

Context-Aware Keyless Computing

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ABSTRACT

In this article, we describe the intrinsic constraints of mobility and discuss how we can work around and often exploit these constraints using information implied by the context of the mobile user. In particular, we outline some of the work we have been doing in providing information to users on the basis of location information, both geographical and logical. A user's location and other contextual information is used to retrieve task relevant information and avoid many of the problems posed by limits of mobile devices and their use.

Keywords

Context, Mobile, Location, Information Retrieval, Media

The incredible expansion of functionality on Internet enabled mobile devices has increased their adoption with the assumption that there soon will be applications that make use of this new connectivity. Unfortunately, there have been few applications that make full use of the power of the devices, to a great extent, because of the constraints they impose on systems. Input modalities, screen size, and speed of connectivity all participate to limit the effectiveness of many applications. The opportunity exists, however, for a "frictionless" approach that makes use of any and all context information linked to these devices to more precisely address user needs.

KEYLESS COMPUTING INITIATIVE

Out and about in the world, people are already engaged in tasks such as shopping, eating, seeing movies, etc., so any system designed to work along side and assist, should not detract from the actual task at hand. In practice, the limited modality of ubiquitous devices makes this challenge non-trivial in that user interfaces must deal with the constraints not only of the device, but also aspects of the user, who may be carrying several shopping bags and a cup of coffee. Fortunately, identification of context can simplify the input, in many cases down to one press of a button. In a mobile setting, context is biased by location.

WHAT'S IN A LOCATION

While there have been many applications aimed at incorporating hi-fidelity location information of the type provided by GPS (Global Positioning Systems) into applications, there still remain very few computational devices in use that are GPS enabled. Because of this, we have decided to focus on two other approaches to location: low-fidelity information that can be obtained using MPS (Mobile Positioning Systems) technology

available to all cell phone users and logical location information that can be obtained through interactions with wireless networks. In the first case, we are able to use cell information to obtain longitude and latitude information down to a one block radius. In the other we are able to identify "known" locations using IP-address digital signatures. From the former, we are able to link users to specific geographical information systems while in the latter, we are able to provide information that is linked to the idea of the place they are in rather than the physicality of it.

STICKY NOTES

Information is often tied to location. Reviews, recommendations, comments, even warnings about general locations and specific services found at those locations (e.g., restaurants, stores, etc.) make the most sense when they are linked to the locations themselves.

Unfortunately, even systems that form these links and



Figure 1. A set of notes in downtown Evanston IL.

expose the information in, for example, the form of annotated maps, are useless to most mobile users. This is simply because the user is placed in the position of having to tell these services exactly where he is when he is out and about in the world. Even when a user has this information (which is often not the case) he still has to deal with having to input it using a device that is at best awkward with regard to text input. This friction renders such systems useless.

The StickyNotes project is aimed at addressing this problem of location centric information access. It does so by using Low-Fi location data to provide a context for information access and presentation that gets users to location specific information without any need for direct input. Because the system itself knows where a phone is, users not only do not have to input their location, they do not even have to know it themselves.

Once invoked, the StickyNotes system presents a mobile user with a map of his general location based upon MPS information (Figure 1). While the system does not know the exact location of the user, it does have enough information to guarantee that the users location is well within the confines of the map itself. The map, which can be navigated using both standard NSEW, focus, and expand controls, is annotated with “notes” from other users and sources trusted by the end user. These notes can then be examined on the phone, giving the mobile user with highly relevant information that can be accessed without ever using a keypad or even knowing where he or she is at any given time.

The StickyNotes system allows users to effectively review and post notes while exploring the real world. With Low-Fi location information in hand, the new generated notes can be linked to the user’s current physical location as the note is generated. The notes are displayed to the user as pushpins on a user’s navigational map. The pushpins categorize the content of the notes by indicating the type of information they provide (reviews, warnings, etc). As a user moves through the world, the system displays a map of his or her current location in addition to the notes that exist in the area.

Integrated with existing “buddies” lists, StickyNotes also allows users to expose their notes to communities of friends and colleagues. Users can create virtual graffiti that is visible only to other people using the system. By sharing notes with other people, StickyNotes helps build community around the commentary and information generated by the system’s users.

The StickyNotes system creates powerful new platform for information distribution. It allows users to read and create notes that are tied to the physical locations. In addition, it allows users to communicate information to a community of users that wander the same space.

YOU ARE HERE

Generating driving directions has become easier with the advent of computer technology that can calculate precise driving directions. These systems, while better than using road atlases, still require a significant amount of user input. Knowing the address of where you are and where you want to go is necessary to make these systems work. Finding directions between two well defined, predetermined locations usually consists of printing out travel itinerary before a trip. In a mobile deployment, however, inputting in a starting and ending location

becomes incredibly tedious. Not only do users need to be constantly aware of their location (in a format the software can understand), but they have to deal with the input limitations of most mobile devices.

You Are Here is a system that alleviates the friction of computational tasks that require location as an input. The system takes into consideration the limitations of location awareness that users have when they are on the move in unfamiliar places. The system has knowledge of location, doing away with the user’s need to know the physical address required to use map generation systems.

