Handbook of Research on Mobility and Computing:

Evolving Technologies and Ubiquitous Impacts

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Chapter 30
Combining Location Tracking and RFID Tagging toward an Improved Research Infrastructure

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ABSTRACT

The popularity of mobile computing creates new opportunities for information sharing and collaboration through technologies like radio frequency identification (RFID) tags and location awareness technologies. This chapter discusses how these technologies, which provide subtly different information, can be used together toward increased benefit to users. This work introduces technologies for RFID and location awareness, including a survey of projects. We describe advantages of combining these technologies, illustrated through our system, TagIt, that uses these technologies in a traditional research poster environment to provide a rich multimedia experience and encourage ongoing feedback from poster viewers. An overview of TagIt is provided, including user commenting and information sharing capabilities that make use of RFID and location information. User feedback and an expert review highlights how TagIt could benefit authors, information consumers, and the research community, leading to future directions for the research community.

INTRODUCTION

Mobile computing provides opportunities for information sharing and collaboration, but also leads to new challenges regarding knowledge of the current location and the surrounding environment. To fully leverage the flexibility afforded by mobility, developers must design their applications with the knowledge that users will not be seated at a desk to use their computers. Instead, they will be on the move, often in unfamiliar locations with artifacts they have not previously encountered. Users want to rely on their technology to assist

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them in understanding their environment and, even more importantly, to be an active participant in it.

Two related technologies help to address these issues: radio frequency identification (RFID) tags and location awareness technologies. RFID uses low-cost tags with minimal internal memory and sensing capability that are attached to an object for tracking and information storing purposes. RFID has been widely used in workplace and educational setting to provide low-cost tracking and storage. Location awareness refers to real-time location determination that can be accessed by computing technology. Once a user's location can be determined, a system can then share necessary information or allow for collaboration. Current location awareness devices include GPS, Bluetooth, and Wi-Fi.

Individually, these technologies help realize the vision of mobile computing--distinguishing it from traditional desktop computing that is tethered to a fixed location. This chapter takes the next step, demonstrating how they can be used together in moving beyond simple tracking tasks to enhance information sharing and improve communication and collaboration. We envision environments where physical objects are tagged, and the users who scan those tags are mobile. Not only is information related to the tag of interest, but so is information related to the current location and prior locations of the objects. The objects could be technology, physical artifacts, or other people. We explore these possibilities in greater depth in this chapter, and we present TagIt, which combines the RFID tagging of professional posters with location awareness that highlights where they have been displayed.

This chapter explores how simultaneously using RFID and location awareness can augment common research tasks to create a richer, more collaborative environment. The coming sections give a background on location awareness technologies and on the structure and use of RFID. We also discuss specific areas in which RFID can be useful, including industry and education. We then expound upon our vision for combining RFID tags and location awareness technologies, and we introduce our tool, TagIT that uses RFID and location awareness to augment poster environments by encouraging feedback between poster authors and viewers that would otherwise be impossible with a basic poster presentation.

BACKGROUND

Much research has been done with the common goal of making digital information more mobile and making their interfaces more "user-friendly". Combining digital information with physical artifacts allows users to keep the advantages of physical objects and merge them with the advantages of digital information. This section provides an overview of the two technologies used in our work: location awareness and RFID.

Location Awareness Technologies

Location-based systems provide location awareness information and allow for users to share and retrieve information locally. This document seeks to use the term location awareness to include the human—specifically, the continual location knowledge the human experiences—as the definitive element. Global Positioning Systems (GPS) has become the primary system for supporting outdoor location awareness. This satellite-based mechanism is commonly used in automobiles and other vehicles to provide accurate location information in three dimensions, using triangulation of signal received from four satellites. To determine indoor location, when satellite signal is blocked and does not provide reliable altitude distinction, technologies such has Wi-Fi, Bluetooth, mobile phone towers and infrared signals have emerged as possible solutions. As with GPS, signal strength from one or more of these technologies are triangulated to determine location.

