Collective City Memory: Field Experience on the Effect of Urban Computing on Community

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ABSTRACT

In this paper we present field experience and user evaluation results from a long-term real world deployment of a novel urban computing application. Our goal has been to study the effect of applying urban computing to its three constituents: place, community and infrastructure. A suitable application for this, should enable us to evaluate how a city is altered, how the perception of people about the city changes, whether the communication among people is encouraged and what is the benefit from a city's infrastructure. We deployed CLIO, an urban computing application that allows forming and interacting with the collective city memory, in two different cities, in Greece and Finland. We carried out in-the-field user trials and interviews, and collected detailed logs for more than two months, evaluating both the suitability of our application for our purpose and the effect of this urban computing application to the city and its people. Our findings shed light on how a city and the perception of people about it change, reveal the extend to which an urban computing system can affect a community and evaluate the role of public infrastructure in those transformations.

Categories and Subject Descriptors

H.5.1. [**Information Interfaces and Presentation (e.g., HCI)**]: Multimedia Information Systems - evaluation/methodology

H.5.m. [**Information Interfaces and Presentation (e.g., HCI)**]: Miscellaneous

General Terms

Design, Experimentation, Human Factors.

Keywords

Urban computing; urban informatics; ubiquitous computing; context-awareness; inference; collective memory

1. INTRODUCTION

A number of content sharing systems have become popular the last decade. Content sharing refers to various media like photos, as in the cases of Flickr and Vuvox and videos, as in the cases of YouTube and Vimeo. Users often exploit social

networking services, like Twitter, Facebook and MySpace, as content sharing platforms, as well. People share personal content inspired by both individual and social motivations; sharing on the Web is a channel for self-expression and self-presentation, however it can equally be means of creating and maintaining relationships or participating in a group.

The interaction with content is often collective; users can simply comment content, enrich it with tags, rate it, recommend it or even collaboratively create it. Such community aspects are present in all content sharing systems. In an abstracted view technology mediates the participation of a person in web communities in a number of ways. It allows people to publish content, i.e. to produce, share and organise it; it allows people to interact, i.e. discuss and connect across time and space; finally it allows people to cultivate communities [28].

A number of content sharing services are focused on story telling [1], [10], [15], [26]; users can share their stories, enrich them with media and be members of a community. Often story telling communities share a common interest in specific places, themes or eras. The stories, which people share, spring from their personal memories and are expressed through narrations, photos or drawings, and texts. Individual memories always refer to the social context in which they are acquired; "it is in society that people recall, recognise and localise their memories" [13]. Halbwachs [13] introduced the term "collective memory" in order to express this social contextualization of individual memories.

Memories, beyond their apparent "temporal anchoring", also offer a sort of "spatial anchoring". Personal memories of events, which have occurred in cities, in time, are melded into a collective memory attached to the physical space; we refer to this as collective city memory. The collective city memory is a form of collective memory that is created through the interaction among individual memories attached to the city landscape; however it is the interaction among people and memories that is the most important factor in this process.

Today, in a time when several subtle revolutions in ubiquitous computing over the last decade have integrated communication and computation technology as well as novel means of interaction in modern cities, we are at a standpoint were we can evaluate how this form of computing has altered our cities and communities. Urban computing has touched upon the three constituents of urban life, namely place, community and infrastructure, as well as the established relationships among them. It has spurred interesting research questions, related to how a place is altered by its introduction into it, how is the perception of people about a place altered, does is affect community dynamics, and to what extend can these be attributed to technology [21], [24]. We have selected to deploy an urban computing application that allows forming and interacting with

the collective city memory, as such a system is related to all three constituents of urban computing, and it would thus allow us to study the effect of urban computing on place, community and infrastructure and on the triangle connections among them.

The target of this paper is to reveal the effect of urban computing on community presenting field experience from the in-the-wild long-term deployment of our system CLIO, which allows people to share personal memories and interact with collective city memory. In the Background section we present the evolution from memory to collective city memory and a number of systems that make available memories on the Web. Following we describe our motivation to develop a system that benefits from mobile and urban computing technologies in order to study its impact on community and present a set of system's typical scenarios. Then we describe the architecture of our system focusing on the client part that makes CLIO available to the users via several interfaces. The next section presents the deployment of CLIO in two cities and the evaluation methodology. Lessons learned from the field experience are thoroughly discussed and we focus on results, which reveal the effect of our system on a city community. Concluding, we support our claim that urban computing has a strong impact on a city community and present our future plans.

2. BACKGROUND

2.1 From Memory to Collective City Memory

Memory is the mental capacity through which events are stored, preserved and recalled in mind; it is in permanent evolution, open to the dialectic of remembering and forgetting [18]. Halbwachs [13], set foundations of the research on the relationship between memory and society, identified that the study of memory is not a matter of reflecting on the properties of the subjective mind; rather, memory is a matter of how minds work together in society as "it is in society that people normally acquire their memories" and "it is also in society that they recall, recognize, and localize their memories". The term "collective memory" was used in order to express the social contextualization of all individual memories. Each individual memory can only be recalled in the social framework within which it is constructed, and as individuals belong to many social groups there are as many collective memories as the social groups that support them.

Halbwachs set the roots of identifying the role that space plays in shaping the collective memory [13]. Since space is a reality that endures, it is in space – the space we occupy, we traverse and have continual access – that our understanding of the past is preserved. Nora [18] identifies that the modern way of life, which is radically different than that of our forebears, has disconnected us from our past and there are no longer real environments of memory (milieux de mémoire); thus we consciously cultivate sites of memory (les lieux de mémoire). As Huyssen [14] mentions we are searching for and building places of memory that can provide a sense of "temporal anchoring" in a world of up-to-the-minute media saturation and "information overload".

