

Enriching networked applications and services through user-generated content

Olivier Van Laere, Matthias Strobbe, Koen Michiels, Steven Schockaert¹, Samuel Dauwe, Jeroen Vanatenhoven², Christof van Nimwegen², Pieter Dhondt, Tim Verbelen, Bart Dhoedt, Filip De Turck, Piet De-meester.

Dept. of Information Technology,
Ghent University – IBBT, Gent, Belgium.

¹ Faculty of Science, Ghent University.

² Centre for User Experience, KULeuven – IBBT.

Nowadays, an overwhelming amount of user-generated content is available on the Internet. The Web 2.0 and the overly popular social network sites result in users all over the world creating movies, photos, articles, comments, blog posts, ‘tweets’ (Twitter posts) and many more... All this content is shared with the world, so everyone else can read these articles and comments or watch the photos and videos. But can we do something else with this user-generated content; apart from consuming it in the way it is shared?

In this paper, we present new ways of using this user-generated content in order to enrich existing services and to identify opportunities for creating new services.

Keywords: Communication, User Interests, User-Generated Content, Context Awareness

I. Introduction

We are all aware of the fact that there is an overwhelming amount of (multimedia) content available on the World Wide Web. It is there, waiting to be consumed by millions of households connected to the Internet by means of broadband connections around the world. But apart from consuming, the rise of the Web 2.0 helped in facilitating the creation of content and its publication to the Web: social networks popped up everywhere (like MySpace or Facebook), many people started keeping a weblog (commonly shorthanded to ‘blogging’) or a microblog like Twitter, people started uploading their pictures to online photo galleries such as Flickr or Panoramio or video's to YouTube, social bookmarks can be posted on Delicious, ... A new trend called social (or folksonomic) tagging has emerged and quickly became the most popular way to describe, categorise, search, discover and navigate content within Web 2.0 websites.

This also introduced new challenges: what can you do with all this content? How can people still find what they need? Is there a way to improve existing services by means of this content? Are there business opportunities yet to be revealed due to these new evolutions? ...

Because of the rapidly and continuously changing character of the content landscape, users are experiencing difficulties in finding things they need. In an effort to meet this challenge, new intelligent services could be developed that can help users in finding the content they need. While doing so, these developments could enhance (‘enrich’) existing services with this content in such a way that the user experience becomes more attractive.

In what follows, we will take a better look at user-generated content (UGC) in section II, and what we can do with it. We will discuss existing services that use UGC in an interesting way and how existing and new research can help users in finding their needs. In section III we present three use cases that make use of UGC: the first being an enriched communication service, by means of chat or speech. The second use case concerns a location-aware city guide that retrieves images bound to locations (so called geo-tagged pictures) and the third and last use case discusses a personalized gaming service using augmented reality (AR). Finally, in section IV, we present the conclusions of our work.

II. Related work

In the first part of this section, we provide an overview of applications that reuse the User Generated Content available on the Web. In the second part of this section we a number of research projects that are looking into new ways of helping users find what they need.

Applications

First of all, [1] identified four example categories of pervasive UGC and applications. Perhaps the most well known category of applications realizes a way of **data gathering**, followed by **editing, annotation and visualization or presentation**. Most of the UGC applications we can think of (and many of the applications mentioned in the introduction of this paper) end up in this category as they allow users to upload content and just look at it. Another interesting category of applications could be **pattern recognition**. Finding patterns in the UGC available can help to answer questions about the way the world works. A third category is **community building** and raising awareness among localized groups of people. And the fourth and last category they describe is **public art**. This introduces an interesting way of reusing UGC. An example of this is the freeSTYLE project [2] by Dana Karwas. People walking by a large display and audio system could send text or pictures to a pre-defined email address and the display would then create a music video from the received content.

Facilitating UGC creation. [3] describes the state-of-the-art in integrating UGC and pervasive communications. One of the ideas presented is the creation of user-generated services. These would allow end users to create their own personalized services using simple graphical tools.

Building a 3D city model with UGC. WikiVienna[4] aims at complementing ambitious large-scale geospatial modelling efforts, such as Google Earth, by letting users add details and refine a 3D city model in real time using their mobile phone cameras.

