December 2008 Newsletter

December 8, 2008

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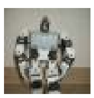
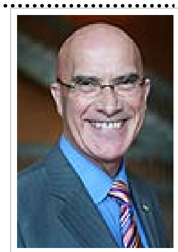


Rushing into damaged buildings is dangerous and can endanger not only rescue workers but also the victims they are working to save. Sending in robots that are equipped with various kinds of sensors to do reconnaissance is much safer, and these robots can search for signs of life and report back to waiting operators.



Dear Friends of CITRIS,

In this newsletter we are pleased to highlight two exciting projects that each address pressing needs for California and exemplify the CITRIS commitment to developing intelligent infrastructures.

The first project, called Mobile Millennium, aims to alleviate a chronic problem we can all relate to: traffic congestion, especially on our overcrowded freeways. UC Berkeley Engineering Professor Alex Bayen and his colleagues have developed a productive strategic alliance with Nokia in an effort that employs ordinary GPS-enabled cell phones to assemble extraordinarily useful traffic information.

The concept's power was demonstrated earlier this year when a fleet of cars driven by our wonderful volunteer graduate students, each carrying a cell phone, was able, using Professor Bayen's mathematical techniques, to reveal traffic patterns, potential roadblocks, and alternative commuting itineraries. Last month the project entered a pilot phase in which anyone can download free software to their phones and contribute data in exchange for an increasingly vital, map-based application that will help them navigate through Bay Area traffic as quickly as possible.

Our second story profiles another project of great importance to Californians. Sometime in our tectonically volatile state's not-too-distant future, search-and-rescue workers will risk their own lives by entering earthquake-damaged buildings in search of victims. The fruits of UC Merced Professor Stefano Carpin's robotic search-and-rescue project will help them decide which buildings to enter first, how best to approach them, and what to expect inside. These key bits of knowledge will allow emergency first-responders to get to the victims as quickly and safely as possible.

Finally, as days shorten and the holiday season unfolds, I wish everybody in the CITRIS extended family warm greetings. I hope to see many of you at our CITRIS Holiday Gala event on December 12 at 4:00 p.m. And, before we know it, on February 27, 2009, the grand opening of the CITRIS building, Sutardja-Dai Hall, will take place on the Berkeley campus. Please follow this URL and register for the Grand Opening celebration: www.coe.berkeley.edu/citris-opening. We look forward to seeing many of our friends from the Bay Area and beyond at this landmark event.

Keep up the good work.

Professor Paul K. Wright
Acting Director, Center for Information Technology Research in the Interest of Society

TOP

CITRIS Awards, Honors, & News

Presentations from TIER workshop
Presentations are now online from the recent TIER workshop, which spotlighted research dedicated to understanding the role of and developing innovative information and communications

technologies for developing regions.
http://www.citris-uc.org/events/TIER.

CITRIS talks are on YouTube

Our many talks are available at our popular YouTube channel: http://www.youtube.com/citris.

Berkeley Big Ideas Marketplace
The Big Ideas @ Berkeley marketplace allows individual to support undergraduate and graduate students who are passionate about tackling major global, regional, and local challenges such as clean energy, the environment, public health, safe drinking water, public policy, and technology-based entrepreneurship.
http://bigideas.berkeley.edu/

CITRIS Holiday Gala, December 12
Please join us for our annual holiday gala on the Berkeley campus, featuring refreshments and live entertainment on Friday, December 12 at 4:00pm in the Gordon and Betty Moore Lobby, Hearst Memorial Mining Building, UC Berkeley. At 6:15 p.m., members of Berkeley's Media Theater Workshop will stage three short plays, "Best E-mails Ever," “Little Red Flag,” and "Missed Connections," that combine video projection with live performance.
http://www.citris-uc.org/holiday2008

