Purdue University
Purdue e-Pubs

Proceedings of the IATUL Conferences | 2017 IATUL Proceedings

Showing the Way – From App to Book: Successful In-House Software Development through a Computer Science – Library Partnership

Alfredo Azmitia
University of Applied Sciences, Wildau

Janett Mohnke
University of Applied Sciences, Wildau

Henning Wiechers
University of Applied Sciences, Wildau

Alfredo Azmitia, Janett Mohnke, and Henning Wiechers, "Showing the Way – From App to Book: Successful In-House Software Development through a Computer Science – Library Partnership." *Proceedings of the IATUL Conferences.* Paper 4.
https://docs.lib.purdue.edu/iatul/2017/partnership/4

This document has been made available through Purdue e-Pubs, a service of the Purdue University Libraries. Please contact epubs@purdue.edu for additional information.

SHOWING THE WAY - FROM APP TO BOOK: SUCCESSFUL IN-HOUSE SOFTWARE DEVELOPMENT THROUGH A COMPUTER SCIENCE - LIBRARY PARTNERSHIP

Alfredo Azmitia Janett Mohnke Henning Wiechers

Technical University of Applied Sciences Wildau
Hochschulring 1
15745 Wildau
Germany
{azmitia|jmohnke|wiechers@th-wildau.de}

Abstract

University libraries offer a much bigger prospective than presenting students with quality research material and a place to study. They promote the idea of working together by providing group workrooms with workstations, beamers, and others modern tools. Such as any other institution, there is a tangible wish to continue to modernize, although often not possible due to financial constraints. However, this reflects an untapped potential for university libraries: they present a window of opportunity for in-house developed projects.
At the University of Applied Sciences Wildau, the collaboration between the library and the Telematics team, a telecommunication and informatics degree course, have successfully proved this theory. Over the years, through this partnership, we have developed several great applications for large multi-touch displays, tablets and mobile devices, presented in previous IATUL conferences, and, now, we present our new project: an indoor positioning system. There has been an increasing trend in maps and localization systems within buildings over the last few years. Both large companies and open source map developers have been working on solving this problem and have done so successfully. Regrettably, most of these solutions are only possible in supported venues, mainly due to crowd sourcing solutions. The granularity of the end position is in these cases still very coarse, e.g. navigating to a store. Our solution covers both levels: a fine granularity within the library and a broader one for the rest of the campus. By using the Bluetooth based iBeacon technology we have achieved an accuracy of around 2m, thus allowing library visitors to be navigated, for example, to a specific bookshelf. We are looking forward to share our experience on building this system, but especially on the feedback-development iteration between the library and the Telematics team.

Keywords: computer science and library partnership, telematics, campus app, indoor positioning system, humoid robot, ibeacon, wifi, gps

Computer science – library partnership

Around five years ago, during the second half of the year 2012, the German Library Association (*ger. Deutsche Bibliotheksverband (dbv)*) awarded the library of the University of Applied Sciences in Wildau the distinguished honor of “library of the year”.[1] By the end of that year, the library had organized and hosted an international library symposium for “RFID and Media” for the fifth year in a row; it had been an integral part of its district by hosting other cultural events, providing free guided tours of the university’s historical buildings, as well as cooperated with local schools and community libraries. Nevertheless, the library was specially decorated by their application of RFID technologies and their forward-looking services, many of which have already have been presented in previous IATUL conferences.[2][3][4] It was on this year that the

[1] http://www.bibliotheksverband.de/dbv/auszeichnungen/bibliothek-des-jahres/preistraeger/2012.html
[2] http://docs.lib.purdue.edu/iatul/2012/papers/41/

partnership between the iCampus Wildau team and the highly motivated library staff began.

Figure 1: The library and telematics team in 2016

At that time, mobile application development was at its peak. The library, being bounded by limits of the design of the university's website, was interested in bringing some of their services to user's devices through a mobile app. With the collaboration of three telematics[5] students working on their theses, the team was able to develop an Android and iOS mobile application, which allowed users to search the library database, save books as favorites, extend loan periods, reserve work rooms in the library, among other things. Although it was initially thought to be solely for library purposes, in order to advertise and attract more users, it was decided to extend the application's capabilities and add the possibility for users to access their timetable, as well as see the meal plan for the day. In time, the app became so popular within students and faculty members, that a few years later it unofficially became the university's app. Around early 2015, three years after it's launch, the iLibrary Wildau app was actively used by little over half of the university's students and faculty. Having grown out of the initial idea, the app was renamed to Unidos Wildau[6], the Spanish translation for the word "united". The new name would come to define the new purpose of the app: unite all relevant university's services into one mobile application. Besides the aforementioned modules, today, the app offers a centralized access to many services such as a campus virtual tour, a map service (with a search capabilities), a job portal, grade results, e-mail client and e-learning platform, among others. And in a university of around 4000 students, no less than 3300 users actively use the app.