Taking management decisions based on UGC. Unortkataster[5] is a web-based application that allows end users to mark locations on a Google map of the city of Cologne, Germany. These locations are so-called “unorts”, bad places. This way, inhabitants of the city can collaboratively bring attention to places they consider bad, e.g. buildings with lots of graffiti or noisy streets due to heavy traffic. They can comment on and rate unorts, and they can upload media related to these places. This user-contributed information can then be used by the city council in an effort to eliminate the unorts.

Automatically annotating UGC. Another interesting idea described in [3] aims at creating user-generated content in a new way is by capturing the interactions between TV viewers and their remote control. Based on the actions they take, a system could automatically annotate the content that is currently shown on TV. If a user mutes the program that is currently being displayed, this interaction is very valuable feedback for annotating the program as e.g. uninteresting.

Browsing UGC by means of a galaxy. Taggalaxy [6] is a web-based universe consisting of Flickr tags. It uses the Flickr API to construct a galaxy of tags that relate to each other. Taggalaxy allows flying through this universe of tags to discover new things and watch photos that contain the tags you are looking at.

Finding interesting content

One very persistent problem in the Web 2.0 pile of content is the so-called long tail of the content: very little content is very popular, while a lot of content is very unpopular. Within this long tail, there might be a lot of content that is interesting for users that will rarely become very popular. Moreover, if this content in the long tail is poorly annotated or tagged, it might be very difficult to ever reveal it. For this reason, recommender systems and techniques are applied to UGC. In what follows, we provide the basic underlying concepts of these systems.

In [7], the authors present a **ranking algorithm** that makes use of similarities between users and similarities between tags to reveal content that might be of interest to the user performing a query. They tested their algorithms on the CiteULike[8] dataset, which is a social bookmarking website (just like Delicious) specifically for scientific papers.

Another feature the Web 2.0 brings us is the large amount of comments and votes users can submit to websites. [9] did some research in order to analyse the social voting patterns on Digg[10], a social news aggregator. Users can submit links and vote on news stories. Their goal is to present the most interesting stories on their front page and it uses the aggregated opinions of the users to identify them. The conclusions from [9] and other work they reference all point to the fact that **social networks play an important role in promoting and locating content**.

Using personalisation in order to better resolve search queries is another technique that is widely accepted as a way to address the issue of finding what you need. In [11], research is presented that **builds user profiles based on folksonomies**. To be more precise, the profile of a user on Delicious, Last.fm or Youtube is monitored and the tags he uses are processed in order to construct a profile of interests of the user. The paper concludes with the fact that it is possible to automatically extract a good profile, but that it depends on the context of the folksonomy used: the results of the Delicious website were quite good, although they tend to be too general.

According to [12], **personalized search** has a significant potential in providing the user with information that accurately satisfies the user’s particular search intentions, but it entails **two major challenges**. The first challenge involves **identifying the interests of an individual user**. This task is particularly challenging mainly due to the reluctance of users to give explicit feedback about their search preferences. The second challenge is that, given that we have identified a given user’s preferences, we need a way to retrieve search results that closely match those preferences. We thus need an efficient **way to rank the results according to the interest model of the user**. [12] then describes a way to personalize the search by means of query and page topical analysis.

III. Use cases

In this section, we will introduce three different use cases that make use of user generated content in different domains of our everyday lives in order to show that it can be used to enhance the experience of the end user in many mainstream (networked) applications and services.



Figure 1 Domains in which our use cases use UGC

One of the most essential applications of the Internet is electronic communication. For this, the first use case is focussed on enriching existing communication channels, such as chat or voice services. In order to enrich the conversation we show photos that relate to the topic of the conversation. In a second use case, we present the idea of a location-aware city guide that retrieves images relevant to the current location of the user, based on the geo-information available next to the photos. The ubiquitous content can also be used in entertainment applications. For this, in the third and last use case, we present the concept of personalized augmented reality (AR) gaming. More specifically, users can be playing a game by means of augmented reality where the content that is shown depends on the user watching it or the role in the game he or she is playing.

Enriched communication services

We briefly introduce the general use case idea of the enriched communication services by means of the figure presented below. Figure 2 presents a broad overview of the general architecture of the use case.

