Lightweight Note-Taking Tools Using a Confederation of Mobile Capture & Access Devices

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ABSTRACT

Informal note taking is a significantly different task from note taking in structured settings. This type of activity requires a special set of requirements including a substantial lowering of hurdles to capture and access across a variety of environments. Cepher is a prototype note capture system that supports the capture and retrieval of short notes through a variety of input devices. People would often like to use a variety of methods to immediately capture these thoughts instead of waiting until later for an available recording mechanism. Current digital note capture systems tend to be monolithic applications that do not either dynamically support a variety of input mechanism or allow flexible access from a variety of viewers. Wireless sensor network research focuses on using sensor nodes in ubiquitous computing environments instead of the traditional routing and ad hoc networking issues. Cepher leverages research advances in hardware and software to provide a flexible infrastructure for note taking applications, which can then be treated as a federation of independent input, output, sensing and storage subsystems.

INTRODUCTION

We believe the special needs of informal note taking can best be met using a confederation of devices. No one device is appropriate for note taking in all situations. For example, typing into a terminal would not be very easy while driving whereas vocalizing the request would not be appropriate while sitting in a meeting. In an effort to explore informal note taking across a variety of input and output devices, we conducted user studies and prototyped a system based on findings from those studies.

Cepher (a Hebrew word meaning "writings" and pronounced "safer"), is a prototype system designed to handle the capture and access of short notes to augment our own ability to record and later use these small pieces of interrelated information. Some examples of short important thoughts that users might record are "to do" items, groceries, potential thesis topics, and contacts. Architecturally, Cepher supports flexible capture devices, a centralized storage service, and multiple access mechanisms. The initial prototype supports capture and access through desktop, tablet, and PDA –class systems, storing information on a personal mobile device.

Mobile and ubiquitous computing inspires many useful but previously unrealizable services that are available through the seamless interaction of devices that are either portable or easily available in our environmental infrastructure. One appealing service is the simplified capture of information from daily life, specifically important or notable bits of information that we create and can review anywhere and anytime [1]. The ephemeral and serendipitous nature of much of this information requires minimizing the obstacles to capturing it; otherwise we might forget an important point when we finally take the time to do it.

Despite advances in personal information management devices, users still have difficulty documenting, prioritizing, and organizing daily tasks. Users may be willing to overcome challenges of recording thoughts in structured settings, such as a meeting or lecture rooms, because their personal note taking environment can be intentionally constructed. Cepher aims to simplify the capture of short but important thoughts in arbitrary settings, which requires a substantial lowering of these hurdles to both capture and access.

The Goals of Cepher

Noting the small details of our daily lives could potentially help us proactively avoid inefficiencies that exist during various activities. Many specific elements of our lives are often difficult to remember without the explicit record of them. Early psychological research projects found that humans are more likely to remember details if that information is learned over a long time period, using multiple modalities simultaneously, or through repeated capture and access of the information[2]. Unlike in structured settings, these types of interactions with short notes are unlikely to occur. Thus, users cannot rely on these memory aid techniques and will require an external record. Improving on current practices will require physical and digital artifacts, flexibility, multi-modality and ubiquity[3]. These notes all have certain characteristics in common: They tend to

be temporary, viewable, mobile, postable, transferable, small, light, short, and easy to create[1]

The Cepher system augments users' current practices to enable them to continue to use traditional interactions (e.g.., writing on paper or typing with a keyboard) while adding value through better storage, organization, and access capabilities than were previously available to them. Cepher allows users to employ a variety of input and output modalities while storing all of their data using a single storage model on a single device. The sorting, transcription, and storage algorithms available to Cepher can thus act on all of the users' data. Users can access all of their data at once through a system that is aware of all of their information and not just pieces.

Another important goal in designing and developing Cepher is to think about application development as a federation of input, storage and output capabilities *from the beginning*. We have seen compelling services, such as email, undergo a transformation from single device activities to multi-device activities, but this transformation has been difficult, often requiring separate accounts for "fixed" and mobile access.

UNDERSTANDING PERSONAL CAPTURE AND ACCESS

The automated capture and access of live experiences is a common theme in mobile, wearable and ubiquitous computing [6]. Most capture and access applications, whether built as research projects or for the commercial market, rely on instrumented environments for structured activities, such as classes and meetings. Little exploration has been done in less structured and informal settings. Understanding the challenges users face is important when building systems to support them. We conducted a study of how users currently capture and access personal information in these informal settings.

