FOSS4G DENVER 2011

12-16 SEPTEMBER 2011 SHERATON DENVER DOWNTOWN
2011.FOSS4G.ORG

Conference Proceedings

Free and Open Source Software for Geospatial Conference

OSGeo Journal
Vol. 10 - Feb 2012

OSGeo
Your Open Source Compass

Volume 10 Contents

Welcome from the Conference Chair

Welcome to this special edition of the OSGeo Journal, featuring selected papers from the academic track that were presented at the FOSS4G (Free and Open Source Software for Geospatial) 2011 conference in Denver.[1] The conference was the largest FOSS4G yet, with 914 attendees from 42 countries. Feedback from attendees was very positive, with the post-conference survey giving it an overall rating of 4.32 out 5. The attendance reflects the strong growth in interest in open source software that we are currently seeing in the geospatial industry.

We made a conscious effort in 2011 to enhance the academic track at the conference by providing improved publishing opportunities. We did this through publishing papers both in "Transactions in GIS" and in this edition of the OSGeo Journal. I would like to thank Rafael Moreno for leading this effort, as well as the rest of the organizers of the academic track who Rafael recognizes below.

Peter Batty, Ubisense
FOSS4G 2011 Conference Chair

[1]FOSS4G: http://foss4g.org

FOSS4G 2011 Conference Proceedings

Open source based online map sharing to support real-time collaboration

Muhammad A Butt, Songnian Li

Abstract

Collaboration is an important part of many tasks involving people from different organizations, in which maps often play a central role in informing and improving debates and facilitating decision making. Allowing groups to share and view maps and spatial images interactively over the Web in real-time not only provides an effective solution to decision makers, but also facilitates scientific and public debates with real-time geospatial information. A few tools have been developed using proprietary software approaches, e.g., PCI Geoconference. More recently, some efforts have been made using open map services to develop simple map sharing applications. However, little has been done on designing and developing such online tools based on open source. Further, a literature search indicates the lack of scientific publications on empirical studies of their practical applications. This paper describes a study on using Open Source Geographical Information System (OSGIS) and mapping solutions to design and develop real-time map sharing applications, which rely on the data served through open map/data services with the option of integrating local data. The study focuses on not only real-time map (or geospatial information) sharing, but also the integration of other open source based groupware solutions. Existing open source solutions are evaluated for the design and development of various prototype collaborative map sharing tools. The prototype is applied in an online virtual public meeting space for initial usability studies. The paper also discusses the issues related to the design, data required to support better map sharing, and adoption of related standards.

Introduction

Multi-user collaboration is increasingly integrated in many tasks involving people from different organizations, in which maps often play a central role for providing visual information to support collaborative decision making. The rapidly expanding range of Web technology has made it possible to collaboratively make decisions over the Web. Demands for web-based open mapping Application Programming Interface (API), integrated with other information and Computer Supported Cooperative Work (CSCW) tools, have rapidly become more important for supporting real-time map sharing solutions. Therefore, the establishment of real-time collaborative map-based applications is one positive step taken by the researchers that are progressively working in many fields, for example, urban planning projects, emergency system, GIS data production, etc., that incorporate collaborative involvement (Chang 2010; Al-Kodmany 2002; Huang 2001; Roseman 1992; Brail et al. 2001; Klosterman 2001).

A synchronous approach is developed to support collaboration among users (Chang 2010); however, little has been done on designing and developing such Open Source Software (OSS) - based online map sharing tools to support real-time collaboration. By examining the researchers' contributions from the literature review, this study seeks to outline the significance of ensuring the implementation of valuable and adequate methods, techniques and tools to fill the research gap. Multi-user synchronous communications and/or discussions among the participants and between the participants and decision makers often improves the understanding that leads to effective feedback and enhanced decision-making (Evans et al. 1999; Ventura et al. 2002; Tang 2006; Bryant et al. 2006; MacEachren et al. 2001; Li et al. 2007; Jankowski and Nyerges 2001; Jankowski and Nyerges 2003). This study expects to develop an open mapping API-based real-time collaborative infrastructure with the option of integrating local data for enhancing involvement during debate. The study focuses on not only real-time map (or geospatial information) sharing, but also integration of other open source based groupware solutions. The objective is to make sure that the model with synchronous collaborative support of information and map sharing mechanisms will help to improve/increase participants' involvement and/or aid decision makers in reaching a final decision efficiently (Chung et al. 1994; Begole et al. 1999).

The study also models and presents the prototype development of an integrated online synchronous collaborative system by putting together the practical integration of various OSGIS, Web GIS, OSS-based tools and open mapping APIs. Some of this research prototype's components are still in development and in early stage of testing. The core purpose of developing such a model is to allow interested groups to share and view maps and spatial images interactively over the Web in real-time: for instance, providing adequate access to real-time collaboration tools (i.e., real-time map sharing for exploring spatial context) to provide information and data as maps and visualizations, which the users can explore in order to make better choices (Li et al. 2007; Li et al. 2006; Li et al. 2004; Laurini 2004; Dragicevic 2004; Laurini 1998; Obermeyer 1998; Rinner 1999; Edelenbos 1999). This study explains certain facts or observations (i.e., core concepts, design and testing, etc.) with an overview of enabling technologies for analyzing and designing a successful mechanism. Moreover, it describes a prototype development based on a research project that looks into integrating CSCW principles and open source groupware tools with web-based GIS.

The enhanced OSS-based prototype integrates social collaboration tools, Web-mapping functionalities, and Human Computer Interaction (HCI) principles. In brief, the prototype system is the integration of various types of open source based modules and open map services i.e., Google, Yahoo, etc. to provide synchronous-based Collaborative Real-time Map sharing Infrastructure (CRMI) to support and/or enhance input during planning and decision making related workflows.

In addition, as a part of the study, there is a plan of testing the prototype's usability by providing a case study and/or pilot project involving participants concerned with planning issues at the York Regional municipality in Canada. The municipality data are provided and acquired by the municipality Website (http://www.york.ca) to create a mock case study for in-house usability testing (see Section 4.1 for more information about the study area and selected sites). In authors' opinion, Web-based synchronous GIS applications need consistent usability evaluation during development and after development regarding end-user's requirements. Therefore, if authors get any chance of an approval and/or agreement from municipal bodies (of York) for conducting the test in a real scenario at later stages (of this study), then the prototype usability testing will be conducted again to get more precise results. The main purpose of this usability evaluation is to find out the results which will depict/conclude that the synchronous collaborative map sharing framework, when integrated and developed with Internet-based GIS and OSS technologies, can provide cost effective solutions and significant support in enhancing real-time participation as well as improving decision making process.

