functionality.

Due to its numerous affordances, primarily the intuitive interaction and lightweight capturing of information anywhere and anytime, paper is often the preferred medium for informal note taking. As paper is also highly portable, it supports mobile usage as well as context- and location-sensitive placement and thus can serve as location-dependent information appliance [3]. Another considerable affordance of paper is the ease of annotation and physical manipulation. Seemingly

irrelevant details in a paper notes appearance like handwritten remarks or dog-ears can be unique characteristics and thus help people to quickly identify a particular piece of paper. Lin et al. noticed that Post-Its® are still the most popular paper media for informal note taking [7]. Post-It® notes in particular, provide additional affordances such as adhesiveness, compact format and attention attracting color. These inherent features make them a very prominent form of paper: to-do lists, shopping lists and reminders are often written on Post-Its® and stuck to prominent places as reminders. While Post-It® notes provide excellent affordances for passive reminding due to their physical presence [4], they do not provide direct support when information needs to be transferred to another device or if *active reminding* is required [7].

In this paper, we present the *Move-It* system, which combines the affordances of traditional paper and digital interfaces and extends it with active feedback functionality (see figure 1). Our setup combines Post-Its® with a technologically enhanced paper-clip, which can be moved and thus give active feedback to the user.

Related Work

Many pen-and-paper applications focus on annotating and structuring notes [5] or slides [11], and present new ways of linking paper sketches with physical and digital notes [12]. The Designer's Outpost [6], for example, shows a successful combination of paper and the physical workspace with the advantages of electronic media to support collaboration. The seamless integration of Post-Its® into a digital whiteboard and the digital annotation with the captured (digital notes) provide high level of flexibility and new ways of

interaction with a traditional medium. In our setup, we aim to provide a similarly fluid transition between paper-based input and digital applications. Automatic synchronization and smooth integration into Personal Information Management (PIM) tools are crucial to get user acceptance.

Numerous pen-and-paper applications are based on digital pens using Anoto's¹ technology as input devices. While Anoto requires a special dot pattern printed on the paper for tracking, some other pen-and-paper applications are based on ultrasonic pens to detect the pen's position [9]. In contrast to Anoto's technology, these pens are less accurate and the real paper has to remain within a very limited tracking area.

Besides this, physical interfaces also provide interesting means to invoke application functions or to obtain feedback. Towards this end, our paper-clips allow Post-Its® itself to give active feedback, instead of using digital feedback only [9].

An alternative to the Anoto-based technology was presented in Quickies [9]. In this work, Post-Its® are used as an "input device" and notes are automatically digitalized and processed. Quickies, however, can hardly be used instantly since a special clipboard-device connected to the PC is required for tracking data.

Move-It Notes

We implemented three different types of interactive sticky notes, each of them designed to support a particular usage scenario (cf. figure 2-4):

Mind-It Notes: By combining a Mind-it sticky not with an enhanced paper-clip, the Post-It® becomes a location-based *active* reminder. So, for example, a Mind-It note can remind us ten minutes before the start of a scheduled meeting by a subtle wiggling motion (see figure 2).

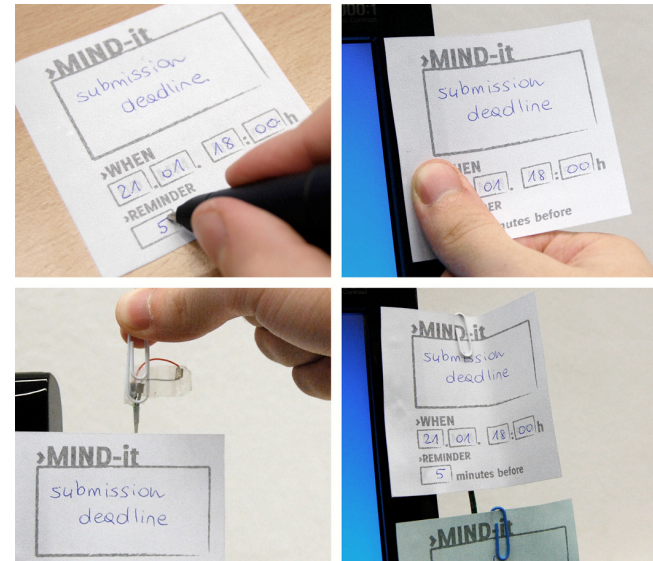


figure 2. An active feedback is triggered upon approaching event (e.g. 5 minutes before).