Boyer [4] considers that a city as a whole can be regarded as a collective memory. Therefore, cities are places where events that have occurred during the time are projected and various aspects are expressed through personal memories and narrations. Lately, research has been conducted on the topic that Crinson [11] names "urban memory". Urban memory is a kind of collective memory that is constituted by individuals' experiences within the place itself and through its history and social environment [22].

The collective city memory is a form of collective memory that is created through the interaction among individual memories attached to the city landscape; however it is the interaction among people and memories that is the most important factor in this process.

2.2 Memories on the Web

The value of people's memories is acknowledged for a long time and a number of systems have been developed in order to preserve it; so far the Web has been the primary platform for presenting them. A number of interesting approaches that share the idea of preserving and presenting collective memory follow.

Since 1999 the Dutch government introduced the policy of the "cultural biography", in which not only experts such as curators, but also citizens would have a say in which artefacts should be made part of the collective memory of The Netherlands. The city of Maastricht, among the first local governments to implement this policy, invited experts and citizens to describe and to assess the qualities and identities of the historical city and its future urban extensions. This dynamic "cultural biography" [9] was written in two ways; in the form of a website and in the form of events on location in which cultural expressions add stories and give meaning to the chosen sites.

The "Indigenous Knowledge and Resource Management" project [15] in Northern Australia provided Aboriginal people, with little or no literacy skills, a cataloguing-type software for TAMI (Text, Audio, Movies and Images) objects to manage their own digital resources for perpetuating collective knowledge traditions [27]. Maps and satellite photographs were used as navigation interfaces, though a central issue has been whether digital archiving technologies are compatible with indigenous knowledge, which is always local and integrated in lands and peoples and the lives they lead.

There are a number of storytelling projects which generate content from the audience itself, creating diverse archives of personal history. The City of Memory project [10] is an online community map of personal stories and memories organized on a physical geographical map of New York City. It offers an online interactive map that plots stories on the urban landscape either as points or as paths; content is open to anyone who wants to contribute. Analogous is the StoryMapping project [26], a project that aims to capture stories digitally about various places and to project them onto Google Maps. The Sharing Stories project [16] mission was to inform the community on the Kelvin Grove Urban Village's history; stories, photographs, archival information and digital stories were shared from the past and the present by students and community participants who chose to share their memories, inspirations and research. The "1001 stories about Denmark" [1] is an attempt to contribute stories about locations in Denmark that altogether constitutes a view on the Danish cultural heritage.

Other approaches have focused on particular themes and have offered tools to the public to share their memories. Aceti [2] at his artistic project called "Without Visible Scars: The Memory Walk" has used digital art to overlay diverse sets of narratives, different timelines and visual systems of representation. Memories, oral narratives and personal interpretations of survivors of the Second World War were pinned down on online virtual representation of physical spaces aiming to re-present a new "real" world, which is continuously compared to the memory and narratives of the lost world. Similarly, in [25] a video diary application enabled users to report their own war related

memories; then the video diaries were made available as a multi-screen projector system and as a collection accessible via a web site.

Lately, the popularisation of the Web 2.0 accustomed people with social networking applications that allow them to share opinions, thoughts and memories. A system that exploits the features of Web 2.0 is the PESE [5] a collaborative Web 2.0 storytelling environment, which combines ideas of multimedia production with the Web 2.0 idea of prosuming users, i.e. users who are media consumers and yet can become media producers. In PESE a user model is integrated, which represents the behaviour and influence of every user in the system and allows feedback and rating mechanisms for stories. The PESE perception is that knowledge is exchanged within communities when stories are told and non-linear storytelling is a kind of interaction between communities and media; it allows people's participation and profile-based story search.

The evolution towards the ubiquitous computing has revealed the potential to create and support relationship that surpass established social and cultural boundaries and enable new practices around place, identity and community. The Urban Tapestries project [3] exploits the ubicomp technology and aims to explore the potential of public authoring, which is mapping and sharing local knowledge, memories, stories, sensed information and experiences.

Urban computing has emerged in the intersection of architecture, social interaction and design of computer systems for use in urban areas; urban computing strives to address the need to let users create and share information in-situ. An application that aims to exploit the potential of urban computing is the Urban Pilot [12]; a system that accumulates the personal memoirs of the users as they retrieve, edit and add information and allows their sharing. According to [7] the exploration of a city is a three-way process of communication between the user, who has particular needs and characteristics, the information, which is a representation of a set of spatial and temporal relationships, and the physical place around the user. The city is neither about information accessed, nor about the technology; it is about the people, their experiences and their connection with the city.

3. MOTIVATION

Earlier works have already demonstrated the importance of collecting personal memories and stories; however memories are usually presented via web interfaces, maps, etc., therefore they do not interact with each other and the only form of collectiveness that they exhibit is the fact that they appear on a shared interface. In the Web era people could only publish and view content adopting distinct roles of producer or consumer. The advent of Web 2.0 blended the roles, allowed people to comment, annotate and rate content offering a variety of tools and eased the process of publishing content. This evolution enabled the creation of all sort of web communities usually centred on a common theme, interest, etc. Mobile computing released the user from the bounds of the pc since users could access any content anywhere and anytime. Additionally, continuous mobile access engaged users more to actively participate in online communities. Urban computing diffuses technology into the city encouraging in-situ interaction with content, and altering people's perception and utilisation of a city.
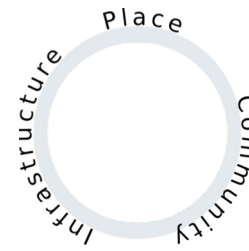

Figure 1. The three Urban Computing constituents.