It is hypothesized that with the lower cost and more effective real-time collaborative communication channels, partially due to the adoption of open source solutions, the prototype would help increase the degree to which the citizen, local bodies, environmental assessment, government agencies and decision authorities work at the same time.

Background-Related Work

The CSCW application or groupware technologies allow people in remote places to interact with each other by sharing the documents and files through voice, data and video links (Scientific 1990; Antunes et. al 2009; Abdalla et al. 2010). Baecker (1993) defined groupware as information technology used to help people work together more effectively. The decision making process is based on group and collaborative activities, however, the procedures that used in GIS have been developed for use by individuals. Armstrong (1994) states GIS applications are not well designed for collaborative activities (e.g., decision making). A few GIS-based tools having groupware and CSCW functionalities have been developed using proprietary software approaches, e.g., PCI geo-conference (see Section 3.3 for detailed comparison between authors' prototype and PCI Geo-conference – a commercial tool). More recently, some efforts have been made using open map services to develop simple map sharing applications.

Rinner (1999), Rinner (2006) and Li et al. (2007) realize the need to support collaborative discussions by introducing asynchronous-based geo-referenced mapping frameworks in which the discussion thread of each individual is linked with one or many elements on the map. These techniques offer a limited way of exploring spatial data or map information collaboratively, while current study is focusing more on providing ways in which participants solve spatial problems together using synchronous communication.

Several prototypes that facilitate anywhere (real-time) collaboration are designed and developed as a result of recent advancements in Geographic Information Technology (GIT) that support large spatial databases, groupware technologies and Web-based GIS (Churcher 1999; Jones et al. 1997; Dragicevic et al. 2004; Boulos et al. 2010). For instance, Spatial Group Choice, a spatial decision support prototype was developed by Jankowski et al. (1997) to support the CSCW technique. Similarly, GroupARC was proposed and developed by Churcher (1996) which provides a tool to geographically scattered people to collaboratively view and annotate map/spatial data. The prototype Real-time Environment Information Network and Analysis System (REINAS) was designed and developed by Pang (1995) which includes functionalities that are useful in the analysis of geospatial data. Virtual Emergency Operations Center prototype was developed which aims to provide a collaborative virtual environment that enables interactivity among participants while executing synchronous, script-driven tests and simulations (Fiedrich et al. 2007). Chang (2010) developed Synchronous collaborative 3D GIS to support synchronous collaboration efforts among geographically-distributed people for enhancing collaborative decision-making.

Research related to the design and implementation of real-time collaborative mapping technologies is still at an early stage of development. There is not much literature in this field. As a result, there have been only a few and/or inadequate empirical studies addressing the synchronous collaboration, real-time map sharing mechanism and procedure of group spatial decision making designed to facilitate collaborative work (MacEachren 2000; Boroushaki et al. 2010). The rapid changes in technology, especially, in the field of GIS, OSGIS, GIT, CSCW, groupware, Internet computing technology, virtual reality, geographic visualization, geo-collaborative technology and others will have a significant influence on the shift and/or merge of those technologies into collaborative synchronous GIS.

Design and Development of OS-based Collaborative Map sharing Tool

The CRMI aims for a combined action or synergy of multiple components that are responsible for a variety of unit functions using two tiers of communication protocols. The presentation tier is called the CRMI protocol suite which runs over HTTP/S and is designed for real-time communication between users (e.g., decision makers) with the help of Web console. The application tier which constitutes CRMI internal architecture is based on OSS-based components, modules and services.

CRMI Architecture

The CRMI architecture is mainly built by using open source modules and services. Figure 1 depicts the CRMI architecture.

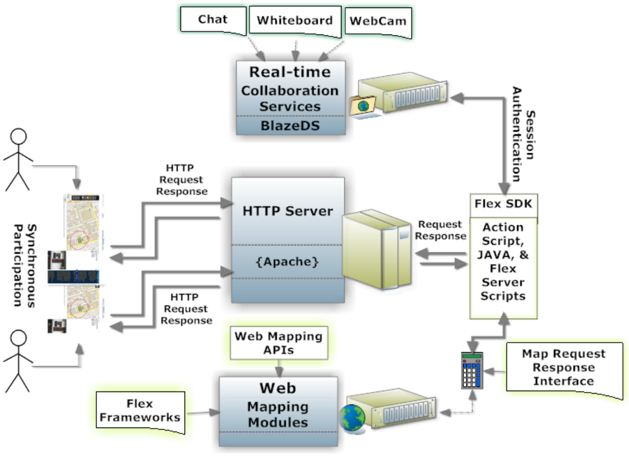

Figure 1: Architecture of collaborative real-time mapping infrastructure

The CRMI backend architecture is internally comprised of three major components that are linked with each other for two-way communications by using Adobe flex framework and JAVA scripting modules. These backend components along with the HTTP server component collectively form the Collaborative Real-time Map Sharing Infrastructure, which are briefly discussed below.

Real-time Collaboration Services: provide the infrastructure which enables developers to add real-time collaboration capabilities (real-time push messaging) to their applications. Collaboration service is JavaScript Object Notation over HTTP/S based system that leverages Web 2.0 messaging and interaction paradigm (Lemos 2006). It is usually commoditized by using Red5 open source media server that uses real-time multimedia protocol to support audio/video streaming (Wang et al. 2010).

Blaze Data Service (BlazeDS): provides real-time Web messaging capabilities (a complete publish/subscribe infrastructure allowing Flex clients and the server to exchange messages) for rich Internet applications using ActionScript message format over HTTP/S.

Web Mapping Modules: handle the user's request on the maps displayed on users' screen by producing open map APIs (Google, Yahoo, and Bing). The synchronous behavior of maps is created to enable co-browsing (co-shared maps) among the participants' Web console (user's screen) by using Adobe Flex framework, map API for flash and Action/Java script programming language. In addition, the open source Flex software development kit provides an integration link between real-time collaboration services and map APIs modules for the development and deployment of CRMI.

HTTP Server: handles the user's requests sent from front-end Web interface (i.e., Firefox or Internet Explorer) to the Web server (Apache) and then response back (i.e., an interface along with real-time map sharing functionalities) to the Web client using HTTP protocols.