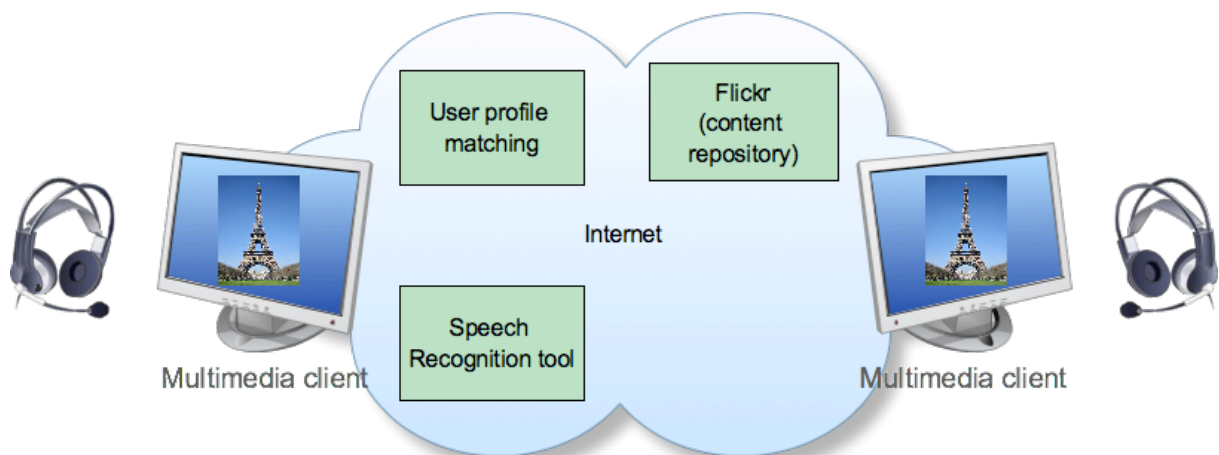


Figure 2 High-level architecture of the use case

A multimedia client is capable of allowing the end user to have a video chat with another user. Both users can see each other on screen in a video window, which shows a streaming video of the other end of the talk by using webcams. By using headphones, the users can have a voice chat and hear each other. So far, this seems like a normal video chat application. However, for this use case, the audio stream of the conversation is analysed by a Speech Recognition tool, which is capable of extracting keywords from the conversation.

Once words are recognized, these are sent to the User Profile Matching component. This component tries to track the topic of the conversation by means of these recognized words. Moreover, by keeping track of specific words users are saying, it is trying to keep track of the user's interests. These interests, along with the current topic of the conversation, are used to look up pictures,

from an online UGC repository (Flickr), that may interest the user or that may enrich the conversation. User interests can either be modelled using a keyword tree, which contains keywords representing specific topics of interest or by an ontology to map the personal interests onto certain topics. By using ontologies, richer semantic knowledge (such as relations between concepts) can be used in order to further improve the tracking of the conversation. This way, one can for example map the relation “is used together” on two keywords to store semantic knowledge about the fact that these two keywords are used in the same context.

Once, pictures are found, their tags are analysed to rank the results according to their matching with the interests or the topic of the conversation. A selected set of the results is finally sent to the client of both users. This way, they get to see pictures that should provide an enriched experience in their video conversation.

Users can also click on any picture in their client if they want to see a larger version of the image, or if they wish to recommend it to the other end of the conversation. Such a click event or recommendation is notified to the User Profile Matching component resulting in an update of the corresponding user’s profile.

Apart from enriching voice communications, this can also be applied to chat conversations, as is shown in Figure 3.

