

# Augmenting Sticky Notes as an I/O Interface

Pranav Mistry and Pattie Maes

MIT Media Laboratory, 20 Ames Street, Cambridge MA 02139, USA  
{pranav,pattie}@media.mit.edu

**Abstract.** The design and implementation of systems that combine both the utilities of the digital world as well as intrinsic affordances of traditional artifacts are challenging. In this paper, we present ‘Quickies’, an attempt to bring one of the most useful inventions of the 20<sup>th</sup> century into the digital age: the ubiquitous sticky notes. ‘Quickies’ enriches the experience of using sticky-notes by linking hand-written sticky-notes to the mobile phone, digital calendars, task-lists, e-mail and instant messaging clients. By augmenting the familiar and ubiquitous physical sticky-note, ‘Quickies’ leverages existing patterns of behavior, merging paper-based sticky-note usage with the user’s informational experience. The project explores how the use of Artificial Intelligence (AI), Natural Language Processing (NLP), RFID, and ink recognition technologies can make it possible to create intelligent sticky notes that can be searched, located, can send reminders and messages, and more broadly, can act as an I/O interface to the digital information world.

**Keywords:** Sticky notes, paper as an I/O interface, connecting the physical and information world, intelligent user interface.

## 1 Introduction

Drawing (including in this definition also the concept of writing) is an essential part of human communicational and intellectual activities. It allows expressing thousands of different types of data; it can be done without paying active attention and it does not require users to be familiar with computers. Since the beginning of modern computer science, research has been conducted in order to develop interfaces that could enable users to draw. The development of digitizers was an important step, allowing users to input their drawings or writing using a digital pen on a tablet or directly on the screen. However, despite these developments, the use of paper as the primary medium for information organization has far from dwindled, but instead increased steadily. Today, the paperless office is more distant than when it was proposed [1]. Despite the enormous popularity of computers and personal digital assistants, along with improvements in screen technology, mobile computing technology, and navigational and input tools, paper usage continues to increase. Paper has visual (resolution, contrast, viewing angle) and functional (null power consumption, low cost, portability, small & light weight) features that can hardly be rivaled.

Support for and augmentation of paper-based routines is an important step in the computerization of human work practices. Several studies [2] have showed that paper objects are very supportive, giving users control, flexibility, and overview of information in ways that are difficult to achieve with computer technology. However, digital benefits such as trace-and-search ability of documents are almost impossible to achieve with solutions based on paper only. Rather than trying to develop solutions that can replace the world of paper, it would be interesting if we can make it possible to use paper as the interface to computers, and augment and link paper-based work practices to our digital information world.

### 1.1 Sticky Notes and its limitations

Since 3M's introduction of Post-it<sup>®</sup> Notes in 1980 [3], sticky notes, one of the variants of paper, have become an integral part of our everyday life - accumulating and keeping track of all sorts of information. In an office, sticky notes are often seen on desks as meeting reminders, to-do lists and contact information; on whiteboards as brainstorming devices; and on paper documents as brief notes to the recipient about the content or intended purpose. Sticky notes are also found at home mostly near telephones or on refrigerators as household reminders and messages. Sticky notes are usually seen in books as bookmarks. In addition, we also use sticky notes to tag our assets for personal or social usage. In short, sticky notes are everywhere. Unlike most of our modern digital information devices, sticky notes are portable, low cost and easy to use. However, as written sticky notes accumulate, keeping track of our stickies and the information they contain gets unruly. Desks, whiteboards, refrigerators, telephones and textbooks are inundated with sticky notes. As a result, stickies become lost, hidden or forgotten about. Furthermore, sticky notes have physical limitations; a particular sticky note cannot be in an office and at home simultaneously. Being a passive piece of paper, sticky notes lack the capability of dispatching reminders about upcoming events or deadlines. After scribbling details of a forthcoming occasion on a sticky note, one can still overlook the appointment due to forgetfulness or loss of the sticky note. Like most paper-based media, sticky notes fall short as a medium that can communicate to other, especially digital, information media we use.

Given the wide popularity and practical usefulness of sticky notes, we are compelled to bring them along with us into the 21<sup>st</sup> century. At the same time, given sticky notes' weakness in communicating with our digital information world in a more orderly and active way, we feel the need to augment the features of sticky notes. In this paper, we presents 'Quickies' that attempts to bridge the gap between the physical and digital worlds of information, linking hand-written sticky-notes to the mobile phone, digital calendars, task-lists, e-mail and messaging clients. Quickies system augments familiar and ubiquitous physical sticky-notes.