These location awareness technologies have evolved through the development of a great many applications. One of the notable early indoor systems was the Active Badge research project at Xerox PARC (Want et al., 1992), for which users would wear badges that emit infrared signals that were picked up by sensors throughout the building. Instead of sensors, MIT's Cricket location system used motes that broadcast location information, which could be picked up by devices carried by users (Priyantha et al., 2000). Intel's PlaceLab system sought to support location determination throughout a city using existing signals from various sources; e.g., GPS, Wi-Fi, and Bluetooth; toward supporting location awareness without requiring new architecture (LaMarca et al., 2005).

Our work on the SeeVT framework continues the Intel vision by using wireless signal triangulation and GPS signals to track the location of a user on campus (McCrickard, Sampat, & Lee, 2007). This system was used in various applications, including a system for finding books in a library, a system for viewing art in a museum, and a information sharing system for disabled users. These types of systems are useful when a user wants to obtain information about the location or to communicate with people in the area or who will be in the area at a later time. The TagIt system described in this paper uses the SeeVT technology to provide location awareness to the user.

Note that this section only provides a brief overview of this highly active field of location awareness; for a more complete overview, particularly with respect to the SeeVT project, see (Sampat, 2007).

RFID Overview

RFID is an effective tool to connect digital content with a corresponding physical artifact. RFID tags consist of an antenna and a small amount of silicon memory. They are abundant, inexpensive, flexible, and do not have to be in view like other barcode systems. RFID tags can be used to indicate presence or identity, allowing for a user to interact with a ubiquitous environment. Each tag has a unique identifier so that no two tags are the same. A RFID reader is used to scan and in some cases, write data to a given tag. Radio waves are sent from the reader to the tag to ask for the identifier and other information located on the tag. The tag then sends back the requested information. RFID objects can be designed to balance various physical and digital qualities, guided by the ways in which these objects are used and experienced (Martinussen, 2009). RFID readers have become mobile by interacting with laptops through USB and are beginning to appear in cell phones. This allows for physical objects to interact with a personal computer interface or web browser. Use of the RFID interface gives users a simple interface to a corresponding database of information that can be viewed and updated. While RFID was originally used primarily in business and industry settings (for package tracking, shipping, and storage), its usefulness is becoming more evident in research and education settings like libraries, museums, and nature trails. For example, items like books and paintings are receiving RFID tags that contain identifying information. A change in location of the item results in an update to the location-aware database and an accompanying map visible to the user. When you add the ability to determine the location of a user with a RFID interface, it moves the system beyond operating simply as a tagging and information system to allows users to discuss and collaborate on the objects that are tagged. The ultimate goal with these mobile systems is to enable a user to have an interface for information and collaboration access at all times. Next we will look at different settings that can benefit from these enhancements as well as different projects that have surfaced.

RFID technology is currently being used in many different areas for the purpose of identification and information retrieval. RFID tags are appearing in clothes, books, food, passports, and can even be used to find lost children. In one example, tags were placed in currency to pair cash with a specific owner. This technique is used to help banks track "illegal" money by combating counterfeit currency and flagging transfers between scent ways. In the remainder of this section, we look at fields in which RFID technology is used and discuss the emerging research being done to further RFID usage and effectiveness.

RFID in Industry

The rise of RFID technology started in businesses that needed a more effective way to track items. In the construction industry, dynamic and uncontrolled environments make it difficult to track components, materials and tools, and access related information. Ergen et al. (2007) have presented the RFID technology as a solution to these issues. As an example, a RFID based data collection system was set up so that a worker's location data could be collected automatically at certain times. This system setup involved the workers carrying the RFID reader while the tags where attached throughout a building. In the paper industry, RFID can be used in an automated identification system which carries the identification code of a specified reel throughout the whole life cycle and supply chain of paper and board reels. Lehto et al. (2009) stated that RFID would "enable more visible, efficient and automated paper reel supply chain by enabling automated reel identification with clamp truck-integrated reader units and by restoring the reel identity throughout the supply chain from the paper mill to the end user." RFID is used in the pharmaceutical industry for inventory and warehouse management as well as for access control and theft control. Potdar et al. (2006) explains the concept of "smart shelves" where a shelf essentially knows what is contained on it. Each shelf that is uniquely identified using RFID tags could be easily and quickly searchable from any location. Much research is being put into extending the range of the readers which would benefit the use of the technology in industries.