Our motivation in this work has been to study a number of interesting questions on the effect of urban computing on place, people and infrastructure and on the connections among them, Figure 1. Our focus is set on how urban computing may affect and benefit a community; in particular community dynamics, people's sense of belonging and responsibility, citizens' engagement and participation, social interactions.

Aiming to address these issues we deployed CLIO, an acronym for ColLective cIty memOry, which is an urban computing application to form and interact with the collective city memory and aims to enhance interaction simulating the traditional way in society that people share memories via conversations. Attempting to reveal whether urban computing furthers engagement and participation, CLIO invites people to share and contribute their individual memories to form a collective city memory. CLIO enabling people to browse individual memories, to share similar ones, to rate and comment them, it allows us to study people's sense of belonging and responsibility. Aiming to answer whether urban computing may enhance social interactions and form communities, CLIO was deployed on different cities exploiting varied public infrastructure. Regarding the benefits that CLIO can bring to a community, we question its contribution to cultural heritage preservation, city identity building and intergenerational dialogue. Typical usage scenarios that reveal people's interaction with CLIO follow.

3.1 Sharing and Contributing Memories

"Ioannis, former mayor of the city, is strolling with his granddaughter around the city. Passing by the ruins of an old church his granddaughter asks if he knows the name of the church. Ioannis, recalls not only the name of the church but also the events of its destruction during the World War II. His granddaughter decides to capture his narration with her mobile phone and upload it to CLIO. On the spot she adds various tags relevant to this memory, like the name and the status of the narrator, the time period in which it refers to and the location."

In this scenario it is evident that a memory is related to a specific location of the city, in this case the church. The memory can be captured by any device and may have various formats; in this case it is captured as a video by a mobile phone. A memory can be contributed to the system either on the spot or later using a pc. The user in order to add a memory has to select the place at the city it refers to, note its time period, describe the narrator and add tags relevant to its content.

3.2 Interacting with Memories

"Joonas, a 30 years old member of an amateur local troupe, walks up to the interactive public display close to city's open air theatre. Browsing through the memories, he stumbles upon a few memories about theatre and theatrical performances. Among
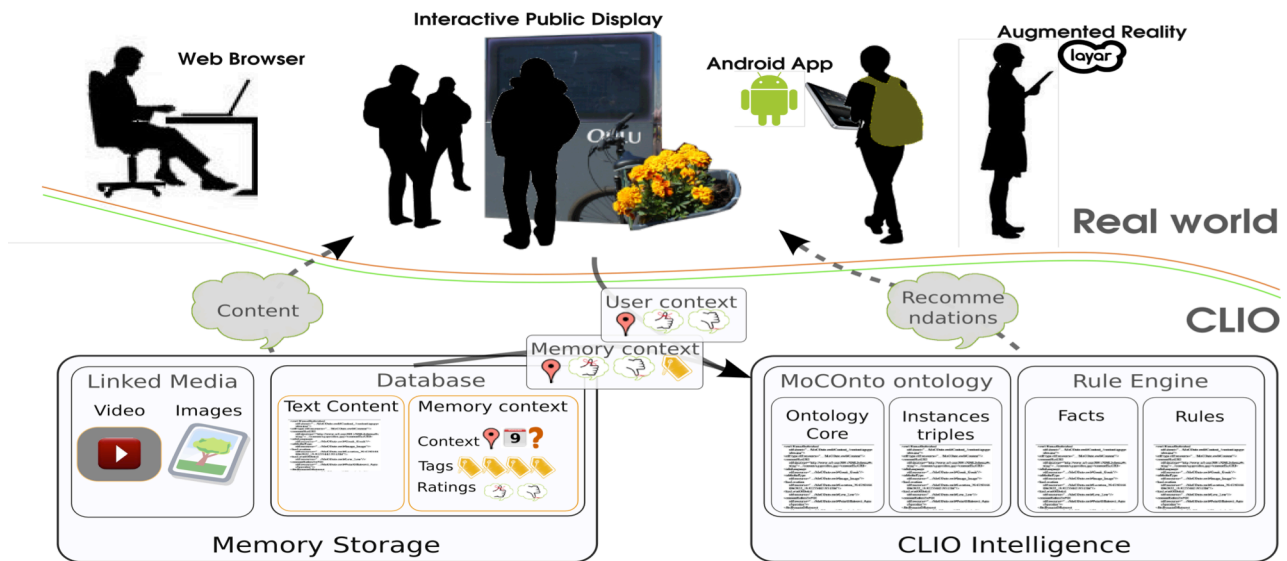
Figure 2: CLIO Architecture

them, he comes across a memory shared by his friend Jarko about a play they both acted in. He decides to comment on this memory and to share his own recollection using his smart phone."

This scenario expects people to usually browse memories related to their location, the character of the space and their interests. As in real life, familiar memories trigger one's own recollections and people are eager to comment others' memories from their own perspective and beliefs and built upon. CLIO should simulate the traditional way in society that people share memories via conversations and enable Joonas to "respond" with his own memory. Varied interfaces are exploited, as public infrastructure allows users to browse, rate and comment memories, while personal devices enable them to contribute richer content.

3.3 User-tailored Ambling through Memories

"Nefeli, a 21 years old student of history, visits a city for the first time. As she walks around the city a number of sights attract her interest. She uses her smart phone to explore memories that are projected attached to the sights close to her. CLIO monitors her ratings and recommends her memories matching her pattern."