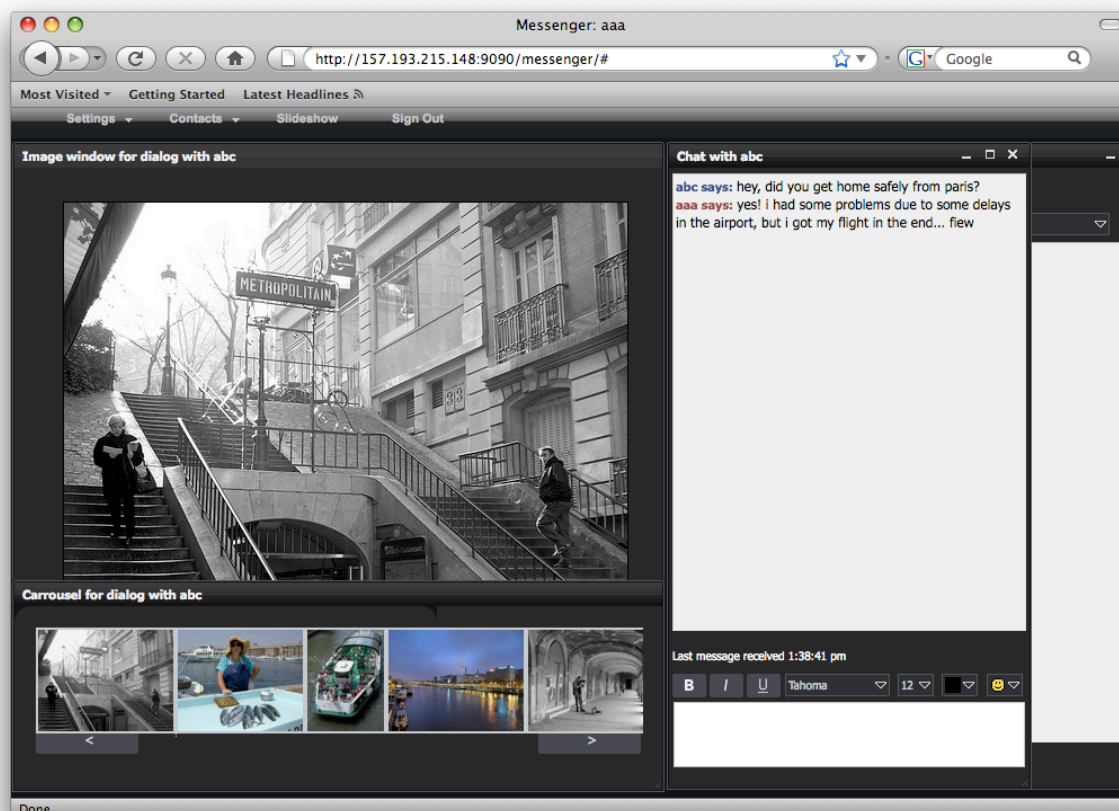


Figure 3 Screenshot of an enriched instant messaging client

User evaluation. 15 end users in the usability lab, of the Centre for User Experience IBBT/KULeuven, evaluated this use case. The focus of this test was to check the user experience more than the usability. For the design of the user interface, user recommendations were already taken into account.

In order to have a good conversation with the test subjects, they were asked to fill in a questionnaire about their level of interest relating to four topics: photography, travel, sports and music. Using this information, the test subjects started having a voice conversation about these topics with a researcher in another room. Based on the topic of the conversation, keywords were recognized and pictures were shown that related to the conversation they were having.

Some of the research questions we wanted to resolve by means of this study are: do the users like the fact that pictures relating to their conversation appear, do the users think the pictures relate to the conversation, would the users like to use their own pictures, what amount of time do the users spend on looking at the pictures compared to looking at their chat partner?

The results revealed that the test subjects liked the kind of application they tested, but they would preferably use it with people they know. They considered the images an added value over an ordinary communication client. The pictures were useful to many users but they considered this an addition over the video feed of the conversation partner, which seemed more important to them. Users indicated that this kind of application is certainly suited for the use in a social context with e.g. friends or family. The users considered that about half of the time the images were relevant to the conversation. But perhaps the most interesting conclusion was that, after using this application, participants would like to use their own pictures (UGC) in a conversation with people they know.

Location aware city guides

In the past few years, new kinds of tourist guides have emerged, such as location aware tour guides. In this use case, we suggest ideas to further improve these applications.

Visitors strolling streets on a holiday might want to retrieve location based information on city landmarks. For example, when walking by the Eiffel tower in Paris, one might want to get to know the history of the monument. Depending on the service that is used, this information might be pushed automatically to the mobile device of the visitor or he or she can retrieve it by interacting with the application. But as user evaluation of the first use case revealed, users are particularly interested in sharing content they are familiar with (theirs or a friends' content), with people they know. So, if they are nearby a popular monument like the Eiffel tower, and they would like to take a picture, they might want to get inspired by or copy a picture taken by people they know.