RFID in the Workplace

Merging physical artifacts with digital content can be a vital tool in the workplace and can also enhance collaboration. Hospitals provide many opportunities for enhanced mobile collaboration. Bardram et al. (2005) states that social and health care assistants, nurses, and physicians at the ward continuously shift between being engaged in face-to-face collaboration and distributed collaboration. During the latter, they cannot see or talk to each other but have to communicate via messages and notifications. An example of an artifact modified in this area was a work schedule. The work schedule was able to maintain its physical affordances and advantages while acting as a physical bookmark to the schedule's digital representation. Another example involves combining a physical whiteboard with digital content. Data including patient data and medical indications are projected digitally to the whiteboard while the white board is used in its normal way. This allows for users to see information both physically and digitally to provide them with a more comprehensive picture. Yankelovich et al. (2005) augmented an office space by using RFID tags in badges to let remote workers know when local workers were in certain areas such as break areas, lounges, or cafeterias. This was created to encourage unplanned interactions between remote workers and local workers. This is just one of the many ways RFID is growing as a way to track location in an indoor environment. Each tag corresponds to some spatial information. Problems that occurred included tags not working when in contact with a user. Researchers have also implemented this system to interact with a robot in a physical space that allows the robot to sense its location and surroundings. (Mehmood, 2007).

RFID in Education

Researchers are currently exploring ways to implement the RFID technology in and out of the classroom to assist with information storing and collaboration among students. Deguchi et al. (2006) combined RFID technology with a PDA to create a system called CarettaKids that encourages collaboration among students by combining a personal workspace with shared spaces. The system allows for a user to use a PDA to interact with digital representation of objects that are on a shared sensing board. Chen et al. (2008) combines RFID technology with a wireless networking and a mobile device to create a context-aware writing system. RFID tags were placed in different locations related to what the user is writing about. The PDA is equipped with a reader, and the user can scan tags to obtain learning content, write essays, or communicate with other people. Researchers at University of Cambridge (Stringer, 2004) used RFID to create a tangible user interface that assists in teaching children rhetorical skills. RFID technology is used in two parts of the Webkit system. Statement cards, which contain claims created by the children related to the discussion they are pursuing, contain RFID tags and a light-emitting diode (LED) that is turned on when the card is read by a reader. Argument squares and a magnifying glass square are used to used to helped the students organize their statement cards. These squares are equipped with a RFID-reading antenna that allows the argument squares to know when a statement card is in its section. When a statement card is read by one of the argument squares, a thumbnail of the webpage which assisted in the creation of the argument is shown on a overview screen on a graphical user interface (GUI). If the statement cards is read by the magnifying glass the GUI shows a complete webpage associated with the statement card. One issue researchers came across using RFID was that only one tag can be read by the reader at a time. This situation caused for the statements cards not to be organized appropriately when the children presented their arguments. Tangible interfaces have emerged as an effective mechanism to teach children (Revelle, 2005). RFID technology can be an effective tagging mechanism to enhance these types of interfaces.

RFID in Social Settings

Bisker et al. (2008) proposed that: "What draws people to social gatherings today is the chance to have face-to-face encounters, be they organized (workshops, speeches, etc.) or serendipitous ("networking"). As a result, conference schedules, spaces and software infrastructure are often designed solely to encourage physical communication. Digital support for attendees today is largely limited to websites for preparation, logistics and organization." We agree that it is the social settings that provide particularly rich opportunities for information exchange, as we illustrate with our TagIt system in the next section. First, we detail several exemplar systems that make use of RFIDs in public settings to enhance communication.

