Everyday problems vs. UbiComp — a case study

Pawel Wozniak
Computer Engineering Department
Technical University of Lodz
Stefanowskiego 18/22
Lodz, Poland
pawel@ubicomp.pl

Andrzej Romanowski
Computer Engineering Department
Technical University of Lodz
Stefanowskiego 18/22
Lodz, Poland
androm@kis.p.lodz.pl

ABSTRACT
It is widely accepted that ubiquitous computing (UbiComp) prototyping is one of the methods that can be used to anticipate how future systems are to be designed and what problems can be solved with computational devices. This paper discusses a number of small-scale projects in which researchers attempted to apply some of the UbiComp methodologies to finding solutions to fairly simple problems that surface during everyday campus life. The process aims at finding ways to discover how pervasive technology can affect even the most trivial aspects of human lives as well as trying to make more profound changes. The projects discussed in this paper include a tool for measuring and communicating campus room occupancy, a mobile mode-of-transport detector and a context-aware application for reducing domestic carbon footprint. The applications illustrate the vast possibilities that present mobile platforms offer to the UbiComp researcher and, most importantly, the opportunity to create large numbers of prototypes by numerous users that can be easily evaluated. The authors claim that the software fulfills many UbiComp prototyping requirements and gives great opportunities for field studies. Furthermore, the wide availability of prototyping techniques suggests that computer enthusiasts are now easily immersed in the experience of the UbiComp of the present and the future face of computing can be shaped by many. If, however, one is to verify the applicability of the prototyped systems, even more users must be involved in the UbiComp experience.

Categories and Subject Descriptors
H.5.2 [Information interfaces and presentation]: User Interfaces—Prototyping

General Terms
Human Factors

1. INTRODUCTION

The very nature of ubiquitous computing is still a debated topic and various research agendas are in place. In this paper, we employ the notion of ‘envisioning through creation’ formulated by Dourish and Bell [3]. We believe that by creating various prototype solutions in a Weiserian spirit [9], some of the features of future technology can be anticipated. As human-centric design is the focal point of UbiComp, we have decided to ask ourselves and our collaborators for common everyday problems that could be solved with pervasive technology. Since modern HCI claims that the thorough understanding of the nature of the given problem in human terms is the only way to build a successful computational system [7], practical problems that affect a well-known social group were the obvious choice. In our research we have decided to conduct projects that could provide solutions to tangible (and sometimes seemingly trivial) tasks in a campus environment.

As for the technical aspects of the prototyping work, we seek a platform that would provide a balance between the prototyping speed and the ease of deployment into real environments. In several proof-of-concept studies, we have utilised the Android mobile platform to show that certain solutions can indeed prove very useful in the near future. Several projects were initiated that differ in robustness, but all of those take advantage of the context-sensing technologies available at hand and suggest solutions to tangible problems.

In the first part of this article, we present three case studies of UbiComp projects that attempt at using the technology of today to produce a small part of a truly Weiserian experience. Afterwards, we strive to identify the consequences of the availability of prototyping tools and its possible use in further UbiComp research.

2. THE PROJECTS

2.1 Room presence evaluation

The International Faculty of Engineering (IFE) of the Technical University of Lodz (TUL) provides several well-equipped student rooms that encourage collaborative work and provide space for after-class activities. These facilities are quite popular among the students and, quite often, they will flock from all around the campus to work just there. Unfortunately, to their disappointment, it often happens that the room is fully occupied. This phenomenon has become a common annoyance, especially in face of the fact that similar space is only available at the TUL library that is located quite far away. We have decided to design a solution that
would alleviate the annoyance. The idea of the project was to render the room occupancy information pervasive thus eliminating the annoying extra walks. Consequently, we have decided to make the data available both as a mobile service and as graphical information on several ambient displays present in the IFE building. But first, one had to obtain the occupancy information. This was achieved by constructing a simple Java-based application that handled webcam data with traditional image processing techniques [5]. After a series of tests, a simple algorithm was designed that made it possible to measure the occupancy with adequate accuracy. The only explicit information required by the applications was the time period when the building was closed so that pictures of an empty room could be taken. Then, through a series of pixel subtractions and thresholding operations the application was able to detect if the room was occupied. Having calculated the occupancy level, the data was broadcast via Twitter, which made the data available indirectly on a variety of platforms. A standalone application for Android was prepared as well as a simple widget to be displayed on the ambient screens in the building. In this straightforward exercise, we have shown that rendering information pervasive is easily achievable with tomorrow’s technology. This particular problem had the advantage of lacking the issues that are usually connected with ubiquitous information access. For example, we have dealt with the issue of privacy by refraining from storing any imaging data of the occupied room and publishing only raw numbers describing the occupancy. What is more, there were no dangers as to the information being available to the wrong audience as access to the rooms is restricted. Yet, the activity itself makes one wonder about the implications of pervasive information access and its social consequences. In fact, seemingly simple cases of such activities can have negative consequences as well. As it was clearly indicated in [10] the information that is rendered pervasive must be thoroughly analysed beforehand so that the social consequences of the process are fully understood and the project constitutes a real improvement to quality of life rather than generating new problems.