OSS-based Collaborative Map Sharing Tool

A prototype as a proof of the concept was designed and developed to support the collaboration in multi-user environment for informing and improving debates and facilitating decision making. Two major components of the prototype which support real-time map sharing mechanism are briefly discussed as follows:

1) Collaborative Map Sharing Component

A collaborative map sharing component was implemented with some basic mapping functions to explore planning and development scenarios within geographical contexts of the projects. A picture is worth a thousand words. For many planning and decision oriented discussions, having a map or map-based displays of different scenarios shared by participants greatly facilitates their discussion on some issues. For that reason, a collaborative map sharing component was developed which allow participants and decision makers to collaboratively explore geographic contexts of the projects while discussing issues. Figure 2 shows the main Web interface of the collaborative map sharing component.

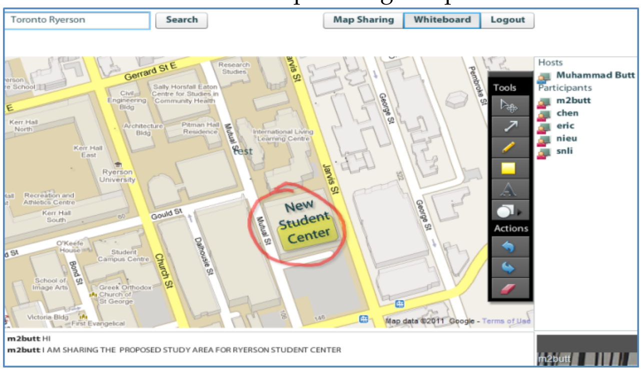

Figure 2: Real-time collaboration using Google mapping API

The component integrates a number of features, including map sharing, chatting, video conferencing and whiteboarding, into a single interface that can be invoked and run in a new window. It is intended to be used by a group of participants who have a common topic of discussion, which requires access to map displays to make their points clearer. Any participant can initiate a collaboration session and invite others to join. All participants who join the session are given the right to use white-boarding tools for creating drawings as well as annotating on a Google map. For example, a free hand drawing object (new student center building area) on the map can be created by one participant and shared by all participants during the meeting session (see Figure 2).

This synchronous (real-time) collaboration function is currently implemented using Google maps as the base map, and authors are working on how to add project-related GIS data into the display. Another feature is to record the session history so it can be replayed at a later time, a feature very useful to later comers.

2) Collaborative Geo-conferencing Component

The virtual geo-conferencing with real-time map sharing is a supplement to the real meetings to give those who cannot physically attend the conference and/or seminars a chance to participate (Boulos et al. 2010; Haklay et al. 2008; Cammack 2007; Doyle et al. 1998). The idea is to stream real meetings online and provide facilitating tools to enable online users to question and interact, and to allow presenters to integrate their electronic presentations and maps (Google, Yahoo, etc.) into the virtual conferencing environment. Figure 3 shows a view of the virtual collaborative geo-conferencing interface.

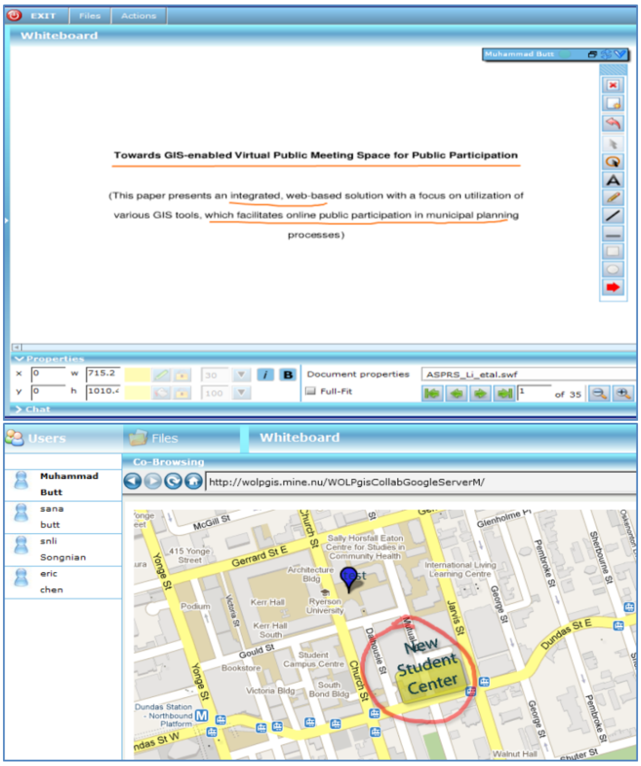

Figure 3: Virtual collaborative geo-conferencing interface with real meeting streams

By incorporating the collaborative map sharing components, the interface allows the presenters to share map displays in the same way as PowerPoint slides are shared on screens in many other web conferencing/groupware systems. The presenters can also use the built-in whiteboard tools to select features, add annotations, and draw graphics to improve debates among multi-users. However, during the virtual conferencing, only the presenters can initiate the tools and control how the map data should be displayed to facilitate their presentations.

Comparison between PCI Geo-Conference and CRMI Geo-Conferencing Component

Table 1 presents a comparison chart constructed using the PCI Geomatics geo-conference application and the developed RCMI geo-conferencing components' features. Both systems were designed to provide an innovative way to share maps, data and images with geographically spread participants in real-time that enhance the participatory approach in the planning and development related discussions. Intended use of these systems is to facilitate the GIS professionals, the decision authorities, the non-professionals and the public to increase participation and enhance decision making. Some of the features of the PCI geo-conference application are unknown, for instance, its support to open map APIs, i.e., Google, Yahoo, Bing, MapQuest for maps sharing as well as its support to documents such as PDF, Microsoft PowerPoint and Word for real-time file sharing. Another major difference is that CRMI geo-conferencing component is purely Web-based (needs Web browser to initiate the session), whereas PCI geo-conference is built around two main components: 1) the geo-conference client application, and 2) geo-conference server. The users access and participate in Internet mapping conference sessions via the geo-conference client which needs to be installed and configured (on the user's machine) in order to connect or participate during the participatory session.