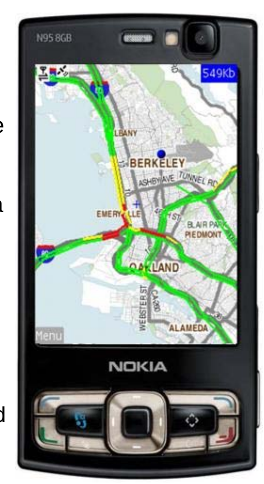
CITRIS Headquarters Dedication, Feb. 27, 2009
On Feb. 27, 2009, CITRIS will mark the official opening of its new headquarters, Sutardja-Dai Hall, with a day of talks and celebration.
http://www.citris-uc.org/HQdedication

Taming Traffic with Your Phone: The Mobile Millennium Project

TOP

>by Gordy Slack

Traffic in the San Francisco Bay Area is bad. But if the early results from the Mobile Millennium project are any indication, our ability to navigate through that traffic is about to get a lot better.



Cell phone users download free software that automatically and anonymously contributes their position and velocity data to a central location.

The idea behind Mobile Millennium is simple. Cell phone users download free software that automatically and anonymously contributes their position and velocity data to a central location. In exchange for this raw data, the phone owner gets a map-based, real-time view of traffic flow all over the Bay Area that can help them navigate around traffic jams and find the most viable alternative routes.

UC Berkeley Civil Engineering Assistant Professor Alexandre Bayen, in collaboration with Nokia, Navteq, the California and Federal Departments of Transportation, and with support from CITRIS, launched the Mobile Millennium pilot project in November 2008. The project uses GPS-equipped cell phones to provide real-time traffic information all over the Bay Area and is hosted by the California Center for Innovative Transportation (CCIT), a deployment-focused research center at UC Berkeley's Institute of Transportation Studies.

Until now, most of our traffic information has come from static sensors built into the pavement and radar devices or cameras mounted on highways and bridges. While these create a network of traffic information (see traffic.com) on the main arteries traveled by commuters, they are mute about less traveled routes not wired with the expensive equipment.

“We hope to eventually provide traffic data for areas currently not covered by the traffic monitoring infrastructure, such as arterial roads frontage roads, rural roads, expressways, and so on,” says Bayen. “GPS can bring traffic information everywhere where there are mobile phones.”

Within a few weeks of the project’s launch, more than 3,000 users downloaded the software. “At first we saw use growing organically both from the university in Berkeley and from the Nokia Center in Palo Alto. Since then the rest of the Bay Area has begun to fill in and light up on our maps,” notes Bayen.

Users of the software, which is available at http://traffic.berkeley.edu/, will get maps with all of the current static data already available on http://www.traffic.com, but they will also get the new layer of analyzed data coming from contributors like themselves.

CCIT expects more dots to be lighting up the data maps soon. “Nokia is producing more than one million phones a day, about 15 phones a second. We are dealing with enormous scales that are able to completely penetrate the transportation network very rapidly,” says Thomas West, the Director of CCIT.

Leaders of the Mobile Millennium partnership cut the ribbon on the software download station that launches a pilot traffic-information system based on anonymous GPS data from participating members of the public. [Thomas West, director of UC Berkeley's California Center for Innovative Transportation; Quinn Jacobson, lead scientist at Nokia Research Center; Harry Voccola, senior vice president of government and industry relations at NAVTEQ; Randell Iwasaki, chief deputy director of Caltrans; Alexandre Bayen, UC Berkeley assistant professor of civil and environmental engineering; and Henry Tirri, Head of Nokia Research Center.]

When the software is in use, your phone will display a map with a dot in the middle. That dot then moves wherever you move and automatically scrolls the map. The roads and highways are color-coded for their degree of traffic: green means fast, yellow means slower, red means congested, and black means totally congested. You can zoom in, zoom out, search, and follow your commute.

Because the system’s algorithms produce speed information, the program can quickly estimate the time a particular trip will take given current traffic conditions.