2.2 Mode-of-transport detector

In the second project, we have explored how easily context-aware applications can be constructed and how can present-day interfaces benefit from implicit input. The main goal of the activity was to use an Android smartphone to differentiate between various modes of transport the user is located in. The embedded accelerometer of the device was used to obtain movement data and a processing algorithm was to be found. The process is shown in Fig. 1. We have spent a significant amount of time gathering data in Łódź’s public transport facilities as well as capturing gait features of different people. As a result, a concise application was developed that differentiates between using the private car and the more environmentally-friendly modes of transport.

The Transport Advisor can be used to monitor the user’s activities and perform context-aware actions. More importantly, this case illustrates that implicit interfaces do not have to be entirely a thing of the future. Whereas these features are not available directly; the hardware that is already present in the ever-so-popular smartphone can be used in novel ways. This particular case shows that new form of interaction and context-aware features are currently within reach and it is mainly the creative effort that is required to design interfaces of the future. Once again such activities can be performed to use UbiComp as a source of challenges for the entire field of computer science.

2.3 Reducing carbon footprints

The last project discussed in this paper is the most complex endeavour that encompasses complete application design and a field study that is currently in progress. We aim to investigate the possible influence of contextualised information on human beings by designing an application that offers a series of environmental challenges that aim at reducing domestic carbon dioxide emissions. Basing on the concept of engaging user experiences [6], we have constructed an application that dares to interrupt everyday routines in order to change behaviour patterns.

In principle, the program (we named it Vertoid) uses a system of proximity alerts to act according to the user’s location. An initial set-up phase is required, in which the user provides details as to where he or she is likely to be located in the future when the system is launched in order to test the overall usability of the system. We aim at increasing their possible impact on everyday routines. The user is also able to measure the volume of carbon dioxide emitted by their car using GPS technology. As time passes by, the data about the challenges is archived and it can be posted on Facebook. We are aware that our test subjects were reluctant to allow any constant monitoring, so we have decided to leave the decision on when to post the results entirely up to the user.

We are currently in progress of conducting an in situ study of the application in cooperation with a team of social science practitioners. It is hoped that the application will prove that UbiComp techniques facilitate self-improvement and can be applied for persuasive purposes. Furthermore, we aim at determining the user reactions to the level of interruption included in the application. This will help in determining whether the users are willing to accept an increased, and sometimes undesirable, presence of pervasive technology in their lives if they are aware of the direct goals of the intrusion.

2.4 Evaluation of the systems

2.4.1 The transport detector and Vertoid

An initial deployment in a group of 10 participants was launched in order to test the overall usability of the system, so that a larger study can be conducted with a system that is functioning properly. The participants (all regular smartphone users) were interviewed before installing the applications and two weeks after using the software. While testing the functionality of the software was a straightforward task, the lifestyle implications of using the application have proven to be quite complex. As the users were already accustomed
to using their devices on an everyday basis and it clearly constituted an important element in their lives, they relied to the new software in many different ways and expressed a variety of attitudes towards the application. As a consequence, a more robust in situ study is now in progress with a much larger group. In order to assure its correctness, we have decided to cooperate with sociologists and psychologists. The participants’ views are to thoroughly analysed since the initial study has shown that the smartphone can easily enter domestic life.

2.4.2 The room presence monitor

It was possible to evaluate the room presence monitoring system quite easily from a practical point of view. Figure 2 shows an empty room and the same room with two students working in front of a computer. The differences between the pictures are identified using a number of binary operation. This number of differing pixels is then computered in order to measure the room occupancy. The free room picture is defined manually. Cameras were installed in three student rooms and ambient displays that were already installed in several areas of the campus were utilised. We have then interviewed the regular students about the experience with the new system. While the users did find the new functionality quite useful and reported to have altered their daily routines according to the information provided by the system, several unexpected drawbacks were noticed. Students expressed privacy concerns regarding the fact that they were not informed of the introduction of the system. Even though we have explained to the users that no data on their presence was being stored. This is especially interesting in spite of the entire building for careful exploration (preferably from an external vantage point such as the garden shed) we entered a student-only area. It has surfaced that the space was associated with a sense of privacy and exclusivity. UbiComp technologies, despite their apparent usefulness, were seen as an attempt to modify the properties of the space. Our experience shows that human values often surface in unexpected places when designing interactive systems, especially for larger communities. This confirms a general trend within the research community that emphasises how complex accounting for human values is when designing interactive systems [8].