Usability Study of the Prototype Components

Usability Evaluation of CRMI: A Plan of Implementing A Mock Case Study in Regional Municipality, Canada

Study Area: To validate or test the research prototype's usability, an existing urban expansion (future amendment) project in York Region, Canada, was selected as a case study. York regional municipality is covers 1,776 square kilometres from Lake Simcoe in the north to Steeles Avenue in the south. It borders Simcoe county and the Region of Peel in the west and the Durham Region in the east. York Region has nine municipalities: Georgina, East Gwillumbury, Newmarket, Aurora, Whitchurch Stouffville, Markham, Vaughan, Richmond Hill and King. The region is very diverse with quaint rural villages, bustling suburban communities and vibrant cosmopolitan urban areas. With a population over 1 million and with one of the nation's highest growth rates, the region is a rapidly growing and changing area. As a result of growing population in the region, issues related to urban planning have become increasingly important.

Selecting Sites in York Region: Based on the by-laws and like other municipalities and regions in Canada, York is required to hold meetings regarding forthcoming projects related tasks undertaken by York Regional council. Notices are posted on the region's website, as well as advertised in local municipality newspapers. The planning department of regional municipality of York has selected three potential sites for amendments in the town of East Gwillimbury, Markham and city of Vaughn in York Region. Notice of the first prehearing conference appeared in newspapers with general circulation in York Region on March 24, 2011. The planning department welcomes any participation with suggestions or recommendations from local residents and/or citizens regarding potential/pre-selected locations for future urban expansion or development.

Amendment 1 to the York Region Official Plan - Urban Expansion in the Town of East Gwillimbury: This amendment proposes to expand the urban area of the Town of East Gwillimbury to provide opportunities for urban growth to the year 2031. The lands subject to this amendment (was adopted by regional council on September 23, 2010) are shown in the key map (see Figure 4).[13]

[13] Source: http://www.york.ca/Departments/Planning+and+Development

Category\Product	CRMI	GeoConference
Map sharing		
Support Open Map APIs	◍ Support Google & Yahoo Maps	○ - unknown
Support MapServer/WMS/IMS	●	●
Open Source		
Require License to deploy	● - Open Source	○ Require License
Available Open Source Code	●	○
Web-based		
100% Browser-based	●	◍ - Need Client to be installed
CMS Integration	●	○ - unknown
Data sharing(PDF, PowerPoints)	●	○ - unknown
Screen Sharing	●	○ - unknown
Feedback		
Send News Letter	●	○ - unknown
Send Meeting Invitation	●	●
Review Capabilities		
Record Session	●	●
Audio/Video Conferencing		
Audio/Video Chat	●	○ - unknown
Meeting Manager		
Administration Meeting Room	●	●
Management of Users	●	●

Legends ● Supported ◍ Partially Supported ○ Not Supported/Unknown

Table 1: Comparison chart for PCI geo-conference and RCMI geo-conferencing component

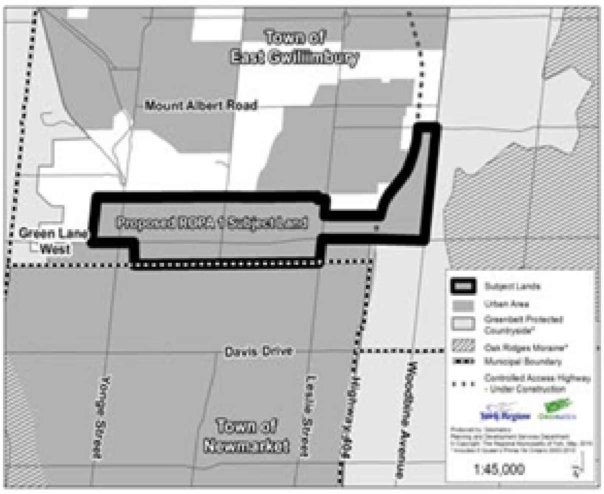

Figure 4: Urban Expansion in the Town of East Gwillimbury

Amendment 2 to the York Region Official Plan - Urban Expansion in the City of Vaughan: This amendment proposes to expand the urban area of the City of Vaughan to provide opportunities for urban growth to the year 2031. The lands subject to this amendment are shown in the key map (see Figure 5).[13] This amendment was adopted by regional council on September 23, 2010 and was subsequently appealed to the Ontario municipal board.

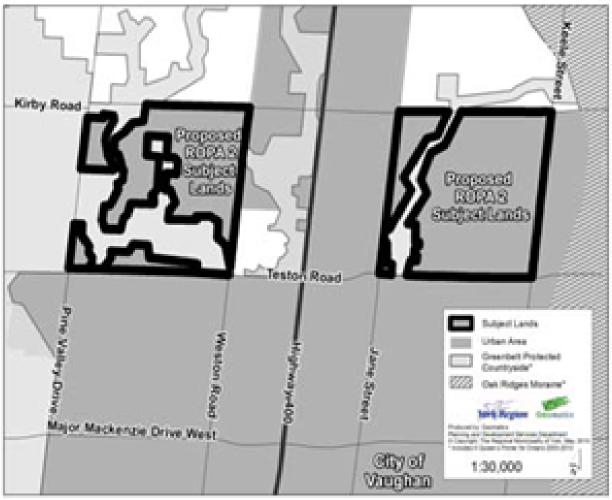

Figure 5: Urban Expansion in the City of Vaughan

Amendment 3 to the York Region Official Plan - Urban Expansion in the Town of Markham: This amendment proposes to expand the urban area of the Town of Markham to provide opportunities for urban growth to the year 2031. This amendment was adopted by regional council on September 23, 2010 and shown in the Figure 6.[13]

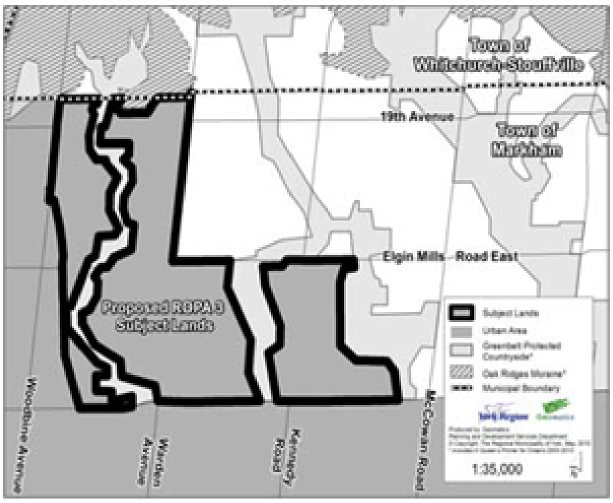

Figure 6: Urban Expansion in the Town of Markham

Evaluation of CRMI

The described context of the case study is used to evaluate and test a system prototype. The system is targeted for different participants or attendees involved during the planning and development related workflows to enhance public involvement. The following explains further the procedures/steps taken during the usability evaluation of the research prototype components as there is a prospective plan of implementing a mock case study (at above mentioned sites) using the urban expansion projects from the Region of York to validate the proposed approach.