Museums have a goal to make exhibits accessible and easily understandable to the public, making them open to using the technologies that enhance visitors' experiences. Brown et al. (2003) used location-awareness technology and a mixed reality system to allow visitors who are experiencing the museum locally, through virtual reality, and through the web to communicate and navigate a shared information space. This system shows how these technologies can be used to enhance off site collaboration and discussions. Bisker et al. (2008) created a system called the PittiFolio which is used at fashion shows. Users tap their badge at an exhibitor to "tag" it for later, and if two users tap their badges simultaneously in a "virtual handshake", each would be sent the other's business card information. Users could then visit a touch-screen kiosk to access information about people and places they had tagged. Technical issues they found included users feeling RFID was too invisible, instead using pen and paper to record why they tagged a place. People generally enjoy writing down information about people they meet on the back of business cards. Another issue was that it was also not sufficiently ubiquitous. Users didn't want occasional access to tagged information. The researchers then created PittiMobi to solve these problems. This system used a mobile phone and QR code technology and could now record voice notes. QR codes are matrix codes that can be detected by a mobile phone equipped with a camera. The camera must be in view of the QR code for it to read and will become unreadable if the code becomes scratched or faded. With the eventual emergence of RFID enabled phones, this will allow the advantages of the RFID technology to once again be implemented in this model.

Like TagIt, McCarthy et al. (2004) attempted to augment conference paper sessions by creating the AutoSpeakerID which is an application that displays the name, affiliation and photo (if provided) of a person from the audience asking a question during the question and answer period following a paper or panel presentation. The microphone is augmented with a RFID reader that communicates with the RFID badge worn by the person asking a question. The researchers stated that the system should not detract significantly from the session's content and intellectual exchange, and people should be able to opt out. They also augmented informal coffee breaks by creating the Ticket2Talk (T2T) system, which displays an image and caption representing a user's interest when that user is near the display. T2T is designed for a more informal setting within the conference rather than the sessions or panels. McCarthy states that: "One of the appeals of a conference is that it creates a context to support mutual revelation: allowing attendees to learn more about others and their work, as well as being open to opportunities to tell others about themselves and their own work." (McCarthy, 2004) Their applications are designed to respond to people nearby, based on the detection of a guest's RFID-enabled conference badges, without the need of direct user interaction. While the AutoSpeakerID and T2T enhances synchronous, face-to-face communication, our system TagIt seeks to resolve asynchronous situations, where the creator of the poster is not available or in the area.

COMBINING RFID AND LOCATION AWARENESS IN TAGIT

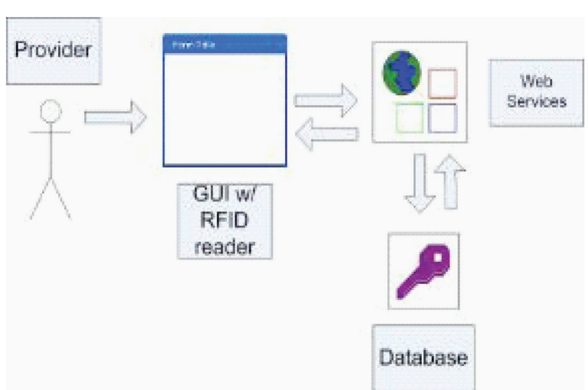
RFID tagging and location awareness both contribute to Mark Weiser's vision of ubiquitous computing: invisible computing that is accessible everywhere (Weiser, 1999). When these technologies are combined together they become more than just a tracking utility but can contribute to improving the experience of communication and collaboration. These technologies can assist a user in learning information about surrounding objects but also information pertaining to past, present, and future locations of the objects. With the ability to tag an object, and with the ability to move tagged objects, stakeholders—object creators, manipulators, and observers—gain the ability to explicitly (through comments) or implicitly (through presence near or movement of the artifact) share information about objects with other stakeholders. This objects could be physical artifacts (groceries, furniture, clothes, and other mobile or semi-mobile artifacts) or people (name badges equipped with RFID tags that give you extended information about that person.). The combination of this information presents a temporal picture of the history of the object to any stakeholder in the object: its creator, past interactors who want follow-up information, or future interactors who want an object overview.

