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NAVIGATING THROUGH THE AIRPORT MAZE

Airports are worlds unto themselves, worlds where a beginner can easily get lost. Most passengers rush to their departure gate as quickly as possible, only to sit there for hours waiting for their flights to be called. To make for more efficient airport stays, a team of LMU computer scientists working with Professor Claudia Linnhoff-Popien has developed a system that can guide passengers through the vast airport environment and send them quickly and surely to their departure gate while also giving some freedoms along the way.

Airports are enormous, confusing mazes. For those who aren't old hands at flying and don't feel at home on every runway on the planet, the journey through an airport can become a daunting experience. Where do I check in? Will I get there on time? When should I go through the security checkpoint? Will I miss my boarding-call? Studies show that navigating an airport can be a truly stressful situation for many people. Many passengers would gratefully be taken by the hand and personally escorted to their departure gates through the bewildering network of buildings that is a modern airport. The Human Interactive Personal Service (HIPS) project hopes to do exactly that: help passengers have a less stressful airport experience. Working together with the Munich Airport, Professor Claudia Linnhoff-Popien of the Institute for Informatics has assembled a team of information specialists with the expressed goal of guiding passengers quickly and surely through the airport terminal. The number one priority was developing an application that would be easily accessible for users.

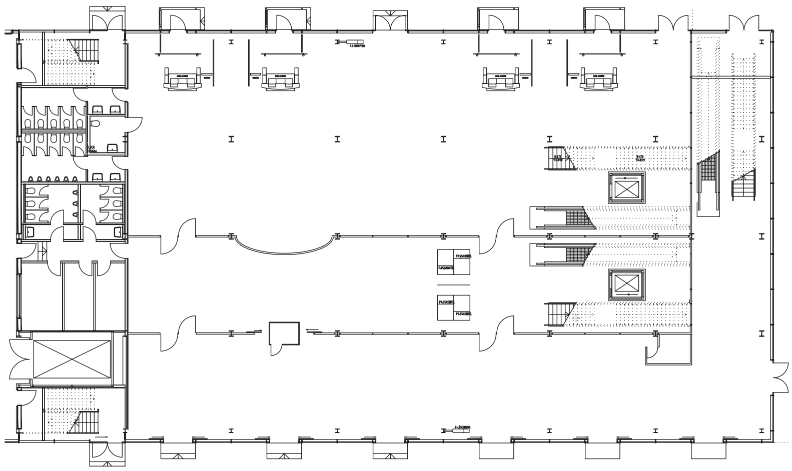
HIGHT-TECH FOR INDIVIDUAL NEEDS

Following a 10-month test period, the LMU-developed software solution will soon be ready for everyday airport service. Thanks to HIPS, passengers no longer need to look for a staffed ticket or information counter and then wait in line. Passengers seeking help can now step up to one of the many video conferencing terminals located throughout the airport, and, simply by pushing the reception bell symbol, be immediately connected with a service attendant who appears life-size on the display. The service attendant can also read paper documents, boarding passes and other types of identification placed on the display, and the passenger can speak directly with the service attendant to ask about things like getting something to eat or purchasing a shirt before boarding. Information displayed at the terminal shows her how much time she has left and the best route for completing all of her errands. The terminal also issues a customer ticket upon which all the passenger's information is saved. She can also request printed directions to various destinations around the airport. Along the way, she can use her ticket at any video conferencing terminal, and it will show her how much time she has left and include a three-dimensional view of the airport showing her location within the airport plus updated directions. Also, the written directions are based on landmarks: Instead of "take the next right," it says, "go right after the Edeka store". Also, the system is constantly being updated, enabling the terminals to quickly guide passengers around crowded areas, alert them to last-minute gate changes and inform them about routes to take.

Although it might sound easy, this project was the result of an enormous conceptual and technical undertaking, and one which was completed in fewer than six months. This was thanks to the collective efforts of airport employees, three LMU computer scientists and 21 students working on thesis papers, term projects or attending summer school. Together, they wrote portions of the necessary software, evaluated existing hardware and sensing options and helped with integrating the whole system as well as conducting the test phase. Interfacing problems presented particular difficulties: The integration of various microphones, cameras, barcode-scanners, printers, input devices, and output displays increased the complexity of the entire project. One initial difficulty was in configuring the cameras and the display screens: fast and trouble-free encoding of the incoming video signal was necessary. Otherwise, there was a slight transmission delay, causing the service attendant's lips to move out of synch with her voice. In addition to integrating the various hardware components, the difficulty of navigating was also a significant factor. "It wasn't easy to program the software to always show the passenger the quickest route to his destination," says Claudia Linnhoff-Popien. "Driving along a street, your options for turning are clearly defined. You drive straight ahead and might occasionally go left or right. Everything takes place on one level." Beyond that, a driver's position can easily be determined via satellite information, and tunnels or other obstructions rarely interfere with the locating signal. This "outdoor" navigational system is well-trusted and technically-proven using the American GPS system as well as its planned European competitor, Galileo.