We employed surveys and interviews to understand the requirements of potential users. We interviewed a small set of participants to gather initial data and inform the design of a questionnaire. We then distributed the questionnaire and analyzed the results. Because some interesting questions arose from that analysis, we conducted follow-up interviews with a subset of the original participants. We describe the lessons we learned in the next section. More details of this study can be found elsewhere [3]. Here we summarize the findings that inform the design of Cepher.

Challenges Related to Capture

An important design implication of our formative study was the need to lower the hurdles to capturing information enough that users who currently choose not to record information will choose to record it.. Incorporating a variety of modalities and input devices into Cepher allows users to interact with the application in whatever way is most appropriate for the situation and their particular preferences, thus lowering those hurdles. We also found that adding the context of a situation to the recorded data was extraordinarily difficult for users at the time but necessary and important for access, imp-lying the need for automated capture of context.

A multi-modal ubiquitous interface could extend use of the system to environments in which an appropriate interface to capture is not currently available. We identified three types of environments that require better support for recording information: awkward social contexts, while in motion, and challenging physical environments. A socially inappropriate context can be an event (movies, concerts, etc) or a one-on-one conversation. Traveling includes any time that the motion of the user requires so much attention that distraction could be dangerous. Challenging physical environments are those in which recording information requires overcoming too many obstacles to seem worthwhile (i.e. bed, shower, surprise meetings).

Challenges Related to Access

The capture and storage of information is nearly irrelevant without the ability for access. In the case of short notes, in which the act of recording is often insufficient to encode the memory, this problem is particularly acute. Users often need quick access to these notes. For example, if a user is driving to an appointment and realizes she is late, she is unlikely to make herself later by stopping and looking for the phone number of the person she is meeting. Without the ability to access this information quickly and easily, she might as well not have it at all. Users must be able to use their information quickly and easily and using an appropriate device for the type of data and context of the interaction.

Although traditional input methods, such as pen and paper or voice, are appealing, substantial benefits, including increased longevity and the ability to reorganize information, exist when the data is stored digitally. A large portion of the study participants with both digital and analogue methods available reported copying information from handwritten to digital format. Some users refer to the problems of carrying paper as well as the ease with which their paper notes could be lost or destroyed. This fragility can hinder later use.

Participants indicated a wide variety of methods used for organizing the information they recorded, including chronologically, alphabetically, and by priority. Participants also listed transcription into different forms as a way of organizing their information. For many, the organization method also changed based upon the age and type of information being stored. This variety suggests that systems with a single, monolithic approach to organizing information may be more of a hindrance than

a help. Users require the ability to quickly and easily reorganize their information directly.

The User Experience

Once a user has installed and configured Cepher on a device, he is able to use the application across all installed devices with his Cepher notes repository. In this way, a user can run the note taking application on all of his devices at one time without fear of losing his information or forgetting it on a different device than the one he uses to later access that information.

Cepher is a traditional client/server application for mobile users and their array of personal information devices. The Intel Personal Server [4, 5] serves as the hardware platform for the server portion of the client/server model. Traditional mobile devices access the data storage and services of Cepher through client applications designed for individual platforms. Users record personal information in whatever modality is most appropriate for capture device and situation. Users can later access this data, stored on the Personal Server, in whatever modality is appropriate for the access device and situation. Because all data transfer occurs over Bluetooth, users can successfully capture and access their information through services in the environment or other mobile devices without ever needing to physically interact with the Personal Server and without any network capabilities inherent to the environment itself.

To the user, the act of saving the data is transparent. The application automatically sends each stoke of ink or line of text to his personal data store. In this way, even if he walks away without explicitly saving his note or closing the application, the data will still be stored and accessible from another device later.

When accessing short notes, users can browse all notes or search for meaningful information in a variety of ways. Keyword searching over text and transcribed ink data allows users to find specific and topical information. Users can also limit the search by choosing a specific date range, or by deselecting particular device and/or data types. Once the user has chosen a query, he can activate that query by pushing the "Get Notes" button. The application will then return a list of notes matching that query and display them. The list of available notes is dynamically compiled using the data available on the personal server. Designed with short notes in mind, Cepher optimally supports small sessions with only one page. Once a user identifies a particular note taking session, he can double-click on that session to retrieve the notes from his personal repository. Only the first page, if multiple pages exist, is returned immediately. Using the returned page count, the application also displays (or hides) forward and back buttons and an editable area displaying the current page number that allows users to jump to a particular page number.