## 2 Related Work

Several projects and products have tried to use the metaphor of sticky notes in the digital world. The Post-it<sup>®</sup> Digital [4] of 3M is a computer software program that provides users digital Post-it<sup>®</sup> Notes. Although Post-it<sup>®</sup> Digital features searchability, the scope is limited to the boundaries of a computer, isolated from the portable and convenient physical experience that paper sticky notes provide. There are more than a dozen similar software applications available today, all trying to imitate the simplicity and ease of use of physical sticky notes in the digital realm.

Stanford University's Post-that Notes [5] project attempts to facilitate both searchability and portability, by creating a mobile phone application which captures regular Post-it<sup>®</sup> notes as pictures within the mobile phone platform. Inspired by the use of sticky notes on whiteboards and walls during the early stages of a project, the Designer's Outpost [6] of the University of California, Berkeley presents a tangible user interface that combines the affordances of paper and a large physical workspace. The Designer's Outpost contains an interactive whiteboard with augmented sticky notes that allow users to collaboratively author website architectures. Rasa [7] is a system designed to support situation assessments in military command posts, providing officers the capability of positioning written sticky notes on a paper map with digitizers that simultaneously update a digital database system. TeleNotes [8] was one of the first attempts to provide, in the computer, the lightweight and informal conversational interactions that sticky notes provide. Projects such as HayStack [9] use sticky notes as a metaphor to provide annotation for the semantic web. Projects such as TeamWorkStation [10] and XAX [11] were one of the first attempts to integrate traditional paper media with electronic media. PaperLink [12] system allows marks made on paper to have associations and meaning in an accompanying electronic world. DigitalDesk [13][14] uses augmented reality to provide an integrated experience of both paper and digital documents. Brief overviews of some of these projects are provided below.

Designer's Outpost [6] and Rasa [7] are designed for the specific needs of web developers and military officers, respectively, and as such are not generic systems. In addition, both Designer's Outpost and Rasa require heavy hardware infrastructure and are targeted towards usage of Post-it notes in collaborative environment. They do not address the use of sticky notes by individuals for the information management task. TeleNotes [8] and HayStack [9] only use the metaphor of features of physical sticky notes in our digital information world. TeleNotes attempts to provide the lightweight and informal conversational interactions that sticky notes provide. HayStack use sticky notes as a metaphor to provide annotation for the semantic web. Post-it<sup>®</sup> Digital [4] and Post-that Notes [5] attempt to bring the familiarity and features of sticky notes to digital world. Rather than linking the physical and digital, they are confined and limited to computers and mobile phones respectively and thus loses the affordance and intuitive interaction of physical paper sticky notes. DigitalDesk [13][14], TeamWorkStation [10] and XAX [11] are great inspiration for Quickies project in devising integrated experience of both paper and electronic media. PaperLink brings the concept of hyper-linking to physical world by allowing marks made on a paper to have associations and meaning in an accompanying electronic world. Although PaperLink links electronic world and paper, it is limited to hyper-

linking. There remains a need for having an integrated system which combines the qualities and affordances of physical sticky notes – portability, adhesiveness, low-cost – with the positive attributes of digital notes – effective information management and organization, automatic reminders and compatibility with the rest of the digital world. Provided their usage can be made as intuitive and efficient as that of regular stickies, the merger between physical and digital stickies can definitely be an added convenience to our fast-paced environment.

### 3 QUICKIES – Intelligent sticky notes

Quickies are regular paper sticky notes that have been augmented in a few ways. First, each sticky note contains a unique RFID tag, so that stickies can be located in different parts of a home or office. Second, we use a small digitizer, so that while a note is being scribbled, a digital copy is created. Character and shape recognition is used to translate the note's content into machine readable data. Finally, special-purpose knowledge, NLP (Natural Language Processing) and commonsense based AI (Artificial Intelligence) techniques are used to interpret what the content of the note means and what relevant actions should be taken. Subsequently, Quickies updates your electronic calendar with the meeting reminder you wrote down on a paper sticky note; and reminds you 15 minutes before your meeting via an SMS. It syncs the list of items to buy with your computer based task-list. You can locate documents or books tagged with Quickies in your home or office. To look up some information quickly from your computer, you can use Quickies instead of keyboard and mouse. 'Quickies' is an attempt to link physical and digital informational media and combine the best of both worlds in one seamless experience.