To illustrate the utility of the combination of RFID and location awareness, we created TagIT. The TagIt system provides information about professional posters, providing a two-way connection to access more information and to provide feedback regarding any given poster. The TagIt system provides information about professional posters. The posters are RFID tagged, and people who scan them can view multimedia content not available with paper posters, and can view and leave feedback with the author of the poster as well as other stakeholders. The TagIt system instantiates the research vision outlined in the previous sections— creating a system that extends the traditional vision of research posters to include collaboration and multimedia content. Required hardware includes a Tablet PC, a wireless (Wi-Fi) card, an RFID reader, and a series of RFID tags in the research environment affixed to posters or other research artifacts. The Wi-Fi card triangulates wireless signal strengths from indoor hubs using ekahau technology. The RFID tags each have a unique unalterable id that can be read by the RFID reader, enabling each tag to be affixed to a poster within a building. Users can enter new posters, edit information for posters they created, view the location map, or view information specific to a nearby poster.

To gain a sense of focus on those who would use a system like TagIt, we identified three stakeholders: the author, the consumer, and the community.

- Authors create the content that they hope consumers will view and critique. Authors generally put forth this content toward gaining feedback. Tagging the content with an RFID tag supports information exchange—through multimedia provided by the author, through location determination identified when the poster is scanned, and through comments left by stakeholders. Authors use the upload interface to create new poster information and upload multimedia to the web server and assign a RFID tag to the poster. The upload interface lets the author enter information relevant to the poster (i.e., project name, year project was published, thumbnail of the poster, abstract, etc.). Multimedia can include video, audio, slides in PDF form, or a link to a website or a related paper. The media is uploaded to a web server and can be accessed by its URL. After all the desired information is entered, the system alerts the user to scan the RFID that will be associated with the poster. The database groups the information entered by the author and the location of the multimedia uploaded to the server by the RFID tag id. An illustration of this structure is shown in Figure 1. The information can now be accessed when the RFID tag is scanned by the reader and processed by the database.
- Consumers are the persons that review the works of others—certainly for their own knowledge gain but also to help improve the work. They presumably want to approach posters of interest, supported by an interactive map with rich filtering. They also ben-

Figure 1. Structure of Author layout



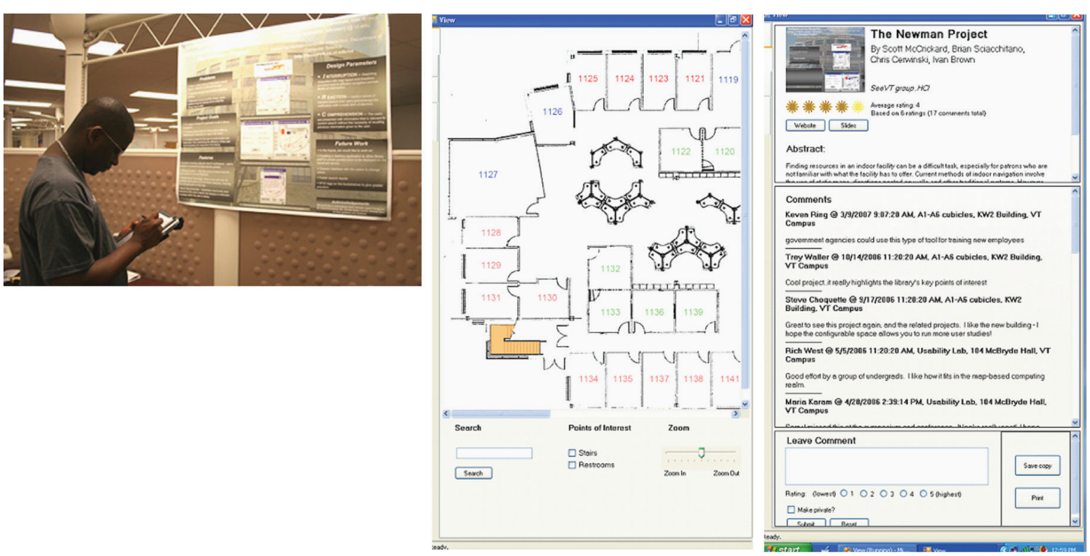
efit from the ability to comment, and (perhaps to an even greater degree) read comments by others, as supported by the comment board described previously.

- The community is the scientific community that benefits from improved research. Certainly a message board supports this, but it is through community-building activities—a local symposium, an international conference, a local visit by a notable researcher—that a picture of the research life of a poster and the ideas behind it begin to emerge. As such, TagIt supports location tracking to show the "life history" of the poster, highlighting where it has been, what prior versions looked like, who commented on it, and what reactions emerged from the author. Only through these interactions can a system like TagIt support the research in a community.