Having met with the project's success early on, both the library and the iCampus Wildau team realized how much could be achieved by providing the telematics students with the tools and environment to develop in-house applications. Now, fortunately, students in the Telematics bachelor course are required to complete a six-week internship at the end of every semester, so this presented the teams with the option of recruiting a group of students during semester breaks to develop and maintain these kind of applications. Thus, a strategy was set: the iCampus Wildau team, consisting of a small team of two developers lead by a Telematics professor, Prof. Dr. Janett Mohnke, would not only act as main developers and system architects, but help train and prepare newer students by developing real-world applications; assistance tools which serve as integrated subsystems and would reach at least 3000 users.

---

[3] http://docs.lib.purdue.edu/iatul/2013/papers/52/
[4] https://internationalassociationofu2016.sched.com/event/6ZRN/parallel-session-2a-collaboration-a-library-and-telematics-tandem-about-an-inspiring-partnership-for-introducing-new-library-services
[5] Telematics means telecommunication and computer science/informatics. It is one of the courses offered to students at UAS Wildau and the cradle of iCampus Wildau.
[6] https://icampus.th-wildau.de/icampus/home/de/unidos-wildau

This proved to be highly motivational for them; being able to see their work be used by their fellow students and have a say and an impact in the development of a campus wide system.

From app to book

Naturally, when searching for a book, users don't want to only know it exists, but want to know where to find it. Through the website it was possible to see in which bookshelf the book was located, but now, with a mobile device, it should be possible to be navigated to it. This time, the request didn't originate from the library team, but from the iCampus Wildau team. The goal was to use the current infrastructure in order to develop a navigation and positioning system (a subject learned throughout the degree course) for the library grounds as a type of showcase for the Telematics studies. Since, logistically speaking, it is first necessary to have a map before any position can be set, the navigation part of the equation must exist, before proceeding with the positioning system.

A navigation system consists mainly of two things: a map and a so-called node graph. These types of graphs help define a walkable path, facilitate the calculation of shortest paths, as well as allow the administration of input POIs (Points of Interest) within a map. So a web application was developed, aptly named as graph editor, in order to manage the graph. It allowed the library team, for example, to define nodes as stairs or as elevators, so that any users with disabilities could be shown the appropriate path.

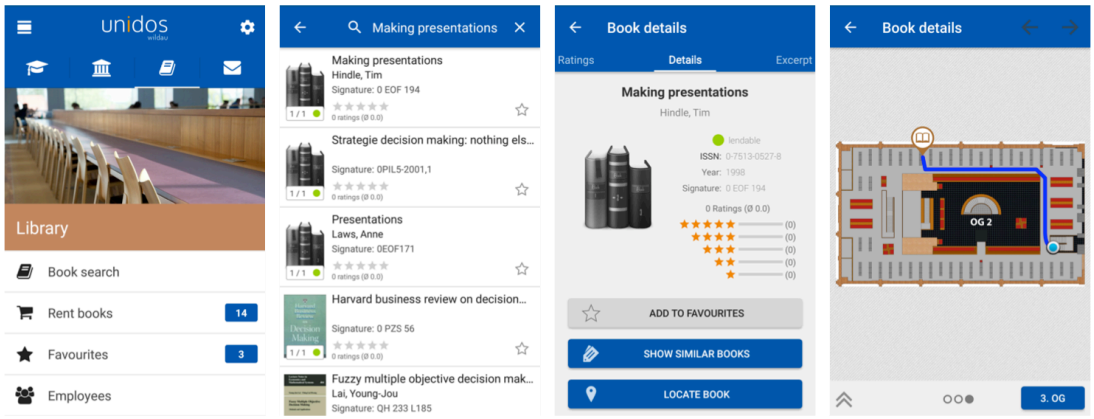

Figure 2: Navigate to the bookshelf with Unidos Wildau

With the mapping in place, a group of students were tasked with development of an indoor positioning system within the library. Nowadays, mobile navigation and positioning systems is something almost self-evident for many users; more commonly used in cars, people are very accustomed to being able to find the shortest distance between two points and be able to be taken step-by-step to the desired destination. For these purposes, the satellite based global positioning system (GPS) has proven to be very successful around the world. But, regrettably, the GPS signal is lost or is unreliable when entering a building. Therefore several companies have tried to develop a complementary system that could be used within buildings and bring users beyond a macro level of navigation to a micro level.