For this reason, we propose an extension of existing location aware city guides that are capable of personalizing the geo-related content to the social network of the visitor.

To realize this kind of application, we need a location aware service. As mentioned before, these services already exist using different technologies (WiFi, GPS, GSM cells, marker based, ...). In addition, personalization is needed in order to narrow the content down to content published by the social network of the particular visitor. And finally, the content remaining after this preliminary filtering needs to be classified according to available geographical information to pick the interesting content for a particular location. Nowadays, a large part of the photos published to the web contain at least some sort of metadata by means of tags, and if we are lucky, the geo-location itself.

In order to increase feasibility of this kind of application, we contributed to the necessary technical components by laying the foundations for a system that is able to determine the geographical location of a picture based on the tags that describe it [13]. This is useful to discover the location of pictures that are missing geographical annotations. In order to realize this, we take a look at the map of a city with geo-tagged pictures on it. We divide the city map into different areas, and collect all the tags used in those areas. By selecting the 250 most appropriate features from each area, a suitable vocabulary is constructed. Pictures are then represented as a feature vector encoding which of the terms in the vocabulary occur among its tags. Finally, a Naive Bayes classifier is used to predict the most plausible area for a given picture. Using our current implementation of this system, we can localize 35% of the pictures with an error margin of at most 250 meter and 22% with an error margin of at most 100 meter. These results are based on a dataset we downloaded from Flickr.

Personalized Augmented Reality Gaming

In order to further distinguish these games from desktop PC games, we propose to incorporate adaptive content in the games industry. Depending on the personal interests or the role of the player in the game, the content (e.g. an item you can pick up or an in-game avatar) shown or the game rules should change to create a more interesting user experience. In [14], a framework is presented to enable networked Augmented Reality (AR) multiplayer gaming. The framework allows two users to play a first person shooter game in the real world, augmenting the game using virtual content items that can be used to interact with in game.

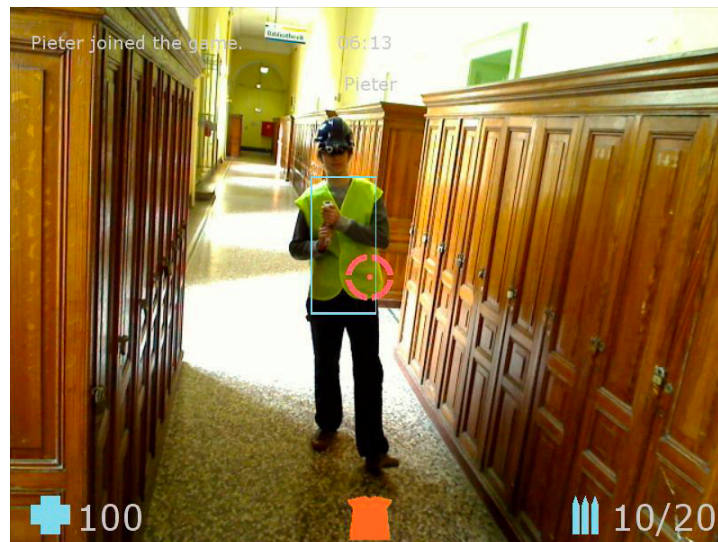


Figure 4 In-game view of the WARGame AR gaming environment

The Wearable Augmented Reality Game (WARGame) development resulted in a working prototype, that was user evaluated by 25 test subject. The platform was technically evaluated as well. Conclusions were that it is feasible to achieve a real-time gaming experience using the technologies described in [14].

User evaluation. As mentioned above, 25 people participated in a user study of the AR gaming environment. Every player challenged an opponent in a single game round that lasted for 10 minutes. After the game, the subjects were asked to fill in a questionnaire concerning different aspects of the application. 3 main aspects were focussed: the influence of the hardware setup, the different features of the game and the overall user experience. The results of the study revealed that all of the users enjoyed the

augmented reality because it is an added value over a mainstream video game. But one of the most interesting results is perhaps that almost all of the players would pay for this kind of application, when it is more mature. Even a part of the test subjects was willing to pay for playing the game as it was now in the prototype setup.