Given the user location, memories close to it, approximately in walking distance or in direct view, are presented on the interface. In order to experience a service closer to Nefeli's interests, CLIO monitors the selected memories and the ratings she applies. Positive ratings lead to recommendations of memories similar in theme and location; negative ratings hide memories with themes indifferent to Nefeli's choices.

Figure 3. Using CLIO in Oulu, on outdoor (Market sq) and indoor (Main Library) public displays.

4. CLIO ARCHITECTURE

CLIO, its architecture appears on Figure 2, has been designed in order to support various context-aware computing applications in an urban environment [6], [24]. A server part stores memories and their context information, it then uses user context in order to select which memories to present. The client part consists of a number of applications offered via several interfaces, on available public urban computing infrastructure as well as personal smart devices, which present to the users views of the collective memory, see Figures 3 & 4.

Memories shared on CLIO consist of a number of media files, like photos, audio or video clips and text, along with the context information like the location and time it refers to, relevant events, etc. Memory storage is handled by a combination of MySQL database storage and file system storage; text is stored in the database, media such as photos and audio are stored on the file system, video is hosted on social media and is linked to the memories.

Along with the memories content, CLIO stores context like the place and time a memory refers to, tags that describe it, comments that viewers attach, ratings and statistics. Context information about each memory is then exploited to categorize a memory in themes. This information is modelled in the MoCOnto ontology and reasoning and rule based logic is applied in order to select relevant memories for each user that browses through the collective memory [8]. The user context is exploited to match
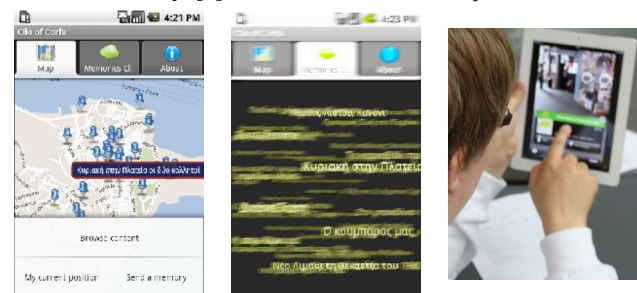

Figure 4. Using CLIO on personal devices (a, b) custom Android App, (c) via Layar Augmented Reality Browser
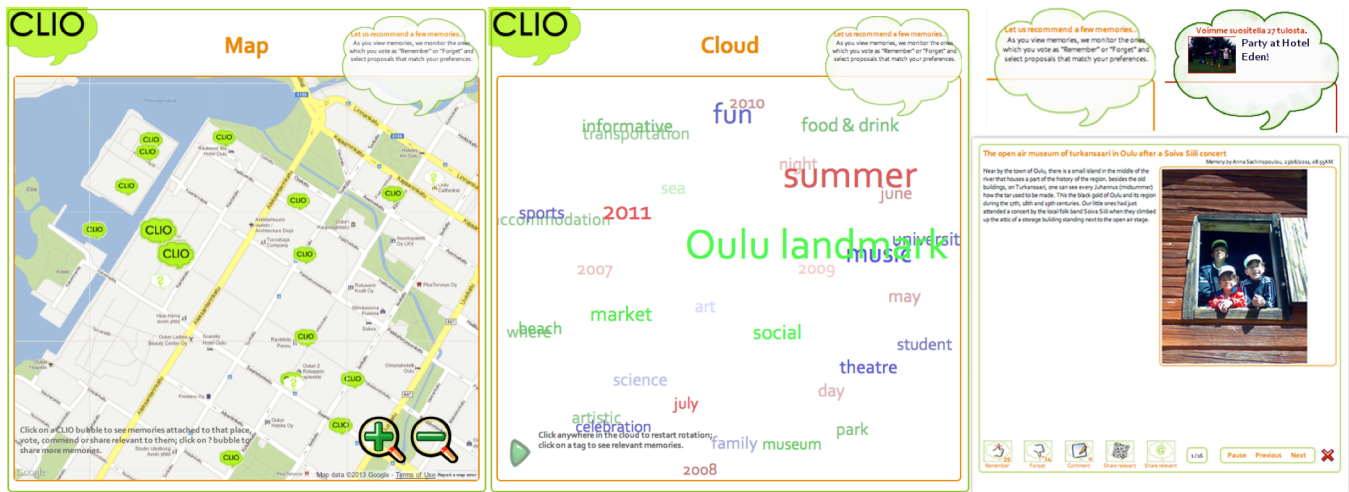
Figure 5. CLIO interface on Oulu's public displays (UBI Hotspots) (a) map view, (b) cloud view (c) recommendations widget prompting for ratings and presenting a recommendation, and (d) memory view and controls

users to memories; at first is just the location of the user, known from the context that the client offers, later as he views memories and rates them more relevant memories are selected. The MoCOnto ontology has been developed in the OWL language using the Protégé editor.

A user can access CLIO via a number of applications available on different physical interfaces [23]. Interactivity with the collective memory varies on each interface. In the ubiquitous computing city of Oulu the primary interface has been the interactive public displays, called UBI Hotspots [20], with rich media capabilities offering access via the city WiFi network and located indoors as well as outdoors, see Figure 3. The UBI Hotspot CLIO application offered two view options to browse memories, see Figure 5. A map based one focusing on the location context of the memories and the public display. Markers on the map denoted, using varied size, one or more attached memories; clicking on a marker the user was presented with all attached memories and was offered controls to rate, comment or reply to each of them. The second memory browsing option, a rotating cloud of words, was based on the context that the contributor of the memory had offered as a set of tags describing the time and theme of the memory. The tag cloud was colour coded to distinguish among tags referring to when, where and what this memory refers to; the varied size of the words visualised the number of memories related to each one. Selecting a word the user was presented with all related memories. The controls on the memory view allowed a user to perform simple interactions with it on the display, like rate or attach a short comment using an on screen keyboard, or to transfer control to a personal device in order to reply via it with a new memory. The latter actions where performed either by scanning a QR code with his mobile device, that instantly launched the sharing form, or by typing in his email in order to receive a reminder to share something later on.

