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Finding Your Way with KLAS: The Development of an Indoor Location Awareness System

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commentary

Finding Your Way with KLAS: The Development of an Indoor Location Awareness System

—**Matthew Lape and Mark Taipan** (Edited by Jennifer Lee and Kristin Brodeur)

We can tell you countless stories of getting lost in Kingsbury Hall, the newly renovated engineering building at the University of New Hampshire in Durham, New Hampshire. Sure, there are signs on each of the doors and small maps at the stairwells but for a new visitor, finding a specific room can be daunting. One way to get acclimated to the building is to take a guided tour. If a prospective student is interested in a specific major, he or she can contact a department to schedule an appointment with a professor. Depending on the time of the year, the process of finding a time that works with both parties can be a laborious process. What if the prospective student wants to learn about other engineering departments in Kingsbury Hall? Few faculty and students know the details about each lab facility, faculty member, and course. Through our own experiences and those of other visitors to Kingsbury Hall, we have identified two main problems.

The first is that using the signs on the doors and the sparse maps by the stairwells is an inefficient form of navigation in Kingsbury Hall. The second problem is that giving knowledgeable guided tours requires human resources that not all UNH engineering departments have. A location-aware digital assistant, a handheld device that knows where its user is, can solve both these problems. The user can get to a location by following navigation instructions on a small screen. The device could also act as a tour guide by providing information about nearby rooms.

The authors (Matthew, left, and Mark, right) navigating Kingsbury Hall with KLAS

Developing the Research Project

Location–aware digital assistants have become increasingly popular in today's technologically advanced world, especially in the field of navigation. Many late model cars come standard with a built–in navigational system, which uses the Global Positioning System, or GPS. These navigation devices allow the driver to type in the address of the destination and then receive turn–by–turn directions while driving. Location–aware digital assistants are not limited to navigation devices either; they can also be digital tour guides. An example of this is at the Marble Museum of Carrara in Italy. Visitors carry personal data assistants (PDAs) which show information relevant to the exhibit they are near.

The success of these location–aware devices has shown that if they were implemented at UNH, the community would benefit. However, building a system like this requires knowledge of electromagnetic theory, network hardware, and software development. This broad spectrum of knowledge suited our two different majors. As an

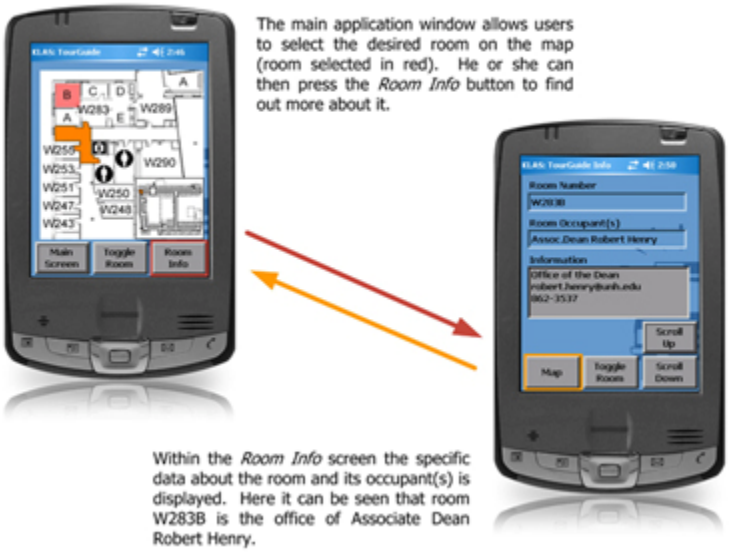
electrical engineer, Matt has a fundamental understanding of electrical hardware design and electromagnetic theory. Being a computer engineer, Mark has experience with computer networks and software development. Together, we had a perfect blend of skills; and, since we had already worked together for two years at CATLab, an Electrical and Computer Engineering UNH research lab, it was natural to cooperatively pursue this project.

This idea quickly turned into a reality during the summer of 2008. We successfully applied for a Summer Undergraduate Research Fellowship (SURF) from UNH to develop a prototype indoor location system called the Kingsbury Location Awareness System, or KLAS. The system was built for the second floor of Kingsbury Hall, the home of the College of Engineering and Physical Sciences (CEPS). We chose it because we have all our engineering classes there and are familiar with the building (and its problems). We chose to deal with just the second floor for two reasons. First, we did not want to over–complicate this prototype system. Second, the floor has several IEEE 802.11 Access Points pre–installed by UNH's Computer Information Services (CIS). These stationary devices provide wireless internet to the UNH community, and CIS has installed several of them in all academic buildings. Using these existing access points would allow KLAS eventually to be expanded throughout the campus without additional costly hardware installation or extensive coding.

KLAS can determine the user's location by the signal strengths from the user's handheld PDA to these installed access points, coupled with a location algorithm. The location system compares the signal strengths of these access points to a previously established master list of possible locations, and chooses a location based on the entry that matches best. As the user travels around the floor, the strengths of the wireless signals are constantly reassessed to determine the location.

Once the user's location is determined, KLAS feeds the location information to one of two KLAS applications: the Tour Guide or the Navigator. These are the software applications that users will interact with. The Tour Guide, using the user's current location, provides information about nearby rooms. The picture shows an example of what the user will see on the PDA when using the Tour Guide application.