ISSUES IN THE DESIGN OF CEPHER

Throughout the design and development of the initial Cepher prototype, a variety of design decisions were made. Some of the issues are left for further discussion. Below, we highlight some of these issues.

Context Collection

Memories, whether of a note taken or anything else, are encoded with the context of the experience. To help users in the accessing of any stored information, we must collect the necessary context to allow for detailed searching and browsing by the user. Context collection can be accomplished in a variety of ways. Using a toolkit of wireless sensor mote interfaces, we will be able to capture a variety of context for a particular user. This toolkit includes a handheld RFID reader, a DisplayMote with an integrated graphical LCD and accelerometer, and a USB and PCMCIA based mote to make connecting to existing laptops, PDAs, and servers more streamlined.

This toolkit was created for the development of specialized personal-area network devices that utilize a standardized wireless communication platform. We leverage the low-power radio and sensor network protocol work already in progress at UC Berkeley and other research institutions. By creating fully reprogrammable I/O devices and making them as general purpose as possible, the hope was that they would be useful in rapid application prototyping, as well as being leveraged as powerful preexisting modules. We plan to use them in the context collection aspects of Cepher as well as in other applications as a test bed for this idea.

Single Repository vs. Distributed Data Storage

For an effective user experience, Cepher needed at a minimum the illusion of a single data store. This could have been accomplished either through a distributed or single data store, assuming that the system has constant availability to the different nodes of the storage area. .

Using a distributed data storage model, the system would by default have multiple copies of some information. Although this model protects the user from a single point of failure, synchronization can be a problem. One major advantage of the distributed model is the ability of users to access their personal data through the network without needing to carry a device. Reliance on network connectivity between the data storage nodes can cause user frustration as a result of network latency or areas with no connectivity at all.

A single data storage model can relieve the frustrations associated with network latency and areas of no network connectivity. Furthermore, this model may reduce synchronization problems across multiple devices. Of course, the use of a single device for data storage also exposes users to other potential problems. A single device means a potential single point of failure.

Both models allow users to off-load information into the world. Regardless of the way in which it is accomplished, the illusion of a single data store which is constantly accessible may create new user habits. For example, users no longer need to remember phone numbers because they are encoded in cell phones that are constantly accessible. This reliance has changed user behavior such that users without their cell phones often have no way to access those phone numbers. The authors believe a single data storage model of interaction will best allow users to encode this data into a constantly accessible store with confidence and ease of accessibility.

Making Personal Information Public

Cepher, designed to enable individual capture and access, augments users' current personal note-taking practices. The authors recognize, however, that there are many situations in which users may want to share their personal notes. Examples of such situations might be a family sharing a grocery list or a group of co-workers sharing the notes from a brain-storming session. The same infrastructure can be used to allow individuals to share Cepher notes. Cepher would still use the initial paring between input device and Personal Server for capture and then relay the information by re-broadcasting the data from one Personal Server to another.

Automatic Extraction of Information

Enabling users to access their information easily is an important goal of the Cepher project. Providing context and better searching capabilities, however, is just part of the ideal solution. Intelligent data extraction algorithms could help users find and use information even more quickly. Future versions of Cepher may include machine learning algorithms that observe users as they work with their data and attempts to organize information based on statistical user models derived from these observations.

Availability of Cepher Services

Currently, interaction with Cepher requires both client and server to be within a small enough distance for a strong Bluetooth connection (usually less than 10 feet). Future prototypes may overcome this limitation through use of data queuing, longer range radio signals, or wireless to wire-line relay networking solutions.

Users can currently search their Cepher notes repository using a minimal amount of context. The addition of location context may help users search by such features as all notes taken while in their home offices. More intelligent levels of context derived from lower level data may give users the ability to search by a particular activity or grouping of people. Future versions of Cepher will include storage and use of these types of context.

Software Architecture

Cepher interactions currently require application installations on all devices within the Cepher network. This limitation prohibits users from using new hardware in an environment as well as from borrowing other people's devices. Future versions of Cepher may overcome this limitation through a server-based implementation. Thus, a user will be able to interact with Cepher quickly and easily with any device available.

CONCLUSIONS

A ubiquitous system for recording and accessing notes, ideas, and other information could help off-load users by augmenting their memories with contextually encoded easy to access digital data. The architecture of this system across multiple devices will allow us to more fully explore the development of multi-device interfaces for note-taking and for other tasks. Cepher integrates interesting wireless technologies, small server capabilities, context collection through a variety of devices, and a usable interface for quick note-taking to support users in capturing and accessing the notable details of daily life.

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