**Fig. 1.** (A) Sticky notes at user's desk (B) Example of a reminder sent to a user's mobile phone.

Quickies are sticky notes that offer portability, connectivity to the digital information world, smart information organization, ability to be findable (searchable as well as locatable) and ability to send reminders and messages. These are just examples, but Quickies can do a lot more. The following usage scenarios present

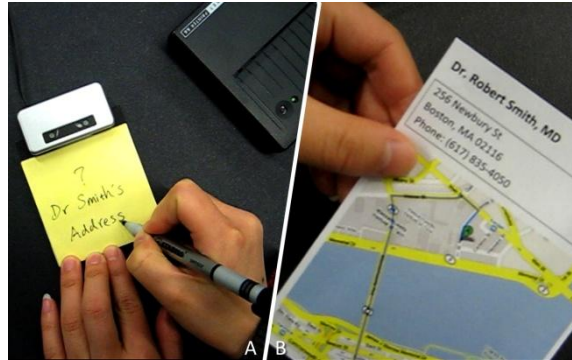
some common problems or tasks that Quickies offers a better solution for than today's paper or electronic solutions.

- Imagine you scribbled a sticky note about an upcoming meeting with a colleague; you placed the note on your desktop. Unfortunately, you overlooked the note, completely forgetting about the meeting and went for lunch. Luckily, your intelligent sticky note added the meeting to your online calendar and reminds you about the meeting via a text message on your phone 15 minutes before the meeting.
- You write down a person's name and phone number on a sticky note while talking on the phone. That new contact information is automatically entered in your computer address book.
- You create a grocery list or to-do list on a paper sticky note. This list is automatically synchronized with the task-lists in your mobile phone and computer. Now, your mobile phone has a list of the things you noted down to buy, which comes in handy when you are at the grocery store.
- You use a sticky note to bookmark a section about the 'Platypus Paradox' in Peter Morville's 'Ambient Findability' book. Several weeks later, a discussion about the 'Platypus Paradox' arises and you remember bookmarking Morville's explanation. You can now use Quickies' graphical interface to search for the keywords 'Platypus Paradox'. As the system is keeping track of all your notes in digital form, it shows all the relevant notes you have created in past. The system also helps you locate that note (and hence the book) in the house.
- It is Saturday and you are at home. You forgot some important information that you noted down on a sticky note while in office on Friday. You ask the Quickies graphical interface to show the notes located at your office. Your computer screen shows you all the notes located at your office. There are many. You filter them by selecting 'notes created on Friday'. You get the particular sticky note and information you were looking for.
- You are in a hurry to get to a doctor's appointment. You ask Quickies system the address of 'Dr. Smith' by writing down on a sticky note (or a piece of paper) 'Address of Dr. Smith' followed by a '?' mark. In just a few seconds, a small printer prints out the address along with the driving directions to Dr. Smith's clinic.
- Your mom prefers using paper rather than mobile phones and computers. She leaves a message for you on a sticky note when leaving for the market. The note recognizes that this is a message to you; looks up your mobile number in the contact-list and sends you her message as an SMS.

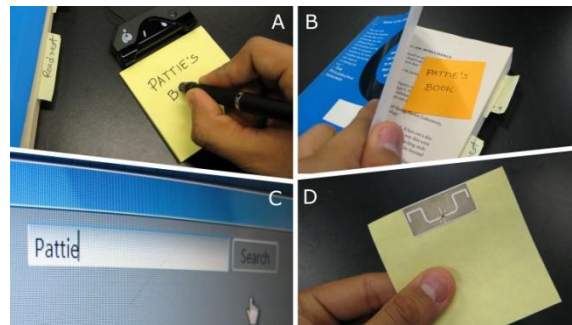
The system of Quickies allows sticky notes to be used as an interface to the digital world of information. As shown in Figure 1 (A), the user writes down a reminder for a meeting with a friend. 15 minutes before the meeting, at 2:15 PM she receives a message on her mobile phone reminding her about the meeting (see Figure 1 (B).) The Quickies system reminds the user at appropriate time or remembers things on behalf of the user. The system is also configurable according to the user's personal preferences so that the user can decide what she wants the system to do in particular situations. For example, if she has a habit of putting a star ("\*") in front of important notes, she can configure the system to interpret accordingly.