On both the views offered on the public displays, a recommendations widget was integrated, as a small cloud on their top right corners. On the initiation of a new user session the widget urged the user to rate the memories he viewed; the rating were then exploited to infer appropriate recommendation without requiring the explicit submission of any profile information by the user. The selected recommendations were re-evaluated with any new rating.

Another means of experiencing the collective memory is through a smart personal device; in this case one could use either a custom Android client to CLIO or use Layar an augmented reality browser that overlays nearby memories to the device's camera view, see Figure 4. Using a smart personal device one can explore the collective memory while traversing the city and fully interact with memories or even share new ones. On the custom app, again, people can explore the collective city memory via two different modes; via a map where memories appear close to their location and via a cloud of themes where users can select a theme and view the relevant memories. On the cloud view, shaking the device presents a randomly selected memory. Using the Layar interface, memories are overlaid to the surrounding environment allowing the user to better relate them to the physical locations they refer to.

5. EVALUATION METHODOLOGY

The last two years we have applied CLIO in various settings aiming to study a number of research issues on the impact of urban computing. In this section we present the deployment process of CLIO in two cities, which differ in computing infrastructure and in character, in Corfu, the capital of a touristic island in Greece, and in Oulu, a ubiquitous city in the northern part of Finland. The key features of the evaluation methodology are also described here.

5.1 CLIO in Corfu

We set off at 2010 applying CLIO in Corfu aiming to research whether people want to share personal memories, interact with collective city memory and discover city via it. We developed CLIO system and made it available through various interfaces, like web browsers, smart personal devices and augmented reality browser. Initially we deployed the web interface through which people could both share their personal memories and browse the collective one. Aiming to provide an interface for people traversing the city we developed an Android application and for an enriched view of the physical surrounding we offered CLIO via Layar, an augmented reality browser for smart phones.

We evaluated our system in Corfu in two different phases, first we conducted observations and interviews and then field trials and questionnaires. During the first phase, end of 2010, we invited a number of schools to assist in the process of collecting memories as an educational activity. Students were asked to gather

memories from older generations about events that occurred in the city, to relate them with city landmarks and to tag them with keywords providing relevant context. The same period people from different age groups were engaged in interacting with CLIO via the various interfaces and performing a number of tasks, like finding memories referring to given location or theme. We observed how users interacted with CLIO and their reactions and then we interviewed them about their experience. In total, 30 students and 15 adults were involved.

The second phase of evaluation in Corfu occurred at the end of 2011, using an Android application as the user interface, see Figure 4(a). Twelve users, mostly male in the 20s and 30s, were asked to explore the collective city memory using the mobile app and they filled in a questionnaire reporting their experience.

5.2 CLIO in Oulu

The CLIO system was invited as a finalist of the 1st UBI Challenge [19] to be deployed in the city of Oulu during the summer of 2011 exploiting the ubiquitous infrastructure of the city. Our goal was to apply and evaluate CLIO in an authentic urban setting enhanced with urban computing as we could exploit the WiFi city network as well as the twelve UBI-hotspots [20], a network of public interactive displays at indoor and outdoor public spaces around the city, such as the library, the market square, the swimming hall, the university. We deployed an interface for the UBI-hotspots, a mobile version for sharing memories and a view for the augmented reality browser Layar, Figure 4. CLIO became available on the 7th of July 2011 via the UBI-hotspots until the end of December 2011 and people were invited to explore collective city memory through them and share their own memories via smart personal devices, Figure 6. We evaluated CLIO using both quantitative data collected from log files and qualitative ones from user study [24].

During the first phase of evaluation, a week after the service launch, we spent time on observations of people passing by the UBI-hotspots taking notes of their behaviour noting whether they were alone or part of a group. We, also, invited 12 users, with equal distribution among genders and ages from teenage up to sixties, to carry out task-based trials, fill in a questionnaire and take a semi-structured interview. Users were asked to share a memory via the mobile interface and exploit the UBI-hotspot to find memories and share comments. We observed users and their reactions carrying out these tasks and they were asked to share their feelings. The questionnaire helped us to assess how easy and friendly our system was and the interview aimed to help us identify the people perception about our system.

The second phase of evaluation, a month later, focused on assessing the recommendation feature of our system and whether and how collective city memory can be blended into the city. Another 12 users were invited to view memories via the UBI-hotspots, rate them positive or negative and explore the recommendations based on these ratings. We also asked users to explore CLIO via the Layar interface.

6. FIELD EXPERIENCE

CLIO was deployed and evaluated both with users in a controlled environment, in Corfu, and out in the wild with random users, in Oulu. We succeeded a large-scale deployment of CLIO both regarding the evaluation period and the number of users. The experience we gathered gave us insight in our research issues relevant to the impact of urban computing on place, community and infrastructure [6], [24]. Findings revealed that CLIO as an urban computing application succeeded in attracting people to

Figure 6: The sharing tool
(a) Share, (b) Locate, (c) Describe

share and interact with the collective city memory and the significant lessons learned on its effect on community follow.