Watch-It Notes: Once associated with an information source, the sticky note can provide an active status feedback by subtle movements or by changing its shape. A Watch-It note can, for example, inform users about the online status of their favorite instant messenger contacts by changing its shape (see figure 3).

¹ www.anoto.com

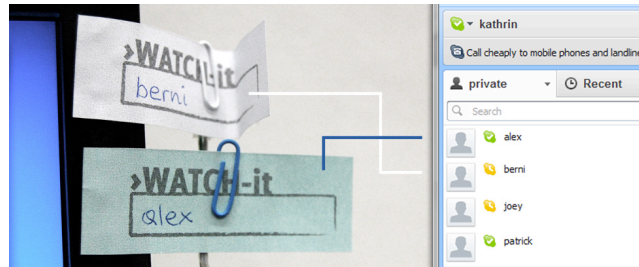


figure 3. Active feedback is triggered upon status change (e.g. online, away, offline) of instant messenger contacts.

Find-It Notes: Post Its® are commonly used as bookmarks in books or documents to highlight important sections and quickly retrieve them later on. The combination of a Find-It sticky note with a paper-clip enables the Post-Its® to facilitate the retrieval process by giving active feedback upon request. A Find-It can help users to retrieve a particular bookmark in a book by drawing their attention through a permanent wiggling motion (see figure 4).

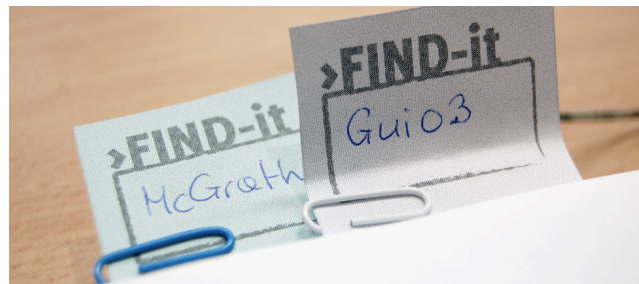


figure 4. Active feedback is triggered upon search request.

Implementation

At the back of each paper-clip, we attached a shape memory alloy (SMA) that can be activated accordingly. In our current version, the paper-clip is connected over USB with the PC. Users can take a Move-It sticky note,

sketch a note (i.e. an appointment with a start time, the name of an instant messenger contact or the keyword for a bookmark), connect it with the paper-clip, and stick it to any desired location. In contrast to Quickies [9], Move-It notes provide an *active* physical feedback to the user. Depending on the usage scenario, once a scheduled event approaches (Mind-It), the online status of a messenger contact changes (Watch-It) or a bookmark keyword is requested for retrieval (Find-It), the Mind-It provides feedback by subtle motion or changes in shape.

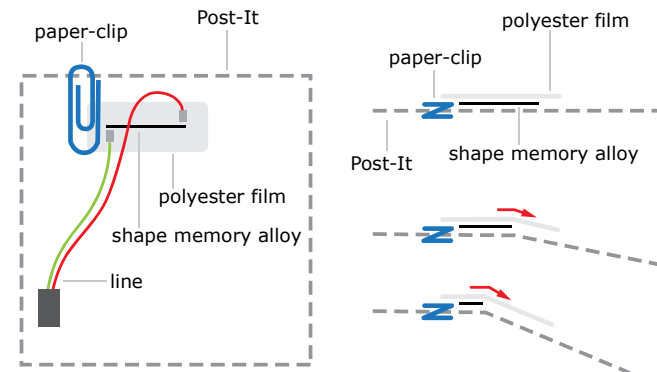


figure 5. Watch-It usage scenario for status monitoring: active feedback is triggered upon status change (e.g. online, away, offline) of instant messenger contacts. (e.g. online, away, offline) of instant messenger contacts.