With Quickies system, sticky notes (or paper) can be used not only as an input but also an output medium. As shown in the Figure 2 (A) the user writes down a query -

“? The address of Dr. Smith” on a sticky note. As shown in the Figure 2(B) a small handheld printer prints out Dr. Smith’s address from the user’s address book in the computer. It also prints out the driving direction to Dr. Smith’s clinic from the current location.



**Fig. 2.** (A) User writes a query on a sticky note (B) A handheld printer prints out the requested address and driving directions.



**Fig. 3.** (A) User writes on a sticky note (B) User tags a book with the sticky note (C) User searches notes related to the word ‘Pattie’ (D) A sticky note with the RFID tag on back.

One of the most interesting features Quickies provide is ‘findability’. The user can use physical sticky notes to tag her assets or documents and later can locate that tag, hence the tagged object, at home or in the office using the Quickies graphical interface. At the back of each of the Quickies is a unique RFID tag, which makes it possible to locate Quickies in the house or office. As shown in Figure 3 ‘A’ and ‘B’, the user uses a Quickie to tag the book given to her by a friend with that friend’s first name. Some weeks later when the user wants to return the book to her friend, she uses the Quickies graphical user interface (Figure 3 ‘C’) to search through all the notes she has created. By searching for her friend’s name she sees all the notes that mention her friend’s name. She can see the digital version of the note saying “PATTIE’S BOOK”, which she used to tag the book. As shown in the Figure 3 ‘D’, the note has an RFID tag on the back that gets picked up by one of the many RFID readers positioned in the house so that the book can be located. The computer

program also provides other information such as when the user created the note, and all the different locations where that RFID tag (and so forth the book) has been detected in the past.

#### 4 How does ‘QUICKIES’ Work?

The Quickies system consists of a digitizer hardware (pad + pen) device, a software program and physical sticky notes. Optionally, the system can also include a handheld printer, RFID readers and RFID tags. The user uses the digitizer pad-pen hardware to write on the paper sticky notes. All the handwritten notes created by the user are captured and the digital representations of the notes are saved in the note database. The system also interprets the content of the notes and categorizes them into one of many possible types of notes. At present, the Quickies system can categorize notes into following types: To-do list, Meeting reminder, Message, List of items, Contact, Payment, Query, and Tag. The Quickies system provides a highly visual interface to browse these digital representations of the notes. The software interface can let the user sort, filter or search for one or more specific notes by keywords, date created, physical location of the note and type of the note. The system also performs a set of operations according to the type of the note.

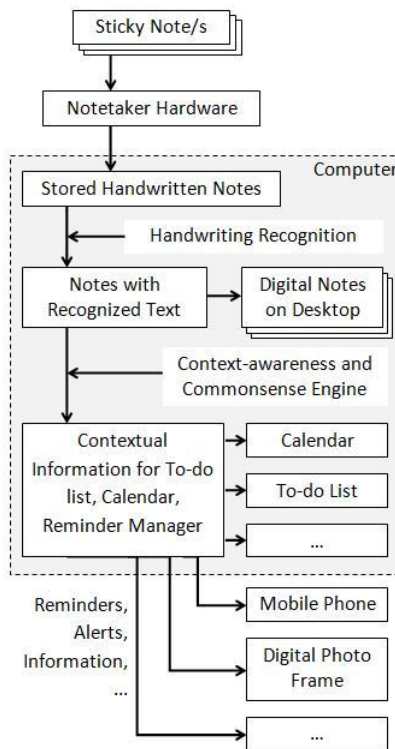


Fig. 4. ‘Quickies’ system.