The team has developed a voice-activated function for hands-free operation. Because the GPS knows where you are, the program can generate trip-relevant audio messages. If you are headed north from Palo Alto, say, the program may tell you that the Dumbarton Bridge is backed up so you should take the San Mateo Bridge instead. Or that you should get off the freeway at an early exit and take a frontage road. Or even that, given what traffic is typically like between Palo Alto and Berkeley at that time of day, it may be better to wait an hour before you leave at all.

Not only will the new technology cover now blank areas on the map and give users immediate and position-specific information, but it could also save California money. The current system relies on equipment that is both expensive to purchase and costly to maintain. The capital investment for the cell-phone-based system is distributed among its users. Although the service will be run through an information processing office, to be distributed between CCIT, the new CITRIS building on the UC Berkeley campus, and several Nokia and Navteq facilities, it will be much less expensive to maintain.

As security issues are of topmost concern in projects like these, the team is being very careful when it comes to users’ privacy, says West. By the time the project receives data from any user, it is thoroughly anonymized.

“The database that I have is a big bucket of measurements, in pairs, of positions, times, and velocities. It would be virtually impossible to figure out where they were coming from,” says West.

Also, before the data is sent to the system, it is encrypted with the same techniques that bank systems use. So, even if someone is eavesdropping on the line they will not be able to interpret the data, says Bayen.

And finally, so that they do not get private data that is not relevant, the team has devised a “virtual tripline” that turns sampling off when cell phone are outside of areas of interest to the mapping system. So, when you pull off the street and into the donut store parking lot, or into your own driveway, the system stops paying attention to you altogether.

“Scientists only need information on very specific places in the transportation network (highways, highway exchanges, or intersections) so this is where we want to sample people,” says Bayen. The virtual trip line is geographic marker defined by GPS coordinates, a line in the middle of the road that triggers the phone to send an update whenever it is crossed.

Bayen uses the system whenever he is in a car, even when it is not his car. For example, he went to the New York City in November to present the Mobile Millennium project to the Federal Department of Transportation. On his way to the San Francisco airport, the cab he was in was suddenly deadlocked in traffic. He checked his cell phone and was much relieved see that the cab was going to be out of the traffic jam in just a few minutes.

TOP

Robots Rush In: In Search-and-Rescue Operations Teamwork is

Everything

by Gordy Slack

Two P3AT robot equipped with Sick laser and sonars. These robots could be sent into emergency situations to help police determine the situation.

At the scene of a disaster—whether natural or man-made—knowledge is power. And not knowing what the situation is can leave emergency responders powerless, as the SWAT teams and police who waited outside luxury hotels in Mumbai in November can attest. Moving forward, vital knowledge about what is going on inside earthquake-damaged buildings, structures on fire, and buildings under siege will be provided by robots, and CITRIS researchers are working to further this field.

The first serious forays into search-and-rescue robotics began shortly after the 1995 earthquake in Kobe, Japan. More than 200,000 buildings collapsed in that tragedy and thousands of people died instantly. But even more died in the aftermath, trapped undiscovered for hours or days inside quake-damaged buildings.

"After a disaster like that, getting to people quickly is the first responder's biggest challenge," says Stefano Carpin, an assistant professor of computer science at UC Merced and the director of the robotics lab. "The number of people you can rescue from destroyed buildings dramatically drops after 72 hours; you need to do whatever you can to locate survivors before then."

But rushing into damaged buildings is dangerous and can endanger not only rescue workers but also the victims they are working to save. Sending in robots that are equipped with various kinds of sensors to do reconnaissance is much safer, and these robots can search for signs of life and report back to waiting operators.

"The idea is not to replace first responders with robots, but to collect as much information as possible so that first responders can do their jobs better without being exposed to unnecessary risks," says Carpin.