Development of Evaluation Criteria

This section discusses the aspects, based on which the prototype is to be evaluated. These aspects mainly concentrates on: 1) intended users; 2) initial cost; 3) interactivity; 4) effective participation; 5) real-time communication; and 5) usefulness. The criteria for the evaluation of prototype implementation are somewhat similar to the ones adopted by different researchers, such as Chang (2010), Tang (2006), Zhao and Coleman (2006), Rinner (2006) and Ma (2006). Answering the questions in connection with the evaluation criteria can also indicate to what extent the (level of) successful implementation of the developed prototype is possible.

1) **Intended Users:** Does the prototype provide a virtual platform to facilitate the non-professionals and citizens for participation during the planning related discussions?
2) **Initial Cost:** The prototype was developed using open source software, open source components/modules and open source GIS technologies, therefore, the initial cost of the prototype development is almost absent. Does the prototype provide a cost effective solutions to smaller municipality regions?
3) **Interactivity/HCI:** Does the prototype provide user-friendly and interactive user-interfaces? How quickly can participants communicate with the consultants/mediators and receive a response back for their queries?
4) **Effective Participation:** As compared with the existing applications, Can the prototype fulfill participation (public involvement) needs in a more efficient manner? To what extent? Can the prototype fulfill participation needs for spatially related discussion during planning? Is the multi-way of participation possible among users as well as higher authorities? Do the proposed participation approaches automate the planning workflows and/or improve decision making significantly? To what extent?
5) **Real-time Collaboration/Communication:** To what extent are Web GIS-based Virtual Public Meeting Space collaboration components (i.e., collaborative map sharing and geo-conferencing) beneficial in facilitating the moderator to share his/her ideas, documents, mapping information, spatial data and decisions related to development among other participants or meeting attendees on a real-time basis?
6) **Usefulness/Connectivity:** Does the system allow participants to easily access additional information and documentation necessary to provide input to the project under consultation? Could this platform be useful for York Region's future amendments? What could be missed in prototype functional aspects in terms of user-friendliness? What could be improved in prototype functional aspects?

How to Evaluate

The evaluation is conducted in three parts: 1) a pre-questionnaire with queries about the user's background, computers expertise and GIS knowledge; 2) using analytical method with the help of Google Analytics tool; and 3) final questionnaire/CRMI polling component for collecting feedback concerning the usability of the system. The procedure is described in detail as follows:

1. The pre-questionnaire will contain some questions about the user's experience of other Web GIS applications, for in-

stance, questions about their GIS experience, finding store location/address, Web surfing experience and public participatory planning experience besides the questions about the user's background.

2. As mentioned above, the second part of the evaluation is the actual interaction with the system. In addition, to evaluate the usability of the prototype and assess the degree of public involvement in the online virtual public meeting session, meeting attendees' interaction and each move on the prototype interfaces will be recorded using Google Analytics. Google Analytics is an easy to use, free, and very handy usability testing tool that provides a comprehensive set of website data tracking and analysis tools. Usability researchers who want to understand user/participant behaviors can use these tools to gather a great amount of usage statistics and reports (Atterer et al. 2007; Aditya 2010). By using the Google Analytics, it is possible to collect highly detailed and useful data about the actual usage of the prototype and its components. Data includes user sessions, visits, page views, button clicks, audio and video capturing, and the user's screen (through a desktop-streaming tool) are automatically captured and/or recorded. These data elements are useful for evaluating the usability as well as measuring the degree of public input during the process of participatory planning and decision-making.
3. Finally, the users are asked to fill out a questionnaire at the end of the online participation virtual meeting session. Questions related to ease of use or interactivity of using Prototype interfaces will be included in this questionnaire.

Banati et al. (2006) states two approaches of prototype evaluation: (1) an inspection method usually performed by system developer, and (2) a user testing when actual users are involved to walk through the system's functionality. Therefore, the evaluation criteria 'outcomes' may not be measured precisely, until the system is deployed and evaluated with a real scenario/case related to any project (Bevan 1995; Lantz 1986; Carl et al. 2005) or by addressing the above questions during the system's usability evaluation that follows any IT-based testing standards (i.e., ISO or IEEE, etc.). In brief, the study goal, developing a GIS-based synchronous map sharing mechanism to involve the user during discussion, will only be achieved if the answers to the majority of the above questions (discussed in evaluation criteria) are favorable.

Evaluation results of this research are not presented in this paper as prototype's usability testing has not been fully accomplished up to this point. No doubt, the ongoing usability testing will more be focused on measuring the prototype's capacity to meet its intended purpose.

Related Discussion

This study introduces collaborative methods to encourage a synchronous approach that support users' involvement during planning and decision-making processes. Although some components of a prototype are designed and developed as a proof of the concept, which support real-time map sharing mechanism along with functionalities of groupware tools. There are still some key design and implementation issues, which need to be further studied and resolved in the next-step of the ongoing research, before its deployment into the real-world scenario testing (i.e., system usability and performance evaluation, etc.). Some of the implementation issues faced during the study and preliminary prototype development is discussed in the following paragraphs.

The authors also expect some sociological issues and forthcoming risks, which may occur after the system deployment, e.g., facing difficulties by the users (public, city staff, project proponent, etc.) for accepting and responding to the Web GIS, multimedia and groupware technologies in connection to traditional practice. These potential hindrances also led authors to use the modular/component-based design implementation (allow and support the incremental implementation of the developed methods), which may be helpful in acquainting users with the shift of new technologies. However, this issue might need further inspection at later stages of the study.

One of the organizational issues is to deal with the privacy of data, which was another concern during the design and development of the prototype. It necessitates the needs for protocols to be implemented that manage the privacy of project data in connection to its copyright protection law. Setting the rights and privileges of the users at the different levels of their interaction with the system may resolve this issue.

Another big issue is to be considered during the system development in terms of interface designs, interactivity, and quick system responsiveness. In addition, special consideration is taken while providing interactivity and user-friendly interfaces by following a common set of rules of HCI. We anticipate that with the implementation of HCI principles, such as strive for consistency using cascading style sheet for fonts and colors, informative feedback using Java-based dynamic effects of tooltips and error prevention using JavaScript-based popup messages, the system can provide more efficient, interactive and user-friendly interfaces to the end-users. The prototype is composed of different participation components, which require or involve some sort of GIS-based functional integration (some technical knowledge is required to better utilize the tools). Therefore, design of such interfaces by keeping in mind the expertise of the naive users or non-technical participant becomes a big challenge during development.