To actuate the Move-Its, we have designed a special paper-clip device (cf. figure 5). The paper-clip can actuate regular Post-Its® by just clipping it on. A shape memory alloy coil is used as an actuator of the paper-clip. Whenever the SMA shrinks it pulls the polyester plate and the plate bends. The bended plate distorts a Post-It® associated with the paper-clip. The clips are

controlled by an Arduino-Board², which is connected via USB to the computer. In the current implementation up to eight paper-clips can be addressed by one controller.

In our current implementation, all paper-clips are color-coded, i.e. a blue clip has to be connected with a blue Post-It® note and so on. To improve the coupling between clip and Post-It®, a RFID tag could be applied to the Post-It® note during production and a RFID reader to the paper-clips.

All notes are captured using Anoto pens, employing an embedded infrared (IR) camera and a special arranged dot pattern on the paper. A unique dot pattern for each paper sheet is automatically created once a Post-It® is printed. Therefore, every stroke can be tracked and addressed to a unique page. The digital pen transmits recorded strokes to the Move-It desktop application, which converts the strokes to text using Microsoft's handwriting recognition SDK and classifies the written strokes. The classification is realized by identifying the area the notes are written on (e.g. text written inside the main area of a Mind-It is classified as subject of the item). The resulting datasets are synchronized with the Personal Information Management tool (i.e. Microsoft Outlook) or Instant Messenger Application (i.e. Skype). The Microsoft Outlook integration was realized by implementing an add-in using Outlook's Interop-Framework based on C#. Thus, all Mind-It notes are synchronized with the Outlook calendar and all Find-It messages are "stored" as Outlook notes. In combination with the Microsoft Exchange server, items created on the Move-It system can be easily shared among others. The Skype integration for Watch-Its was

done by utilizing the Skype API³ to access messenger contact information.

Conclusion and Future Work

In our system, paper is not only seen as an input device but also as a tangible artifact suitable as a temporary storage, communication, and reminding. While the Mind-It interactive sticky notes provide the same flexibility as their paper-based forerunners, the digital enhancements provide functionalities the analog system cannot provide easily, such as information distribution and active physical feedback.

The current implementation of Move-It is a prototype and there is still a lot of space for improvement. First, coupling between the SMA paper-clips and the Post-Its® could be done in a more ubiquitous way by using RFID hardware and wireless paper-clips. Second, the processing of Anoto pen input could be extended by a more advanced text analysis in order to make text input more flexible (e.g. 5:00pm vs. 17:00 etc.).

Another area, which has not yet been explored, is the establishment of a physical input channel. While Move-It sticky notes provide a physical output channel by giving feedback through deformation, it is also desirable to sense user input through physical manipulation e. g. dog-ears, tearing or crumpling. A Move-It could for example react to a dog-eared corner by opening the associated item in the Personal Information Management tool on the desktop computer, tearing or crumpling could invoke the deletion of the digital representation associated with the Move-It. With this extension, our interactive sticky

² <http://www.arduino.cc/>

³ <http://developer.skype.com/accessories>

notes could both give *and* receive active physical feedback.

An idea, that goes even further, is the introduction of interactive paper instead of a normal Post-It® combined with an enhanced paper-clip. Following the Pulp-based Computing [1] approach, interactive materials such as electro-active inks, conductive threads and smart materials could be embedded directly into paper during the papermaking process. Consequently, even the SMA actuator we used in our setup could be integrated into an interactive paper Post-It® and heated through wireless control systems [7], thus making the use of paper-clips redundant.

Finally, we will run a formal user study to get feedback using a shaking Post-It® as an active, ambient display for interrupting people.

Acknowledgements

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