It was at the beginning of the year 2014, a few months after Apple Inc. had released their new indoor positioning technology, namely iBeacon[7], when the team decided to try this new and promising technology. By this time, the iCampus Wildau team had already had its first experiences with a proprietary indoor positioning system based on RFID called OpenBeacon from the BitManufaktur GmbH[8]. Unfortunately, such system was not an appropriate solution since it required the users to carry an active RFID nameplate, in order to be located, thus

[7] https://developer.apple.com/ibeacon/
[8] https://www.bitmanufactory.com/

immensely reducing the usage possibilities. Nevertheless, much was learned from such a system, e.g. where to position the sending beacons in the library, how people and the surroundings were disturbing the 2.4 GHz signals, and how the different positioning algorithms acted at different times of the day and year.

Given the fact, that the iBeacon technology is a Bluetooth low energy based beacon system (i.e. compatible with a large part of smartphones), and seeing a big similarity to the previous RFID system, a first set of test devices were procured through the library financing. Apple initially developed the iBeacon standard in order to provide service providers with the idea of notifying users (and possible clients) via Bluetooth about any services as soon as they entered a predefined virtual area, a system known as geofencing.[9] So it was first necessary to verify that the beacons could be used in the same way as the RFID system, mentioned above, worked. The prototype proved successful and it was decided to purchase enough beacons to cover the library grounds, in this case around 80 beacons. Due to the nature of the Bluetooth signal, i.e. because it does not behave linearly, it is not possible to correlate signal strength to the user's distance to a beacon. This is the same case for RFID, so the old positioning algorithms were repurposed, rewritten and adapted for the Android and iOS mobile applications. It is important to keep in mind, that the university library in Wildau is neither enormous nor a labyrinth. This means that the accuracy of the positioning system did not have to be so high, but since the intention of the system was to develop a showcase, it was decided that a user should be able to correctly position itself between bookshelves. By adapting the aforementioned OpenBeacon algorithms, it was possible to calculate a user's position up to an accuracy of two meters when standing still, and around five meters when walking. It is important to note that the positioning algorithms are implemented in the application itself and runs in its entirety in the user's device. This was an important aspect to consider, in order to respect the users' privacy.

From the library to the university

With the system in place, the next step was to scale the system to cover the whole university. For this, some big changes had to be made to the current implementation. The biggest change was to adapt the system to use a proper coordinate system instead of simply using an image as a map. Here, the Google Maps API[10] presented itself as the best solution, since it does not only expose a recognizable interface, but allowed, through its programming interface, the possibility to dynamically display all floors and buildings. It was also ultimately decided to implement the map service as a web-based application, as opposed to a mobile native implementation, because both teams were convinced that the application would grow beyond the grasp of the Unidos Wildau application. The backend had to also be modified to scale properly. A new group of students were tasked to adopt a more dynamic node graph, leaving the own implementation behind and to look for an open source solution, finally arriving to the Neo4j[11] graph database management system. This allowed the system to perform more efficiently when requesting nodes and while calculating shortest paths. Porting the graph editor from a pixel-based Cartesian coordinate system to a Geographic coordinate system also facilitated the implementation of further positioning systems.

Even though the iBeacon indoor positioning system proved successful for the library, it was not an adequate solution for the whole university due to cost and maintenance. For the rest of the university's buildings, it was necessary to adapt the algorithms to use the existing WiFi infrastructure. Fortunately, the granularity of the wireless access point distribution in the university is quite fine, that it enabled a seemingly accurate position. Localization within rooms was relatively trivial, since almost every room in the university has at least one access point. Nevertheless, the calculation on aisles proved to be more difficult. Mainly due to the long range of the signal, but also through user action, for example, the opening and closing of doors or windows drastically changed the strength of the received signal. Regardless, the solution provides a five to ten meter accuracy on aisles.