The prototype developed is an effort of technology integration from a technological perspective. Some (main) key design issues related to technologies used during the development of the prototype are described as follows:

As the mapping component was designed initially for the proof of the concept, GIS mapping functionality over the base layer (Google map) is limited, which needs to be enhanced by embracing more carefully-selected functions. Moreover, the real-time (synchronous) collaborative participation component is currently developed and implemented using Google maps as the base map, whereas, it should be able to use any open map APIs (Yahoo, Bing, MapQuest, OpenStreet, etc.) to implement synchronous participatory behaviors and/or function based on the presented architecture for sharing spatial data during discussion and/or debate. As discussed earlier, in the future authors are working on how to add project-related GIS data as a background layer into the display.

The collaborative real-time map sharing component was initially designed for enabling "spatial" virtual conferencing along with WebGIS support. This component was developed using Google map API, adobe flex, and flash collaboration service technologies. The Adobe Flex platform provides and builds real-time collaboration-enabled applications rapidly as it offers a complete software development kit, which contains ready-to-use components, designed with collaborative workflow. The issue at this moment is that flash collaboration services in the Adobe platform does not support screen or media sharing protocols (another design challenge, which is not considered during the initial development). The purpose of this function is to record the session history during the conference/seminars so it can be replayed and shared at a later time. However, the issue might need further inspection at later stages of the study.

The collaborative geo-conferencing component (having combined functionality of collaborative map and documents media sharing) was designed and developed using JAVA and Adobe Flex platforms. Integration between two platforms was a challenge in relation to their suitability, connectivity and scalability in the beginning of the development. For instance, Flex code requires a flash player to run or execute, whereas Java requires Java Virtual Machine (JVM) to execute the compiled code. Other problems common to all online application developments are the compatibility of different web browsers (i.e., Internet Explorer, Mozilla and Google Chrome, etc.) and Internet connection speed. The benefit of using a JAVA platform will resolve the issue related to screen and video sharing protocol of Adobe flash collaboration services. Therefore, the share/record screen module will be developed and added as a recording function along with a meeting planner component (useful to the city staff for scheduling public meeting reminders or auto-notification) using JAVA as a part of the virtual public meeting interface at later stages of the study and prototype development.

Finally, the usability evaluation and performance testing for measuring the functionality of the prototype during the case study (at York Region) will be an important future task of this research, which needs to be performed for evaluating important aspects: (1) to determine whether or not the designed framework will help in improving the public participation during the planning process by maximizing public substantial input; (2) to evaluate that to what extent the system will be usable and to fulfill participatory needs of the current practice; (3) to deduce how the public responds in adopting the GIT-based means of participation; (4) to assess the amount of training required for non-technical staff and/or participants to use the system's components efficiently; (5) to find out how the city staff, higher authorities, and project proponent handle the citizen's feedback in timely fashion for the quick and/or effective decision-making and determine how quickly the system responds to participant; and (6) to find out how citizens' access to information, communication channels, level of public participation, and the overall decision-making process may be impacted or influenced by adopting the prototype, in relation with traditional participatory approaches (Li et al. 2007). In addition, to get the proper feedback and have the answers to all above-mentioned questions it is necessary to implement the system in a real world scenario as a case study and/or pilot project for part of the study.

Conclusions

The study reported in this paper brings together OSGIS, groupware, other web-based information technologies, and open source mapping APIs-based solutions to design and develop real-time collaborative map sharing components, which rely on the data served through open map/data services with the option of integrating local data. Armstrong (1994), Craig (1998), Craig (2002) and Baker et al. (2005) state more collaboration among users involved during developing the plan, the more likely that the plan will appropriately address issues that are important to the bodies. The prototype aims at providing a web-based virtual conferencing environment that encourages multi-users to get involved.

CRMI map sharing and geo-conferencing components have been presented as a concept for enhancing public involvement and aids decision support in spatial planning related tasks. The effectiveness of such a system in supporting real-time collaboration, especially using a synchronous participatory approach that provides a virtual conferencing platform through which live meetings/seminars, spatial data and information can be accessed anywhere and anytime on a real-time basis. Furthermore, it gives users online access to their work, convenient Web-based mapping, and the ability to increase collaborative decision-making via real-time participatory functions, i.e., open API-based map sharing, screen sharing, seminar recording, video streaming, and easy project documents sharing (Bailey 2010).

The prototype framework is designed and implemented using OSS-based technologies to obtain a quality and to minimize a potential cost (i.e., dependence on vendors, a huge early investment and high licensing cost) required to implement the system, which provides the somehow cost effective solutions for the end-users (e.g., small municipalities) with limited or inadequate financial resources. On the contrary, there is a debate among some groups of people about the negative aspects (i.e., stability, scalability, maintenance and reliability, etc.) of the OSS technologies, which was well considered during its selection in the development of the prototype.

During the system development, special attention is given to the selection of enabling OSS technologies as it plays an important role for increasing throughput (quick response), scalability, and design/maintenance cost of the system. For example, the spatial data in the prototype is handled by using PostGIS, the spatial database extension of an open source PostgreSQL Object Relational Database Management System (ORDBMS) that supports broad scale-interoperability with spatial data handling in relation to other open sources ORDBMS (Sano et al. 2003; Wangmutitakul et al. 2003; Wangmutitakul et al. 2004; Wuttiwat et al. 2003). At this stage, due to the lack of availability of the spatial data related to the real projects, the prototype is not demonstrated and configured by using spatial database PostGIS.

The prototype offers user-friendly and self-explanatory functions (with the implementation of HCI rules) for interactive exploration of communication among participants using Web GIS-based virtual meeting participatory platform.

Future work on the prototype will concentrate on the integration of missing features described in the discussion section. The benefits of an integration of OSS-based modules and groupware technologies will be analyzed when the realistic usability testing and evaluation of the prototype (as a proof of concept) is set up or performed, as a mock spatial planning case study for the municipal region, Canada. As the prototype development is based on object-oriented procedures (reusability), further enhancement of the prototype is practicable.

Acknowledgement

This work reported in this paper was partially supported by the funding from the Canadian National Science and Engineering Research Council (NSERC).