To browse the local area for posters, the user is provided with a map interface that includes information from the location awareness system and the TagIt server. The system shows the last known location for posters, though if new posters are added or posters are relocated to the area, they can be scanned by any user and the new location will be noted on the TagIt server for the benefit of future users. The user can filter posters based on interests. When the user approaches a poster and scans the tag, the tag id is recovered and compared to the ids on the database. If there is a match, the database sends all the information and media locations to the interface and it is displayed on the interface. The user can then view the associated information and provide comments.

As noted previously, the ability to support commenting on the posters is considered the most vital feature of this work—toward supporting the type of colleague feedback that is difficult to establish even during focused poster sessions, much less ad-hoc tours of a building. We expect users to leave comments with the intentions of starting a dialog with the author(s) that extend past comment feature of TagIt so that the community can have

Figure 2. The TagIt user interface in use. A user has approached a tagged poster (left) and can view multimedia information about the poster (right) that allows him to see information about the poster and leave and view comments about the poster. He can find other nearby posters using the map interface (center).



the benefits of other aspects of communication (such as non-verbal). As such, the comment area dominates the screen so that users may enter hand-written comments or questions using the Tablet PC. Importantly, the user can view comments from others and be part of an asynchronous dialog about the research described on the poster. TagIt can also alert the user if someone has responded to his comment or question, and alert the author about any comments about the poster—creating the opportunity for continuing the dialog beyond the initial viewing time.

ASSESSING TAGIT

The assessment of the utility of TagIt involved two steps: a deployment period, in which the system was used in poster symposiums, visits by professionals, and continuous display; and an expert review period, in which we visited with experts in relevant domains toward gaining their insights about uses for the system. While this type of assessment does not provide the statistically significant results of a controlled experiment, it seemed appropriate for this type of exploratory research.

Participants: Five domain experts were interviewed, with areas of expertise including interface development, civil engineering, and geographic information systems. Number of years in research and development ranged from 2 1/2 to 8 years. Three of the five had used TagIt previously, but all were provided with an overview of the system and a description of its utility to inform or remind them of its use.

Method: During the deployment phase, we provided TagIt to information professionals in various situations: at a poster symposium, during distinguished visits to the department when posters were deployed, and during a continuous display phase when posters were constantly hanging in the research building. We reference comments from these people—generally more informal statements—as user comments. As it was difficult to identify and interview people during these situations, we performed most of our information collection during the expert review period, in which we told participants that we were interested in learning what aspects of sharing information and communication are important to users, and that we also wanted to see how users would response to using a Tablet PC to leave feedback for users. We refer to comments from these people—generally semi-focused responses to questions—as participant comments.

Results: According to users, the two most praised features were the ability to view multimedia information (specifically, additional pictures and videos not part of the poster) and the ability to read prior comments and provide follow up comments of their own. However, it was difficult to inspire any of the users to provide more than cursory comments; never did they go beyond a few brief words of praise to include lengthy or substantial comments, even when they were experts in the domain of the poster. Perhaps this was due in part to the heavy nature of Tablet PCs—even the lightest of which are still somewhat cumbersome to carry around for an hour-long symposium, as noted by one user.

The participants were asked to rate the usefulness of each feature as well as the entire system on a scale from 1 to 5 with 1 being not useful and 5 being very useful. As shown in Table 1, while the participants felt that the commenting and feedback feature was useful, they did not feel that the mapping feature was as useful which also brought down their feelings on the system as a whole.

When asked how participants currently obtain feedback on a poster, answers ranged from pen and paper, laptops, to body language of people at the poster and how long they remain there. None of the participants had a method of collecting feedback when they were not at the poster. Some just assumed that if someone had questions or comments that they would contact them through email which was provided on the poster.