6.1 Participation and Engagement

CLIO was not designed as an application that arbitrary users would get information, but as one that addresses to a community
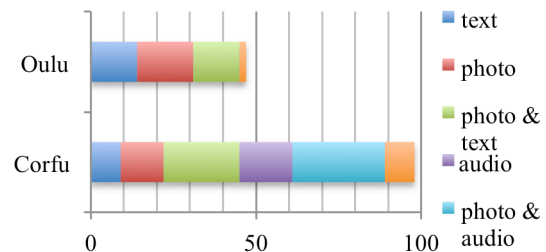

Figure 7: Peoples' shared memories via CLIO.

and invites its members to participate and be stakeholders. In our view, a community is the people who live in a city and have an interest for its past, present and future.

We approach participation studying first whether people share their personal memories. Experience from both cities suggests that people wanted to share memories; in Corfu around 100 personal narrations were collected, in Oulu around 50 experiences were uploaded, Figure 7. The collection method was different in the two cases affecting considerably the result. In Corfu, students acted as interviewers to persons close to them collecting personal memories, usually from childhood, rich in media. In Oulu, arbitrary users were invited to share in-situ using their personal devices; this process resulted in spontaneous memories focusing on recent experiences described mainly with text or photos.

The number of collected memories was not the anticipated in relation to the time period of deployment. This can be attributed to two reasons; interviews revealed that people prefer the role of "consumer" than "contributor" and task-based trials exhibited that the process of sharing using personal devices was too technical for the general public. However, encouraging signs for our system emerged from observations of the random walk up users at the public displays in Oulu. We observed that when groups of people interacted with CLIO members of the group started conversations and exchanged similar personal memories. A challenge for us is to come up with a novel way of sharing, similar to the one among human-to-human communication that would ease capturing of spontaneous people recollections.

A different angle on participation is to study the number of people that exploited CLIO and browsed memories. In Corfu, the evaluation occurred in a controlled group of users, thus we consider more representative the results from Oulu, where CLIO was open to the general public. We present results from the period between July and September of 2011 extracted from logged data on the launches of CLIO application on the public displays, Figure 8. In this period, there were in total 1424 launches of the application, but we consider almost half of them as "meaningful", in the sense that they had substantial duration and at least a memory viewed. We have to note that CLIO was selected from 753 persons or groups of people among other applications on the public displays; this figure reveals a clear interest of the public and an eagerness for community participation.

The total number of launches can be an assessment criterion for people's participation, but it cannot indicate sufficiently community engagement. In order to assess this, we studied the duration of user sessions and people's interactions with CLIO with respect to the number of viewed memories. Studying only the meaningful sessions, log analysis revealed that users spend on average more than 2.5 minutes (160 sec), with a median of 95 seconds. These data also exposed a variation between the duration of sessions occurred at indoors and outdoors public displays, with the indoors sessions being one minute longer. Shorter sessions at the market square than at the main library are consistent with our observations at these locations. We noted that people at the market square were more "curious" about the CLIO than the users at the main library as they tried out more features and viewed more memories, on the other hand users at the main library paid more attention and focused on fewer memories spending more time. It is worth mentioning the longest session, which lasted almost 2 hours, occurred at the midnight of the 17th of July 2011 at an outdoor public display and the recorded user actions show that the user or group of users had meaningful interactions with CLIO for the whole period as most of the memories were viewed.
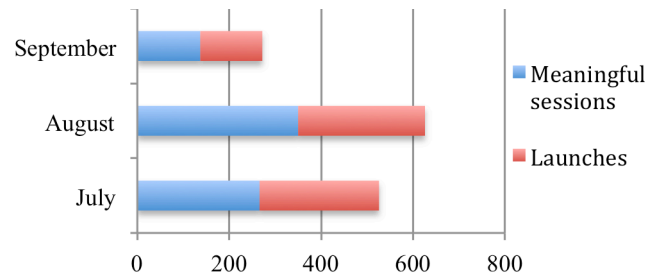

Figure 8: Launches of CLIO on public displays in Oulu.

The duration of user sessions positively indicates people's engagement with CLIO, but the aspect that can confirm our claim that CLIO can engage a community is the pattern of users interaction with CLIO. From our observations in various locations we figured out that people who actually interact with CLIO browse, view and pay attention to more than one memory. They usually follow a pattern selecting other memories located at the same place or relevant to the same theme or annotated as similar from other users. This fact was confirmed from the log analysis that also revealed that the median number of viewed memories is almost 4.

6.2 Belonging and Responsibility

Another research issue that we aimed to answer with this study was whether an urban computing application like CLIO may enhance the sense of belonging in a community. To address this issue we carried out a number of observations focusing on the experience that people gained interacting with CLIO as well as looking into data analysis on people's ratings and comments.

In the case of Corfu, after the students collected some initial material we observed older people, at their 50's, interacting with CLIO and we focused on their reactions while viewing some memories. The results were encouraging as practically everyone commented on the viewed memories and shared similar ones. Users were either individuals or groups of people; in both cases the result was the same and in the latter case it was frequent the lively discussions spurred. For example, presenting a group of users with a memory about a well in Vrahlioti sq., one started sharing a memory about his father who had a grocer shop in this square and yelled to the then prince of Greece who had "stolen" a watermelon; the conversation then moved on by another user who shared an old postcard showing traditionally costumed guard in front of the Palace, where the Royal family of that time used to spend their summers. The same observation held true in Oulu; the majority of the participants at the beginning were hesitant to interact with CLIO, but once they started to view and read one or two memories they said that they can also recall similar ones and they started sharing. These observations are consistent with Livingstone's claim [17] that each memory fragment is a valuable building block of the collective memory as not only it reveals part or all of an event, but it can also trigger others' memory fragments.