References

1. Abdalla R, Li J (2010) Towards effective application of geospatial technologies for disaster management. International Journal of Applied Earth Observation and Geoinformation, 12: 405-407.
2. Aditya T (2010) Usability Issues in Applying Participatory Mapping for Neighborhood Infrastructure Planning. Transactions in GIS, 14: 119-147
3. Antunes P, Zurita G, Baloian N (2009) A model for designing geocollaborative artifacts and applications. Groupware: Design, Implementation, and Use, 278-294.
4. Armstrong MP (1994) Requirement for the development of GIS-based group decision support systems. Journal of the American society for information science 45:667-677
5. Al-Kodmany K (2002) Visualization tools and methods in community planning: From Freehand Sketches to Virtual Reality, Journal of Planning Literature 17 (2)
6. Atterer R., Schmidt A. and Wnuk M., 2007, "A Proxy-based Infrastructure for Web Application Sharing and Remote Collaboration on Web Pages", Proceedings of the 11th International Conference on Human-Computer Interaction, Rio de Janeiro, Brazil, September 2007, 74-87,
7. http://murx.medien.ifi.lmu.de/~albrecht/pdf /interact2007-usaproxy.pdf Accessed April 04, 2009
8. Baecker RM (1993) Reading in groupware and computer supported cooperative work: assisting human-human collaboration. San Fransisco, Morgan Kaufman
9. Bailey K, Grossardt T (2010) Toward Structured Public Involvement: Justice, Geography and Collaborative Geospatial/Geovisual Decision Support Systems. Annals of the Association of American Geographers, 100: 57-86
10. Banati H, Bedi P, Grover PS (2006) Evaluating Web usability from the user's perspective. Journal of Computer Science 2(4): 314-317
11. Baker WH, Addams HL, Davis B (2005) Critical factors for enhancing municipal public hearings. Public Administration Review 65 (4):490-499
12. Bevan N (1995) Measuring usability as quality of use. Software Quality Journal 4 (2):115-130
13. Brail RK, Klosterman RE (2001) Planning support systems: Integrating geographic information systems, models, and visualization tools. ESRI Press, Redlands, California
14. Boulos M, Warren J, Jianya G, Peng Y (2010) Web GIS in practice VIII: HTML5 and the canvas element for interactive online mapping. International Journal of Health Geographics, 9: 14-26
15. Boroushaki S, Malczewski J (2010) Measuring consensus for collaborative decision-making: A GIS-based approach. Computers, Environment and Urban Systems, 34: 322-332
16. Bryant L, Wilcox D (2006) Some lessons from Web 2.0 for participation and e-democracy. http://www.headshift.com/archives/002787.cfm. Accessed June 2006
17. Begole J, Struble CA, Shaffer C, Smith RB (1999) System resource sharing for synchronous collaboration. Technical Report TR-99-11, Computer Science, Virginia Tech. http://eprints.cs.vt.edu:8000/archive/00000524/01/BetEtAl99b.pdf. Accessed Oct 2011
18. Cammack R (2007) Cartographic Approaches to Web Mapping Services. Multimedia Cartography 1: 441-453
19. Carl C, Warwick I, Neville C (2005) A User Evaluation of Synchronous Collaborative Software Engineering Tools, Proceedings of the 12th Asia-Pacific Software Engineering Conference (APSEC'05)
20. Chang Z (2010) Synchronous Collaborative 3D GIS with Agent Support. PhD. Thesis, Ryerson University, Toronto, Canada
21. Chung G, Jeffay K, Abdel-Wahab H (1994) Dynamic participation in computer-based conferencing system. Journal of Computer Communications, 17(1): 7–16
22. Churcher N, Churcher C (1999) Realtime conferencing in GIS, Transactions in GIS, 1999, 3(1):23-30
23. Churcher N, Churcher C (1996) GroupARC – a collaborative approach to GIS, proceedings of 8th annual colloquium of the spatial information research center, University of Otago, New Zealand, July 9-11, 1996, pp. 156-163
24. Craig WJ, Elwood SA (1998) How and why community groups use maps and geographic information. Cartography and Geographic Information Systems 25 (2):95-104
25. Craig WJ, Harris TM, Weiner D (2002) Community participation and geographic information systems. London: Taylor and Francis
26. Dragicevic S, Balram S (2004) A Web GIS collaborative framework to structure and manage distributed planning processes. Journal of Geographical Systems, 6: 133-153
27. Dragicevic S (2004) The potential of Web-based GIS. Journal of Geographical Systems, 6: 79-81
28. Doyle S, Dodge M, Smith A (1998) The potential of Web-based mapping and virtual reality technologies for modelling urban environments. Computers, Environment and Urban Systems, 22:137-155
29. Edelenbos J (1999) Design and management of participatory public policy making. Public Management Review 1 (4):569-576
30. Evans A, Kingston R, Carver S, Turton I (1999) Web-based GIS used to enhance public democratic involvement. Geocomp'99 Conference Proceedings, Mary Washington College, Virginia, USA, July 27-28 1999
31. Fiedrich F, Burghardt P (2007) Agent-based systems for disaster management. Commun. ACM 50: 41-42
32. Haklay M, Singleton A, Parker C (2008) Web mapping 2.0: the Neogeography of the Geoweb. Geography Compass, 2:2011-2039.
33. Huang B, Jiang B, Lin H (2001) An integration of GIS, virtual reality and the Internet for visualization, wanalysis and exploration of spatial data. International Journal of Geographic Information Science 15(5): 439 - 4
34. Jankowski P, Nyerges T (2001) GIS supported collaborative decision making: Results of an experiment. Annals of the Association of American Geographers 91 (1):48-70
35. Jankowski P, Nyerges T (2003) Toward a framework for research on geographic information-supported participatory decision-making. URISA Journal 15 (1):9-17
36. Jankowski P, Nyerges T, Smith A, Moore TJ, Horvath E

(1997) Spatial group choice: a SDSS tool for collaborative spatial decision making, International Journal of Geographical Information Science, 11(6):577-602