Table 1. The participants were asked to rate each of the features as well as the entire system on a scale from 1-5 (1= not useful; 5 = very useful)

Feature:	Participant #1	Participant #2	Participant #3	Participant #4	Participant #5
Mapping/Directional Rating:	3	3	2	3	3
Feedback/Commenting Rating:	4	4	3	3	5
Total System Rating:	3	4	2	2	3

Participants greatly appreciated the ability to leave and access comments, with all but one participant rating it useful or very useful. 4 out of 5 participants expressing that the person creating the poster would benefit most from this feature, especially when the presenter was not present. One participant commented that this type of system adds validity to comments, demonstrating that TagIt proves the commenter was physically present and not submitting an uninformed review.

Participants were more neutral about the utility of the map. Some comments were about its usability: mentioned having the ability to directly manipulate the map instead of using the scroll bars to move the map, or using a web based or Google Maps interface to give the map a richer graphical look and feel. However, one participant wanted a list of the nearby posters instead of a map, leveraging location information at a coarser granularity. Others suggested a schedule of presentations as well as the ability to locate the author when he is not at the poster—perhaps by equipping the author with a RFID badge. Some participant comments pertained more to general system usability, toward simplifying TagIt. As one participant stated, "less is more". Some participants felt that the focus should be on the commenting feature, with focus on making it easier to leave comments. Some participants felt the map would be useful for gaining an overview of posters in an area, while others liked the feature better as a navigation tool from poster to poster. Participants commented that the TagIt system would be useful during an open forum (e.g. conferences) for collecting opinions and also as a poster rating system when giving feedback or grading a poster while attending a poster competition.

Another criticism amongst all participants was that the system was implemented on a Tablet PC—also specifically noted by one of the users. Many expressed concerns that they would not want to carry the Tablet PC around and that it was too cumbersome to leave comments. This aspect was the cause of some of low ratings given during the interviews. Most of the participants felt that the system would be more useful as a mobile or iPhone application—or perhaps it will be better suited to the next technological innovation!

CONCLUSION AND FUTURE RESEARCH

The combination of location-aware systems and RFID tagging are beginning to have many industrial uses, but this chapter has discussed how this combination can have uses in other situations—highlighted by the research setting explored with TagIt. We have discussed how combining physical tagging with location awareness can contribute to allowing information to be shared and encourage dialog about physical artifacts. Physical tagging with technologies like RFID seems effective in merging digital contents with everyday physical objects. It is our expectation that interest in this area will be sparked by the discussion brought forth in this chapter and that future endeavors will make use of an approach similar to the one identified in this chapter—tailored to the unique characteristics of mobile computing, leveraging emerging locative and tagging technologies, and supporting rich and meaningful collaborative interactions.

TagIt provides the ability for researchers to share information through the familiar and well-liked poster format, but with augmented abilities beyond a traditional paper or even digital screen technology. As the interviews suggested, the system would be more effective as a mobile phone application. Within a few years, more than 50 percent of all cell phones will have RFID readers in them which allow for more RFID enabled mobile projects to be developed (Swedberg, 2004). We also envision using augmented reality to overlay information on the physical poster. This setup can be useful for when a user wanted to make comments on specific content on a poster. We also want to explore using this type of set up in other situations. A commonly suggested setup was a grocery store, where the system could be used to navigate aisles, compare brands and prices of items in the cart and on the shelf, and to provide and see product reviews of different products. This system provides the opportunity to create "living documents", meaning physical objects can have digital links and comments attached that allow for ongoing discussion on that particular object. Since beginning this work, technologies have been developed that combine RFID and GPS in new tags, to support the tracking of packages (RFIDNews, 2009). As the cost of these tags drops and as similar technologies are developed, we expect that the types of applications we describe will become practical and affordable.

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KEY TERMS AND DEFINITIONS

Radio Frequency Identification: an identification technology that combines low-cost tags with minimal internal memory and sensing capability that are attached to an object for tracking and information storing purposes

Location Awareness Systems: provide location knowledge and allow for users to share and retrieve information locally.

Tagging: merging physical objects with digital information using identification technology.

Information Sharing: the presentation of data or multimedia content that is intended for public usage.

Authors: the creators of the information that will be shared with the public.

Consumers: persons that review the works of others for personal knowledge or improvement of work.

Community: the scientific community that benefits from improved research.