In the case of Oulu, people via CLIO could comment on a memory and vote if it is worth to be remembered or if it is better to be forgotten. Results showed that only few comments were posted; this is attributed from questionnaires and interviews to the technical difficulty of the process, which demanded writing on a virtual keyboard on a public display, and not to the reluctance of people to comment. On the other hand, the total number of 295 positive and 90 negative votes revealed that users, who are

accustomed to such "evaluation" of content, expressed their belonging and responsibility via the voting process.

We did not directly address responsibility to our study, but two remarks hint on the public attitude. In the case of Corfu, where interviews first occurred and then a control group of people interacted with CLIO, all participants expressed their feelings of owing to be engaged in a process preserving a part of their city cultural heritage and no one declined some form of participation. In the case of Oulu, it was unexpected that there were no inappropriate shares on a system hosted on public displays for a period of three months.

6.3 Social Interactions and Intergenerational Dialogue

In both cities, one of the most interesting findings of observations was that people experience strong emotions interacting with CLIO like laughing or arguing, as they often feel connected with the memories they view. Individuals spend more time and view more memories, while groups start talking, commenting and long conversations emerge.

Our research showed that the key factor that affects how CLIO may enhance social interactions is the availability of public infrastructure. In Corfu, where no public infrastructure was available we only observed social interaction when we brought together groups to shared facilities; users of personal devices expressed only emotions. In Oulu, where public displays were available throughout the whole city, it was typical that groups of people started interacting. For example, in Oulu when a couple of visitors accompanied by a local friend browsed through the memories, turned to their local friend asking for more information about the places the memories referred to.

Another impact that CLIO may have on the community is the promotion of intergenerational dialogue. This was evident at Corfu, where students during interviews pointed out that they liked the idea and enjoyed talking with their grandparents and people from older generations about their experiences related to the city, commenting:

"me and my grandfather used to play in the same square, but the surrounding shops are not the same",

"until now I felt that I had nothing in common to talk with my grandparents".

Similar observations occurred at Oulu, where an elder woman with her teenager granddaughter spent some time interacting with CLIO in the main library; the younger interacted with CLIO and he public display, while the elder commented and shared similar stories to her.

6.4 Benefits to the Community of a City

Regarding the benefits that CLIO can bring to a city community, we question its contribution to cultural heritage preservation and

Table 1. Questionnaire results from field studies

Question	Eval #1	Eval #2
Exploring CLIO I learned interesting things about Oulu.	3.09	3.00
Exploring CLIO motivated me to visit specific places in Oulu.	3.09	2.77
Exploring CLIO I found interesting memories.	2.82	3.62

to city identity building.

On the former question we gathered many positive comments during interviews from the people of both cities where we applied CLIO. People shared with us their excitement with the idea of capturing personal memories, preserving this part of city culture and knowing new things for their own home town, commenting:

"we find important the idea of "keeping" memories and we think that it has a potential",

"we really liked the idea and found it very interesting",

"I did not know that the Old Fortress was used as an army camp".

On the latter question, a definitive factor was the characteristics of the collected memories. In the case of Corfu, where more thorough memories were collected, users had the opportunity to learn more about their town, discover past views of locations, compare the past and present. In Oulu, where we collected more recent experiences, responses from the questionnaires, Table 1, did not live up to our expectations.

Urban computing affects both cultural heritage preservation and city identity building on a higher level; embedded infrastructure in a city allows blending information like collective city memory with the physical space this refers to. In Corfu, we observed that users via pc web browsers selected randomly located memories, whereas people traversing the city with their smart phones they usually selected memories close to their location. In Oulu, this was confirmed and we also noticed that people also selected memories related to the character of the space they were in.

7. CONCLUSIONS AND FUTURE PLANS

The presented CLIO application was designed to invite people to share personal memories, which combined reflect the collective conscious of a city. One of our goals was to provide an urban computing application that offers an insight on how modern media and communications can mediate the dialectic between a person and the community he belongs to as well as novel means of recording and transferring culture and tradition.

Field experience from the in-the-wild deployment of CLIO in two different cities offered insight to many research questions on the impact of urban computing on a community. Results can prove the significant benefits for a community regarding participation, sense of belonging, social interactions, intergenerational dialogue. Even though we demonstrated the effect of such applications on a city community, it is an ever-lasting challenge to retain long-term engagement. Engaging a community to create a collective city memory demands novel means of collecting personal memories, that simulates the traditional interaction in society, and support from the city infrastructure.

Our future work will emphasize on the social and cultural impact of urban computing. To our view, cities are the people that inhabit them, their memories, stories, concerns and the culture that develops through their social interaction. We will focus on defining the "sociable smart city" and how this can be realized.

8. ACKNOWLEDGMENTS

9. REFERENCES

[1] 1001 stories from Denmark. Retrieved on December 1, 2010, from http://www.kulturarv.dk/1001fortaellinger

[2] Aceti, L. 2009. Without Visible Scars: Digital Art and the Memory of War. *Leonardo*. 42, 1 (Feb. 2009), 16–26. DOI=http://dx.doi.org/10.1162/leon.2009.42.1.16.

[3] Angus, A., Lane, G., Martin, K., West, N., Thelwall, S., Papadogkonas, D., Papamarkos, G., Roussos, G., Sujon, Z. and Silverstone, R. 2008. Urban Social Tapestries. *Pervasive Computing*. IEEE. 7, 4 (Oct.-Dec. 2008), 44-51. DOI=http://dx.doi.org/10.1109/MPRV.2008.84.

[4] Boyer, C.M. 1994. *The City of Collective Memory*. MIT Press.