Based on the new developments we realized in the field of Augmented Reality (AR) gaming and the positive evaluation of the users who tested it, new business opportunities arise in the entertainment industry. This new gaming experience, evaluated as attractive at a prototype stage might evolve into a new line of products.

IV. Conclusion

In this paper, we elaborated on the current applications, challenges and opportunities user generated content brought us. The enormous amount of content leaves us the issue of finding what we need when we are looking for it, but also the challenge of discovering new content that might interest us. New algorithms are needed that make use of personalization, intelligent query resolving, ranking, recommendation, ... in order to help us cope with these challenges. In this paper, we discuss existing and new services that help end users find and discover new content in a fascinating way. New business opportunities arise in industries like communication, entertainment and tourism if they manage to incorporate personalization and user generated content in next generation services.

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Matthias Strobbe is a research assistant of the Research Foundation – Flanders (F.W.O.-Vlaanderen). Steven Schockaert is a postdoctoral fellow of the Research Foundation – Flanders (F.W.O.-Vlaanderen).

References

- [1] J. Krumm, N. Davies, and C. Narayanaswami, "User-generated content," *Pervasive Computing*, IEEE, vol. 7, no. 4, pp. 10-11, 2008. [Online]. Available: <http://dx.doi.org/10.1109/MPRV.2008.85>
- [2] [Online]. Available: <http://www.dk22.com/free.html>
- [3] C. Baladrón, M. Baldauf, P. Falcari, A. Cadenas, F. Paganelli, M. Pimentel, C. Raibulet, M. Serrano et al. "Integrating user-generated content and pervasive communications," *Pervasive Computing*, IEEE, vol. 7, no. 4, pp. 58-61, 2008. [Online]. Available: <http://dx.doi.org/10.1109/MPRV.2008.76>
- [4] [Online]. Available: <http://www.vrvis.at/projects/running-projects/WikiVienna>, Visited June 21st, 2009.
- [5] [Online]. Available: <http://www.unorkataster.de>, visited June 21st, 2009.
- [6] [Online]. Available: <http://taggalaxy.de>, visited June 21st, 2009.
- [7] V. Zanardi and L. Capra, "Social ranking: uncovering relevant content using tag-based recommender systems," in *RecSys '08: Proceedings of the 2008 ACM conference on Recommender systems*. New York, NY, USA: ACM, 2008, pp. 51-58. [Online]. Available: <http://dx.doi.org/10.1145/1454008.1454018>
- [8] [Online]. Available: <http://www.citeulike.org>, visited June 24th, 2009.
- [9] K. Lerman and A. Galstyan, "Analysis of social voting patterns on digg," Jun 2008. [Online]. Available: <http://arxiv.org/abs/0806.1918>
- [10] [Online]. Available: <http://www.digg.com>, visited June 21st, 2009.
- [11] M. Strobbe, O. Van Laere, B. Bogaerts, S. Dauwe, B. Dhoedt, F. De Turck, P. Demeester, "Tag based generation of user profiles," to appear in *Proceedings of ICOMP09 as part of WorldComp09*, Las Vegas, NV, USA.
- [12] S. Stamou and A. Ntoulas, "Search personalization through query and page topical analysis," *User Modeling and User-Adapted Interaction*. [Online]. Available: <http://dx.doi.org/10.1007/s11257-008-9056-y>
- [13] K. Michiels, "Geographically informed retrieval of photos ", Master Thesis, 2009, Ghent University, Belgium.
- [14] P. Dhondt, T. Verbelen, "WARGame: A distributed augmented reality game environment ", Master Thesis, 2009, Ghent University, Belgium.

Glossary

AR	Augmented Reality
UGC	User Generated Content

Authors' Biographies

Olivier Van Laere received his M. Sc. degree in Computer Science in July 2004, and his M. Sc. degree in Computer Science Engineering in March 2007, both from Ghent University, Belgium. As of October 2006, he is an assistant at the Faculty of Engineering, affiliated with the Department of Information Technology of Ghent University. Apart from educational activities, he is currently doing research for his Ph.D. The topic of his research covers the study and development of architectures and algorithms for management of context information, which can be used in advanced multimedia and mobile services.