Moreover, our work indicates that users are more likely to include technology in their lives if it is presented to them partially through well-known paradigms. Using the familiar smartphones, we have strived to introduce new ways of interaction and our initial results show that the attitudes towards the solution are mainly positive. What remains to be analysed is how the users perceive the new ways their devices react to the events in the user’s life. We sincerely hope that further studies will give more answers on the social acceptability of context-awareness and the perceived usefulness of such solutions.

2.5 Discussion

2.5.1 Entering new spaces

In our study we have explored introducing ubiquitous computing technologies to new spaces and new users. Just as Dourish and Bell in [3] see the domestic zone as a place for careful exploration (preferably from an external vantage point such as the garden shed) we entered a student-only area. It has surfaced that the space was associated with a sense of privacy and exclusivity. UbiComp technologies, despite their apparent usefulness, were seen as an attempt to modify the properties of the space. Our experience shows that human values often surface in unexpected places when designing interactive systems, especially for larger communities. This confirms a general trend within the research community that emphasises how complex accounting for human values is when designing interactive systems [8].

Moreover, our work indicates that users are more likely to include technology in their lives if it is presented to them partially through well-known paradigms. Using the familiar smartphones, we have strived to introduce new ways of interaction and our initial results show that the attitudes towards the solution are mainly positive. What remains to be analysed is how the users perceive the new ways their devices react to the events in the user’s life. We sincerely hope that further studies will give more answers on the social acceptability of context-awareness and the perceived usefulness of such solutions.

2.5.2 The important role of user communities in future prototyping

The wide availability of mobile devices and smartphone development tools may prove crucial to understanding the role UbiComp technologies will play in the life of the future. Moreover, it suggests new ways of creating pervasive software solutions outside of the usual laboratory environment. This issue can be analysed using both of the two UbiComp paradigms first postulated by Bell and Dourish [1]. If one views UbiComp as a formerly futuristic vision that has already come to pass, then developing a multitude of prototypes must be encouraged as it will make it possible to cope with the messiness of everyday infrastructure through a community effort. Easily accessible mobile solutions prove that ubiquitous technologies have entered the everyday realm and not only are they used by the general public, but, indeed, the general public can easily create custom-made programs that solve their common problems. Consequently, mobile platforms provide a medium that permits technology to weave into the fabric of everyday living. Thus, the technically-conscious users will soon be able to use the increasingly user-friendly development tools to manage the commonplace infrastructural messiness themselves [2]. Once again, UbiComp will strive to unburden those who “juggle” [4] devices, but the solutions will be mainly created and maintained by the community, thus directing faculties and corporate laboratories towards focusing on a broader problem spectrum and concentrating on envisioning future applications. Yet, an even more optimistic view emerges when one looks at UbiComp as set of tools and paradigms that are used for researching the “proximate future”. In this case, a multitude of users can contribute small pieces of the general vision. Users will find new areas of their lives that computational
Figure 2: The room occupancy information system

devices can enter and try to tweak the hardware at hand to suit their needs and this process will no longer be limited by knowledge required prior to creating software. This, in turn, leads to a conclusion that mobile platforms will greatly contribute to uncovering what is the role of UbiComp in future societies desired by the general public.

3. CONCLUSIONS

There are no good or bad ways to prepare for the "proximate future" that UbiComp will create. We believe that developing partial solutions with the present-day technology is a proper way of estimating what the world of UbiComp might look like. Creating experimental smartphone software makes it possible to ask the already technically-conscious for their views towards ubiquitous computing. We believe that the fact that pervasive technologies are within reach needs to be communicated to a wider audience and perceptible systems that show novel ways of operation are the proper way to do so. We hope that these small-scale applications that hint on the future shape of implicit interfaces or context-awareness can complement the more robust research that uses custom-made devices and mock-ups. It also enables students and researchers to attempt at applying the theory of UbiComp to simple problems and possibly reflect on the organisation of the design process. Our projects illustrate that mobile platforms provide opportunities for UbiComp research.

We think that, ultimately, in the world of UbiComp, devices will be omnipresent and available to everyone and everyone will participate in the design of the computerised environment. The wide sensing capabilities of the devices that are already available will only increase and the only way to manage the vast and messy data and ensure that the technologies still benefit humans will be to create tools that will enable each and every user to create tailor-made software solutions. We believe that the present state of mobile platforms and the widespread presence of smartphones is a step in the right direction.

The work presented in this paper has also allowed us to gain another perspective on UbiComp exploring new domains and the methodologies that need to be applied in these cases. We have learnt that users will often reluctantly accept even the solutions that they find useful. The great advantage of pervasive technologies — their integration within the user environment can only benefit the community if proper precautions are taken and the users are fully acquainted with the functions of the system.

4. REFERENCES