[5] Cao, Y., Klamma, R. and Martini, A. 2008. Collaborative Storytelling in the Web 2.0. 1st International Workshop on Story-Telling and Educational Games (STEG'08).

[6] Christopoulou, E., Ringas, D. and Stefanidakis, M. 2012. Experiences from the Urban Computing Impact on Urban Culture. In Proceedings of the 16th Panhellenic Conference on Informatics (Piraeus, Greece, October 5-7, 2012). DOI= http://doi.ieeecomputersociety.org/10.1109/PCi.2012.53

[7] Christopoulou, E. and Garofalakis. J. (2011). Context-Aware Cultural Heritage Environments. In Styliaras G., Koukopoulos D., Lazarinis F. (Eds.) *Handbook of Research on Technologies and Cultural Heritage: Applications and Environments*. IGI Global.

[8] Christopoulou, E. and Ringas, D. 2011. CLIO: Context Supporting Collective City Memory. In *Proceedings of the 5th FTRA International Conference on Multimedia and Ubiquitous Engineering* (Loutraki, Greece, June 28-30, 2011). MUE 2011. IEEE, 6-11. DOI=http://dx.doi.org/10.1109/MUE.2011.12

[9] Cities and citizens writing history and shaping the future. Retrieved on November 18, 2009, from http://www.fdcw.org/maastrichtvks/research/

[10] City of Memory – New York. Retrieved on November 18, 2009, from http://www.cityofmemory.org/

[11] Crinson, M. (Ed.). 2005. *Urban memory: History and amnesia in the modern city*. London: Routledge.

[12] Goel, A. 2002. Urban Pilot: A Handheld City Guide That Maps Personal and Collective Experiences through Social Networks. D*igital Cities II: Computational and Sociological Approaches, LNCS 2362*, Springer-Verlag Berlin Heidelberg, 621-629.

[13] Halbwachs, M. 1992. *On Collective Memory*. University of Chicago Press.

[14] Huyssen, A. 1995. *Twilight memories: Marking time in a culture of amnesia*. New York: Routledge.

[15] Indigenous Knowledge and Resource Management in Northern Australia - Making collective memory with computers. Retrieved November 18, 2009, from http://www.cdu.edu.au/centres/ik/about.html

[16] Klaebe, H. G., Foth, M., Burgess, J. E. and Bilandzic, M. 2007. Digital Storytelling and History Lines: Community Engagement in a Master-Planned Development. In *Proceedings of the 13th International Conference on Virtual Systems and Multimedia* (Brisbane, Australia, September 23-26, 2007).

[17] Livingstone, J. L. 2006. The Memory Library - a New Approach to Collective Recall. In *Proceedings of the Workshop Designing For Collective Remembering at the CHI 2006* (Montreal, Quebec, Canada. 22-27 April 2006).

[18] Nora, P. 1989. Between memory and history: Les lieux de memoire. *Representations*. 26, 7–25.

[19] Ojala, T. and Kostakos, V. 2011. UBI Challenge: Research Coopetition on Real-World Urban Computing. In *Proceedings of the 10th International Conference on Mobile and Ubiquitous Multimedia* (Beijing, China, December 7-9, 2011). MUM 2011. ACM, New York, NY, USA. DOI= http://dx.doi.org/10.1145/2107596.2107622

[20] Ojala, T., Kukka, H., Lindén, T., Heikkinen, T., Jurmu, M., Hosio, S., and Kruger, F. 2010. UBI-hotspot 1.0: Large-scale long-term deployment of interactive public displays in a city center. In *Proceedings of the 2010 Fifth International Conference on Internet and Web Applications and Services* (Barcelona, Spain, May 9-15, 2010). ICIW 2010. IEEE, 285-294. DOI= http://dx.doi.org/10.1109/ICIW.2010.49.

[21] Paulos, E., Anderson, A. and Townsend, A. UbiComp in the urban frontier. http://www.urbanatmospheres.net/UbiComp2004/

[22] Postalcy, E., Kuruç Ada, A. and Özbek Eren, Y. 2006. The New Urban Memory, In *Proceedings of the 42nd International Society of City and Regional Planners Congress* (Instanbul, Turkey, September 14 – 18, 2006).

[23] Ringas, D., Christopoulou, E. and Stefanidakis, M. 2013. Infusing Collective Memory into the City Landscape. In *Proceedings of the Hybrid City Conference 2013: Subtle rEvolutions* (Athens, Greece, May 23-25, 2013).

[24] Ringas, D., Christopoulou, E. and Stefanidakis, M. 2011. CLIO: blending the collective memory with the urban landscape. In Proceedings of the 10th International Conference on Mobile and Ubiquitous Multimedia (Beijing, China, December 7-9, 2011). MUM 2011. ACM, New York, NY, USA. DOI= http://dx.doi.org/10.1145/2107596.2107620

[25] Sas, C., Dix, A., Davies, N. and Friday, A. 2006. Capturing and Sharing War Memories. In *Proceedings of the Workshop Designing For Collective Remembering* (Montreal, Canada, April 23, 2006).

[26] The StoryMapping project. Retrieved November 18, 2009, from http://www.storymapping.org/resources.html

[27] Verran, H., Christie, M., Anbins-King, B., van Weeren, B., T. and Yunupingu, W. 2007. Designing digital knowledge management tools with Aboriginal Australians. *Digital Creativity*. 18, 3 (Sept. 2007), 129–142. DOI=http://dx.doi.org/10.1080/14626260701531944.

[28] Wenger, E., White, N., Smith, J. D. and Rowe, K. 2005. *Technology for communities*. CEFRIO.