KLAS Tour Guide Application



The other application the user can interact with is the Navigator. This application provides the user with directions to a room. The user first selects a destination from a list of the rooms on the second floor of Kingsbury Hall. The KLAS software will then show a map of where the user is currently, and where he or she needs to go to reach the destination. The map will then update with new directions as the user moves on the shown path. (See a video of a student using the Navigator to go from the CEPS Dean's office to Professor Andrew Kun's office here: http://www.youtube.com/watch?v=Iv6scJdNWek)

Future Development

Even though the SURF project has been completed, our excitement fueled us to continue working on KLAS. In particular, we want to improve the system's ability to adapt to its environment, such as humidity and number of people in the hallway, which currently adversely affect its location accuracy. However, accuracy would be useless if the user interface on the screen were difficult to follow. Therefore, we plan to experiment with different navigation interfaces to see which one results in the user going most quickly and easily to the desired destination. The picture shows three possible interfaces that utilize different methods of providing directions.The information from our experiment will allow us to create an easy to use, efficient and effective user interface for our Navigator application.

The SURF grant opened an enormous opportunity for both of us that normally would not be offered through the traditional Electrical and Computer Engineering undergraduate career. While we have enjoyed the classes and have learned a tremendous amount from them, the time spent on our SURF project has been one of the most satisfying and rewarding experiences of our lives. Not only have we both improved our technical skills dramatically, we also were able to use technology to give back to the UNH community. Our hope is that the groundwork we have laid will help make a similar system available in not just Kingsbury Hall, but in all the academic buildings on the UNH campus.

We would like to extend our gratitude to the Hamel Center for Undergraduate Research and donors, our advisor Professor Andrew Kun, Research Engineer Oskar Palinko, CATLab, our families, and to the faculty and staff in both the Electrical and Computer Engineering Department and the Computer Science Department for giving us an overwhelming amount of support, advice, time, and lessons that will stay with us throughout our engineering careers.

Author Bios

*Senior electrical engineering major **Matthew Lape**, from Francestown, New Hampshire, spent most of 2008 developing the Kingsbury Location Awareness System with his research partner, Mark Taipan. Although their summer grant from the University of New Hampshire ended, the research did not; and Matthew and Mark are continuing their efforts to improve KLAS as part of their senior project. Matthew found great satisfaction in being able not only to find a problem to solve and hypothesize a solution, but also to carry out the research to test the solution as well. "This gave us a glimpse of real–life, hands-on engineering. . .that is not always present in the standard engineering curriculum," Matthew said.*

Matthew also works part time on Project54, a graduate–level research project here at UNH. With Project54, Matthew and his colleagues work to integrate all aspects of emergency response vehicles into a computer that can be controlled by either voice or touch screen. The project's goal is to help reduce distractions and allow the emergency responders to do their jobs more safely.

After graduating in May 2009 with a bachelor's of science in electrical engineering, Matthew hopes to develop his skills as a technical project/program manager in both the worlds of technology and business. He plans to work toward a master's of business administration to better prepare himself for the future.

***Mark Taipan** is a senior computer engineering major from Waltham, Massachusetts. Mark and his research partner, Matthew Lape, have continued working on their Kingsbury Location Awareness System (KLAS) as part of their senior project. Mark credits his work on KLAS with giving him a better perspective on how engineering actually impacts real people. "You sometimes lose the sense of how what you learn and what you do with it impacts society," Mark said. He enjoyed the numerous hours spent developing KLAS and described the project as his favorite part of his academic career.*

After graduating in May 2009 with a Bachelor's of Science in computer engineering, Mark plans to pursue a Master's of Science degree in electrical engineering right here at the University of New Hampshire. He will also continue doing research for UNH's Consolidated Advanced Technologies Laboratory. He has no specific plans yet for a career after graduate school, but looks forward to learning more about digital signal processing and network communication while exploring future options.

Mentor Bio

*Dr. **Andrew Kun** is an associate professor in the Electrical and Computer Engineering Department at the University of New Hampshire. A specialist in user interfaces for in–car devices and handheld devices like cell phones, Dr. Kun is the principal investigator of Project54 at UNH's CATLab. It was there that he met undergraduate researchers Matthew Lape and Mark Taipan. Although he had never been a mentor before, Dr. Kun agreed to be their mentor for the project and grant application they were developing. Dr. Kun considers proposal writing a big part of his job as a professor, and was very satisfied to watch Matthew and Mark write their own grant proposal and get their project funded. When Matthew and Mark presented their research at a conference in November 2008, Dr. Kun couldn't help but feel proud of their work. "They gave the presentation as a team," he said. "Not only was the content interesting, it was presented flawlessly, with clear slides and a very informative video."*

Dr. Kun graduated from UNH in 1992 with a bachelor's of science in electrical engineering. After completing his master's degree in the same field in 1994, he continued on to a Ph.D. in engineering with an electrical engineering option in 1997. After spending two years working as a development engineer at Falmouth Scientific, Inc., an oceanographic instrumentation manufacturer in Cataumet, Massachusetts, Dr. Kun decided to return to his alma mater. He has been on the faculty of UNH since July 1999.