But how does one find his or her way around inside a building? LMU information specialists are developing applications for Galileo that will do exactly that: allow easier and more efficient positioning and navigation within indoor spaces. The Federal Ministry for Education and Research has recently approved a three-year initiative called "Indoor Project," which will run until

◄ The HIPS navigation screen shows that the usage of so called landmarks enables the system to give easily memorable instructions, e.g. "towards bakery" or turn "left at the Boss store".



◄ At the beginning of the HIPS project over 30,000 rooms had to be assigned to the different levels. Basis were quiete usable CAD data, nevertheless, they were meant for building applications. The difficulty was for automated algorithm to recognize doors and stairs from these data. As a result, the LMU scientists developed a graph-based model of the airport.

the end of 2011. The project proposes a fundamentally new development: eliminating the need for each terminal to keep sending position updates to a server even when the target is not moving. Instead, LMU scientists have assigned a reasonable area to the target based on automatic requests and the target's actual movements. Data are sent to the server only when the target leaves that area. This method is more efficient and also more cost-efficient because charges are only made when positioning data is sent to the server. This technology works best with GPS-supported terminal devices, so it will be interesting to see how the Galileo modules fare when confronted with the new challenge of positioning within buildings, where architectural obstacles or mechanical equipment may cause shadowing effects and reflections, thus greatly affecting signal strength. The origins of this technology can be traced back to research conducted by Professor Linnhoff-Popien and her team working on mobile and distributed systems. This new technology has already been presented in prominent academic journals, and has been the subject of numerous dissertations, patent applications and a post-doctoral paper.

ELECTRO-MAGNETIC FIELDS AND BLUETOOTH HELP LOCATING PEOPLE

The goal of the "Indoor Project" is to improve the algorithms needed to enhance the energy and cost-efficiency of location-based services applications. Algorithms for positioning will be further developed for indoor software applications. Existing platforms and concepts will be evaluated and a user study conducted. In addition to completing other airport projects, the scientists will be able to benefit from the experience gained from working with the multi-floor layout in Munich. But even that may not be enough: The Munich Airport has, in addition to multi-floor buildings, almost 30,000 rooms that need to be identified. "We had access to good CAD data," explains researcher Peter Ruppel, "but these were meant for building applications, and it was difficult for automated algorithms to recognize doors and stairs from these data." As a result, the LMU scientists developed a graph-based model of the airport.

Still, even if developers have access to such images, other questions remain unanswered: How can a passenger be located and necessary data about him be transmitted? This is where the customer ticket comes in. It is fitted with an RFID (Radio Frequency Identification) chip that combines both position information and additional data, and functions using an electro-magnetic field instead of either touch contact or line-of-sight linkage. But the

RFID chip technology is only part of the tracking solution, and there are still many hurdles to overcome in locating people in enclosed areas. Current navigational software gives coordinates, but how is one supposed to deal with, for example, information indicating that a person is located at 11 degrees, 35 minutes, and 20.56 seconds East longitude and 48 degrees, 9 minutes, and 34.50 seconds North latitude? LMU scientists take this raw position data and convert it into specific room assignments. This enables users to go from a certain room and, for instance, proceed to the nearest building exit. Beyond the difficult technical aspects of localization, there is another basic problem. “How does one describe a building semantically?” asks Peter Ruppel. One cannot tell from a floor plan whether a certain door is only for staff use or is otherwise restricted. And floor plans do not indicate the direction in which escalators are running. Passengers with mobility challenges or those with baby strollers cannot use stairs, which is something that must also be reflected in the data output. In addition to structural information, LMU scientists also needed to consider dynamic data like delays at various security checkpoints. The security screening problem was solved using a simple yet effective method: Bluetooth transmissions were measured at the beginning and at the end of the security screening areas to determine the length of the line. Computer scientists know through experience that about ten percent of all passengers have their Bluetooth functions running, so monitoring Bluetooth transmissions can allow scientists to accurately determine the current wait time at any given security check.

Later in the project, plans have been made to join with the navigation hardware developer, Ifen GmbH (Poing, Germany) for the development of a prototype hardware module that implements the methods developed by the aforementioned research fellowship. During the test phase, the Walt Disney Company of Germany is also expected to come on board as a partner. Disney is interested in developing of the product for a possible application in its amusement parks. Children could be given a small rubber toy with an embedded electronic chip, which, should they become lost, could broadcast the child’s location within the vast confines of the park.

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