Figure 4 presents a detailed explanation of how Quickies work. Physical sticky notes are captured and stored in the computer using commercially available digital-pen hardware, which captures the movement of the pen on the surface of a sticky note. The digital-pen hardware used in the prototype uses an ultra-sound wave sensing mechanism. Two stationary sensors receive ultra-sound waves that are emitted by a transmitter placed at the tip of the pen. The device measures the location of the pen tip on the paper based on the calculation of receiving-time differences of the signals received by the two stationary receivers. A software program stores the handwritten notes as images/strokes and converts the stored hand-written notes into computer-understandable text using handwriting recognition algorithms. As shown in Figure 5, the computer program also provides a highly visual user interface for browsing or searching all of the user’s notes based on keywords. The user can also use the ‘Advanced Search’ feature for searching notes at created at particular time or located at a place in office. For example, the user can search for all the Quickies on the user’s desk at work that contain the word ‘Urgent’? The recognized text is processed using a commonsense knowledge engine which is based on NLP and ConceptNet [15]. This process provides the note database with contextually rich information. Later, the computer program uses its understanding of the user’s intentions, content and the intended purpose of the notes to provide the user with reminders, alerts, messages and just-in-time information.



Fig. 5. Graphical user interface of Quickies

## 5 Implementation

We implemented a fully working prototype of the ‘Quickies’ system [16]. Handwritten note capturing is performed by the Pegasus PC NoteTaker digital pen hardware. The ultrasonic sensing mechanism provides the system with X and Y coordinates of the pen tip ( $X(t)$  and  $Y(t)$ ). The spring mechanism at the tip of the pen picks up pen-up/pen-down switching. Time sampling of X and Y coordinates of pen tip ( $X(t)$  and  $Y(t)$ ) are captured in strokes. These strokes (also known as digital ink) are passed to the handwriting recognition engine. On-line handwriting recognition algorithms convert the pen strokes of text into digital text. The engine also analyses layout of the written text and primitive shapes, if any, on the sticky note. The output of the handwriting recognition engine with added information of layout and graphical shapes is passed to the interpretation engine that uses ConceptNet [15], Natural

Language Processing (NLP) and some other computational methods in order to support categorizing and understanding the intended purpose of the notes. This engine categorizes and tags the note with its type. The system currently supports following categories: to-do list, meeting reminder, message, list of items (not a list of tasks), contact, payment reminder, query to the system and tag. Each note is saved in an XML database. Along with the content and type of the note, for each note the system also captures extra information such as the note ID, creation date and time, author of the note, etc. The actual graphical representation of the note is also saved as an image file and also referenced in the XML database.

According to the type of the note, the system also performs relevant extra actions. For instance, the system updates the user's digital calendar with the 'meeting reminder', by adding the entry for the event at the specified date and time. It can also remind the user about the meeting via an SMS or an Email. For notes of type 'message', the system looks up the contact information of the person that the message is written for in the address book and sends that person an SMS or an Email with the message. The to-do lists get synced with the user's digital task-lists and new contacts are updated in the user's address book, even though they are written on sticky notes. The system is also capable of processing simple queries on the user's address book, email clients or digital calendars. Notes of type 'query' are replied to with requested information on the computer screen or on a printout. A portable pocket printer is used as an output medium for printing out answers to the user's queries in the prototype. The most important feature of the Quickies system is that the user can customize what he or she wants the system to do in different cases or in case of different types of notes. In order to make the Quickies trackable at home or in office, each sticky note contains a unique RFID tag on the back. Multiple RFID readers keep track of the availability of the individual RFID tags in their vicinity. UHF (902-928 MHz) RFID readers and EPC Gen 2 tags are used in the prototype system. This mechanism provides sticky notes unique IDs and links the IDs to content. The user can use the Quickies graphical interface to browse, search or filter particular notes he is interested in. The user can also find the location of a note and hence the object he has tagged with the note at home or in office. The RFID tracking mechanism enables this feature.

## Conclusion

This paper presented 'Quickies' – a system that bridges the gap between the physical and digital world, linking hand-written sticky-notes to the mobile phone, digital calendars, task-lists, e-mail and messaging clients. We explained what are 'Quickies' and what they can do. The paper also described the system design and implementation details of the 'Quickies' system. By augmenting the familiar and ubiquitous physical sticky-note, 'Quickies' leverages existing patterns of behavior, merging paper-based sticky-note usage with the user's informational experience. Upon synchronizing with and connecting to the popular digital devices for information management, such as personal computers and mobile phones, 'Quickies' - intelligent paper sticky notes can prove to be an alternate and intuitive interface to digital information for people around the world, the majority of whom have found it

frustrating struggling to enter a strange digital world dominated by mouse and keyboard.

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