---

[9] https://developer.apple.com/ibeacon/Getting-Started-with-iBeacon.pdf
[10] https://developers.google.com/maps/documentation/javascript/
[11] https://neo4j.com/

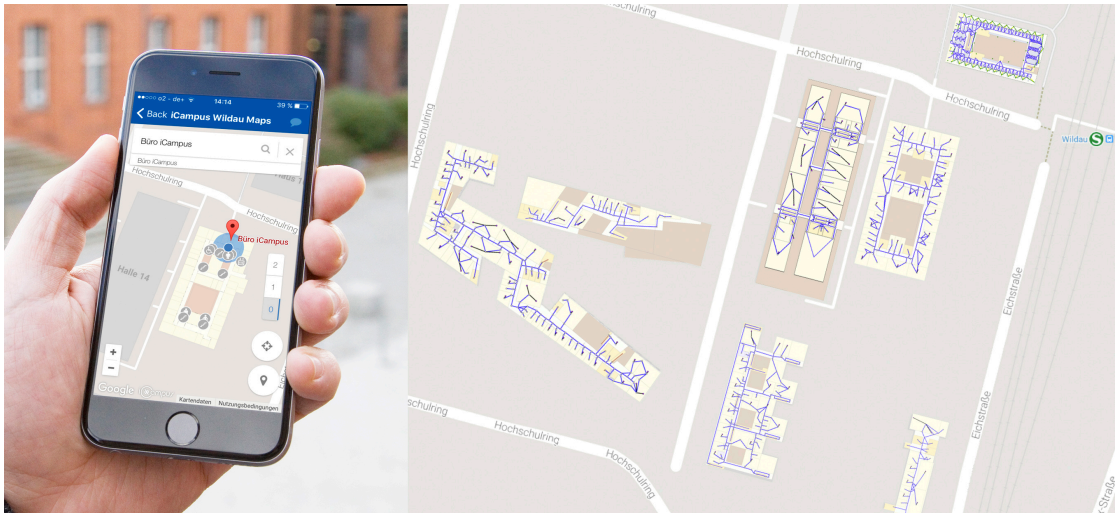

Figure 3: Indoor positioning with the iBeacon system and WiFi

All in all, the overall map service and indoor positioning system was a total success. Especially for visitors and newer students, who can let the Unidos Wildau application guide them through the campus by turning on their GPS, WiFi and Bluetooth services on, and let the application do the hard work.

Future plans

Future plans should not only be projects to come, but projects that have a futuristic concept at its core. Right now, both teams are working on an innovative 24/7 unmanned open library concept. This ambitious idea is based on utilizing a humanoid robot as a point of contact outside normal opening hours. Besides monitoring indoor environment, such as temperature and acoustics, the “Pepper” robot[12] should serve as an interactive interface for visitors, either through spoken communication or through its attached touchscreen, in order to provide them with any basic information about the library services, such as finding, lending or returning of literature; printing or scanning services; or simply direct them on the right path if it cannot answer the question correctly.
This research and development project doesn’t live own its own. It plans to combine existing services, for example the indoor positioning and navigation system (described here before), in order to move around the library autonomously. Additionally, further uses, such as a “Call-a-Robot” service, could be added to the Unidos Wildau app.

Even though many other practical implementation scenarios must still be worked out, it is planned that, before the end of 2017, this mobile assistant should be able to give short tours of the library.

[12] https://www.ald.softbankrobotics.com/en/cool-robots/pepper

Figure 4: The humanoid robot Pepper as mobile library assistant

Conclusion

As in any other successful partnerships, any collaboration can only thrive if all parties benefit from such endeavor. As computer scientists, the highest goal is to create; to create new and innovative systems that positively affect peoples' lives, and, especially, have fun while doing so. This has been clearly the experience over the last years. In similar form, the library's team goal was to provide its users with a modern and interactive information system and have been able to do so thanks to in-house developed software. Naturally, such software cannot be built without external input. The iCampus Wildau team had the opportunity to start small and be under the shelter of the library team, which helped find errors, gave ideas, evaluated options, but, maybe especially, gave inspiration and moral support. The opportunity to try out ideas and test different scenarios within the library and get direct feedback of users and librarians cannot be valued high enough.
Not missing from the equation, interns duly helped in the development of such systems. Through the guidance of different professionals (computer scientists and librarians) they were able to achieve a lot, personally and work-related. The motivation of being able to positively affect fellow university affiliates proved to be of great help.

In this paper, the partnership's success can be underlined once more by the newest project: the installation of a fairly accurate indoor positioning with iBeacons and the campus-wide rollout through GPS and WiFi, a solution not found in many other places.

For both the iCampus Wildau team and the library team, these showcases open many possibilities for fruitful discussions and the exchange of experiences with colleagues at conferences and workshops worldwide. New inspirations are guaranteed. And, as a throwback to last year's IATUL conference, to summarize in a sentence: "Successful interdisciplinarity rocks!".

Acknowledgments

We would like to thank Fabian Götz, Jonas Wolf, Tobias Kannenberg, and Michael Pekar. They spent their time and knowledge to design, implement and test the indoor positioning system based on iBeacons. Our special thanks goes to Tobias Kannenberg whose work has had a judge impact on the success of the campus-wide rollout of the positioning system.