Matthias Strobbe received his M. Sc. degree in Computer Science Engineering from Ghent University, Belgium, in July 2004. He is now a research assistant and Ph.D student affiliated with the Department of Information Technology of Ghent University. His main research interests include software architectures for support of context awareness and location based services.

Samuel Dauwe received his M. Sc. degree in Computer Science Engineering from Ghent University, Belgium, in July 2007. He is now a research assistant affiliated with the Department of Information Technology of Ghent University. He is involved in the research of context awareness and location based services.

Koen Michiels received his B. Sc. degree in Computer Science in July 2007, and is currently finishing his M. Sc. degree in Computer Science Engineering, both from Ghent University, Belgium. The subject for his master thesis is 'Geographically informed retrieval of photos'.

Steven Schockaert received his M. Sc. degree in Computer Science in July 2004, and his Ph.D. degree in Computer Science in April 2008, both from Ghent University, Belgium. Since October 2008, he is a postdoctoral fellow of the Research Foundation -- Flanders. His current research interests include the fusion of computational intelligence (fuzzy set theory, evolutionary algorithms) with symbolic artificial intelligence, as well as the application of these techniques for the web (information retrieval).

Jeroen Vanattenhoven has a master in Industrial Engineering Option Electronics ICT, and a Master in e-Media Engineering from GroupT in Leuven, Belgium. In 2004 he started working at the Research Group on Document Architectures at the Katholieke Universiteit Leuven. Since October 2006, he has been working as an HCI-researcher at the Centre for User Experience Research, IBBT/KULeuven, where he is starting a PhD trajectory.

Christof van Nimwegen has a master in Cognitive Psychology, with specialization Cognitive Ergonomics. He worked several years as a usability engineer and interaction designer in Internet related businesses in the Netherlands and abroad. At the end of 2002, he became a teacher at Utrecht University, after which he enrolled in a Ph.D. project in 2003. In March 2008 he received his doctor's degree. His interests are representations in interfaces, and Human Computer Interaction in general. He started working as a senior researcher at the Centre for User Experience, IBBT/KULeuven in 2008.

Pieter Dhondt is currently finishing his M. Sc. degree in Computer Science Engineering, at Ghent University, Belgium. The subject for his master thesis is 'WARGame: A distributed augmented reality game environment'.

Tim Verbelen is currently finishing his M. Sc. degree in Computer Science Engineering, at Ghent University, Belgium. The subject for his master thesis is 'WARGame: A distributed augmented reality game environment'. Tim will be joining the INTEC Broadband Communication Networks group of the Department of Information Technology, Faculty of Engineering of Ghent University in August 2009.

Filip De Turck received his M.Sc. degree in Electronic Engineering from Ghent University, Belgium, in June 1997. In May 2002, he obtained the Ph.D. degree in Electronic Engineering from the same university. At the moment, he is a part-time professor, affiliated with the Department of Information Technology of Ghent University. Filip De Turck is author or co-author of approximately 250 papers published in international journals or in the proceedings of international conferences. His main research interests include scalable software architectures for telecommunication network and service management, performance evaluation and optimization of routing, admission control and traffic management in telecommunication systems.

Bart Dhoedt received a degree in Engineering from Ghent University in 1990. In September 1990, he joined the Department of Information Technology of the Faculty of Applied Sciences, Ghent University. His research, addressing the use of micro-optics to realize parallel free space optical interconnects, resulted in a PhD degree in 1995. After a 2 year post-doc in opto-electronics, he became professor at the Faculty of Applied Sciences, Department of Information Technology. Since then, he is responsible for several courses on algorithms, programming and software development. His research interests are software engineering and mobile & wireless communications. Bart Dhoedt is author or co-author of approximately 340 papers published in international journals or in the proceedings of international conferences.

Piet Demeester received the Masters degree in Electrotechnical engineering and the Ph.D degree from Ghent University, Gent, Belgium in 1984 and 1988, respectively. In 1992 he started a new research activity on broadband communication networks resulting in the IBCN-group (INTEC Broadband communications network research group). Since 1993 he became professor at Ghent University where he is responsible for the research and education on communication networks. Piet Demeester is author of more than 1000 publications in the area of network design, optimization and management. He is member of the editorial board of several international journals and has been member of several technical program committees (ECOC, OFC, DRCN, ICCCN, IZS, ...).