You Are Here also eliminates the often difficult process of typing in an address into a mobile device. Since the system retains a constant notion of the user’s location, generating travel itinerary is reduced to pressing a single button. Friction is removed by eliminating the need to type in an address to a mobile device that probably has limited input capabilities. Removing the input step reduces the time and effort required to use the system, allowing users to focus on other things.

The You Are Here system leverages users’ cellular phones to create travel itineraries that can be distributed to other users. The system allows a user to generate directions from their location to other locations without explicitly knowing where they or the other users are. A user can select a friend (or set of friends) from existing communication tools (i.e., Outlook Contacts, MSN Messenger) and send them directions to his or her location. The directions are different for each user, since each user may have a different starting point.

From a security point of view, the system is flawless. The target user (who is advertising his or her location) only has to know whom he or she is sending a message to. The user receiving the information accesses directions by sharing his or her Low-Fi location information with the system but not with the other user. As a result, the person who is distributing the invitation never has access to the locations of the people who are accepting it.

The starting point for any set of directions is automatically determined and users can distribute the directions to large sets of people without modification. The system generates an identifying link for each user using their moving location via MPS. When a client accesses this URL the appropriate map and text directions to the tracked device are generated. Since the location identifying URL is sent by using a SMS (Simple Message System) and no map or directions are statically stored, the URL can be freely forwarded to more people. This allows automatic creation of travel itineraries from different starting points to the same, possibly moving, destination. Each device dynamically renders the map when a user accesses the URL, the direction set is guaranteed to be up-to-date, even if both parties have changed location. The system allows mass communication of directions with little or no user input.

The You Are Here system uses information about a user location to eliminate some of the friction related to the retrieval of driving directions. It allows users to easily track and meet friends, while promoting mass communication of directions to social hotspots.

Similar systems (AT&T – Find Friends) have not integrated with users’ existing address books or buddy lists. The lack of integration fails to reduce friction since it requires users’ to input phone numbers to the system. This becomes a huge use issue, since address book technology has all but eliminated the need to remember 10-digit numbers. In addition, these systems require users to constantly monitor and change their “visibility” to other users. Failing to change their status of the system would result in anyone they have previously interacted with (via the system) to track their location.

One feature that we have been exploring allows secondary users (those who have received a set of directions) to pass the target information to others (when allowed by the target) allowing maps and directions to a moving target to be transferred to large groups. For better or worse, we see these as enabling a dynamic version of the “swarming” behavior that is now associated with IM systems.

MEDIAPOINT

Digital media and content, however accessible, requires users to find the media and specify their locale. In many cases, the needed information has to be found by the user either by exhaustive web searches or by visual hunt and peck through portals and data aggregators. MediaPoint assists by removing the search entirely, connecting people and media. Simply running a media player brings video tailored for the coffee shop you are sitting in or visiting a movie website knows your nearest theaters and its listings.

MediaPoint constructs a signature of the user’s logical location and uses it as the identifier to deliver content without requiring the user’s active participation. Meta-information about the signature is stored in various databases that bring media back to the user. Viewing content can be as detailed as network programming leveraging off the known users location or as simple as a push localized to the signature’s known zip code in the database.

MediaPoint is a simple object, local or networked, which can either be sent from a server to the client or installed on the client as an application plug-in or background service queried whenever appropriate. Once invoked, MediaPoint generates the network signature and queries the known or discovered databases for meta-information and content.

The signature can be encoded to add an additional layer of network security, on top of existing digital rights management, ensuring the content is actually being

played in the provider’s desired location. When embedded in a word processing document or spreadsheet (Figure 2), MediaPoint checks the network signature when the document is opened. If the signature matches that of a secure location, the document is then decrypted

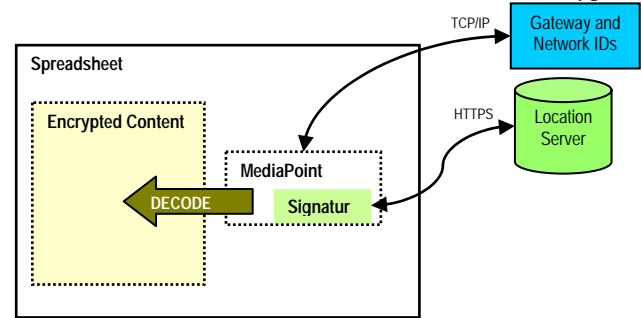


Figure 2. A spreadsheet document is encrypted and contains an instance of the MediaPoint object. MediaPoint delivers the decode key when the document is opened if it is in a known secure location.

and displayed. If the signature/location is insecure, the document remains encrypted.

Having the client know its location can also protect appliances and other objects in the world. Any networked appliance or device (autonomous vacuum cleaners, robot dogs, even a WiFi enabled toaster) would have known ‘home’ locations. If a device is taken outside its home, its behavior would change. An autonomous vacuum knows to tread more cautiously at an unknown location, a robot dog could become mean outside its home, or your toaster would cease to operate.

CLOSING

In all these systems, location becomes a key point of information that defines a context which, in turn seriously improves their functionality. Rather than seeing mobility as a deterrent, location coupled with the device’s modality becomes an important component in proactively retrieving relevant information.

AUTHORS BIOS

Kristian Hammond is a Professor of Computer Science at Northwestern University and Director of its Intelligent Information Laboratory. His work is aimed at removing the friction from the use of information systems by capturing and employing a user’s context and using it to decide how to retrieve, organize and present information.

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