The current generation of robots is mainly tele-operated, which means each operator is dedicated to only one robot. If you have thousands of buildings to examine, it can be very slow going. If they are controlled by a human from outside the site, the robots will also need to be in constant communication with their operators. In disaster environments, radio signals can easily be lost. And in a situation such as a post-earthquake collapse, there might not be any recognizable landmarks inside the damaged structure to guide a robot and keep it within signal-receiving range. Power or transmission cords, on the other hand, are cumbersome and easily snagged.

Professor Stefano Carpin develops teams of intelligent robots (overseen by a single human operator) that can work together and keep track of both their own locations and each other's.

Carpin has a solution. "Almost all the research we do at the Merced lab deals with having multiple robots cooperating for a shared goal," he says. He and his colleagues develop teams of intelligent robots (overseen by a single human operator) that can work together and keep track of both their own locations and each other's.

First responders can cover a big area much faster if the robots can coordinate their efforts and merge the information they collect. The robots can use each other as navigational points when they do not have contact with their human commander. This will allow a single, well-trained operator to turn the team of robots loose and pay close attention only to the ones that find signs of life or death. Meanwhile, the robots will share information with each other, compiling a model of the disaster environment. It turns out that putting together a single geographical model from multiple moving sources is no small trick and requires complex mathematical algorithms, subtle programming, and advanced engineering.

Carpin is planning to use new types of sensors, still under development elsewhere, that will be put in place quickly in a disaster environment. Like Hansel and Gretel, the robots will distribute the sensors as they move into a new area, establishing a grid that they can refer to for the rest of their mission.

However, even with the grid in place, coordinating the robots and building a model of the scene from their various reports is a big challenge. “It is a multidimensional position problem,” says Carpin. “You have many very different constraints that you must satisfy at the same time. That is where the tricky part comes…and also the excitement.”

When robots are put into a new big environment and asked to explore it, it would not make sense for two robots to go in the same direction. They should distribute themselves throughout the place efficiently. But if it is a damaged building, say, with fallen walls and dust everywhere, the robots can only learn as they go about what that their environment is like. By working as a team pursuing the same goal and not as selfish individuals, the robots will build a model of the place, and discover whom and what is in it orders of magnitude faster than current methods, says Carpin.

It is difficult to compile and make sense of sometimes contradicting reports from different robots. On the other hand, with multiple points of view, if scientists can overcome the obstacles to integrating them, they would get a representation that has much more value than the individual pieces would alone.

“It is a case where one plus one equals much more than two,” says Carpin. “What made no sense in one robot's view can be clearly interpreted from a second robot's point of view or informed by a different kind of sensor. But all this needs to be done quickly, in real time, and the mathematical models to accommodate all this information are tricky.”

Some robots will be equipped with cameras to search for motion and detectable figures. Some of those cameras will be infrared, because disaster scenes are often dark, or covered with dust and colorless. Infrared cameras can identify human figures by their warmth. Other robots will have listening devices or instruments that “smell” C02. All of this information will be gathered and then “glued together,” says Carpin, into a single model of the environment that the emergency response team can use to figure out whether to enter a building and how to do so with the least risk. And it is in the “gluing together” that Carpin’s Merced team exceeds.

Last year, in Suzhou, China, the team came in second place in the search-and-rescue portion of the prestigious international RoboCup competition, which pits different search-and-rescue systems against each other.

Patching all these pieces of the data puzzle together can make software pretty unstable, but the Merced team’s program, developed with Microsoft’s Robotics Studio software, was solid as a rock, says Carpin. The interface for the competition was developed by Carpin’s graduate student Ben Balaguer, whose research was also supported by Microsoft.

In addition to operating more autonomously and more cooperatively, says Carpin, the next generation of search-and-rescue robots will also be more user-friendly, a direct byproduct of the RoboCup competitions, where engineers and end users, such as firefighters, discuss real life scenarios and needs. “The user interface has to be simple enough for firefighters to use without too much training,” says Carpin. "We have begun closing the link between the first responders and the scientists."

UC Merced Robotics Lab: http://robotics.ucmerced.edu

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