37. Jones RM, Copas CV, Edmonds EA (1997) GIS support for distributed group-work in regional planning. International Journal of Geographical Information Science, 11(1):53-71
38. Klosterman RE (2001) Planning support systems, ESRI Press, Redlands, California, pp 1–23
39. Lantz K (1986) An Experiment in Integrated Multimedia Conferencing. In: Proceedings of the Conference on Computer-Supported Cooperative Work (CSCW '86). Austin, Texas: ACM Press. Reprinted in I. Greif (editor), Computer-Supported Cooperative Work: A Book of Readings, pp. 533-552, Morgan Kaufmann, 1988
40. Laurini R (1998) Groupware for urban planning: An introduction. Computers, Environment and Urban Systems 22 (4):317-333
41. Laurini R (2004) Computer systems for public participation. http://www.gisig.it/VPC_sommet/CD_Sommet/ws3/articololaurini.pdf. Accessed 10 January 2011
42. Lemos M (2006) PHP clases blog: Is PHP ready for Web 2.0? http://www.phpclasses.org/blog/post/53-Is-PHP-ready-for-Web-20.html. Accessed 31 May 2009
43. Li S, Chang Z, Yi R (2004) GIS-based internet noticeboard to facilitate public participation in municipal developments. Proceedings of the 20th ISPRS Congress, Istanbul, Turkey, July 12–23 2004
44. Li S, Guo X, Ma X, Chang Z (2007) Towards GIS-enabled virtual public meeting space for public participation. Photogrammetric Engineering and Remote Sensing 73 (6):641
45. Li S, Ma X (2006) An open source GIS solution for supporting public participation in municipal developments. Proceedings of the ISPRS Commission IV Symposium on Geospatial Databases for Sustainable Development, Goa, India, September 27–30 2006
46. Ma X (2006) A prototype of Web-based PPGIS for municipal planning using open source software. Master Thesis, Ryerson University, Toronto, Canada
47. MacEachren AM, Brewer I, Steiner E (2001) Geovisualization to mediate collaborative work: Tools to support different-place knowledge construction and decision-making. http://hero.geog.psu.edu/products/ICC16009amm.pdf. Accessed 5 June 2010
48. MacEachren AM (2000) Cartography and GIS: facilitating collaboration, progress in human geography 24(1): 445-456
49. Obermeyer NJ (1998) The evolution of public participation GIS. Cartography and Geographic Information Systems 25 (2):65-66
50. Pang A, Fernandez D (1995) REINAS instrumentation and visualization. Proceedings, OCEANS '95. MTS/IEEE. Challenges of our changing global environment, San Diego, Oct. 9-15, pp. 1892-1899
51. Roseman M, Greenberg S (1992) GroupKit: A groupware toolkit for building real-time conferencing applications. In [CSCW92], (1992) 43-50,
52. Rinner C (1999) Argumentation maps – GIS-based discussion support for online planning. Ph.D. dissertation, University of Bonn, Germany
53. Rinner C (2006) Mapping in collaborative spatial decision making. Collaborative Geographic Information Systems, Idea Group Publishing, Hershey, PA, pp 85-102
54. Sano J, Wanalertlak N, Maki A, Minoura T (2003) Benefits of web-based GIS/database applications. Proceedings of 2nd Annual Public Participation GIS Conference, Portland, Oregon, July 2003
55. Scientific A (1990) Special issue on communications, Computers and Networks 265(3)
56. Tang M (2006) Design and implementation of a GIS-enabled online discussion forum for participatory planning. M.Sc.E. thesis, Department of Geodesy and Geomatics Engineering Technical Report No. 244, University of New Brunswick, Fredericton, New Brunswick, Canada
57. Ventura S, Niemann B, Sutphin T, Chenoweth R (2002) GIS-enhanced land-use planning. In Community Participation and Geographic Information Systems. London: Taylor and Francis, pp113-124
58. Wang D, Xu K (2010) Red5 Flash server analysis and video call service implementation, Web Society (SWS), 2010 IEEE 2nd Symposium on 16-17 Aug. 2010
59. Wangmutitakul, Paphun, et al. (2004) WebGD: Framework for Web-based GIS/database applications, Journal of Object Technology 3(4): 209-225
60. Wangmutitakul P, Li L, Minoura T (2003) User participatory Web-based GIS/database application. Proceedings of Geotech Event Conference, Vancouver, British Columbia, March 16-19 2003
61. Wuttiwat T, Minoura T, Steiner J (2003) Using digital orthographic aerial images as user interfaces. Proc. of ASPRS Annual Conference, Anchorage, Alaska, May 2003
62. Zhao J, Coleman DJ (2006) GeoDF: Towards a SDI-based PPGIS application for e-governance. Proceedings of the GSDI 9 Conference, Santiago, Chile. http://www.gsdidocs.org/gsdiconf/GSDI-9/papers/TS9.3paper.pdf. Accessed 7 Dec 2010

Muhammad A Butt, Songnian Li
Dept of Civil Engineering
Ryerson University, Canada
m2butt@ryerson.ca, snli@ryerson.ca

and ready for the future. TRLIB was only recently released under an open source license (and made available through https://bitbucket.org/KMS/trlib), but in the near future we hope to implement means for better interoperability with the more well established libraries in the open source geomatics field.

Acknowledgements: We thank Willy Lehmann Weng and Knud Poder for commenting on the draft of this paper.

Bibliography

C. W. Clenshaw. A note on the summation of chebyshev series. *Math. Tables Aids Comput.*, 9(51):118–120, 1955. URL http://www.jstor.org/stable/2002068.

Karsten E. Engsager and Knud Poder. A highly accurate world wide algorithm for the transverse mercator mapping (almost). In *Proc. XXIII Intl. Cartographic Conf. (ICC2007), Moscow*, page 2.1.2, 2007.

Gerald I. Evenden. Cartographic projection procedures for the unix environment—a user's manual, 1990. US Geological Survey Open-File Report 90–284.

C. Gram, O. Hestvik, H. Isakson, P.T. Jacobsen, J. Jensen, P. Naur, B.S. Petersen, and B. Svejgaard. Gier - a danish computer of medium size. *IEEE Transactions on Electronic Computers*, EC-12(5):629–650, December 1963. URL http://www.datamuseum.dk/site_dk/rc/gierdoc/ieeeartikel.pdf.

Charles Karney. Transverse mercator with an accuracy of a few nanometers. *Journal of Geodesy*, 2011(1):1–11, 2011. doi: http://dx.doi.org/10.1007/s00190-011-0445-3.

R. König and K. H. Weise. *Mathematische Grundlagen der Höheren Geodäsie und Kartographie, Erster Band*. Springer, Berlin/Göttingen/Heidelberg, 1951.

Knud Poder and Karsten Engsager. Some conformal mappings and transformations for geodesy and topographic cartography, 1998. National Survey and Cadastre, Denmark, Publications, 4. series vol. 6.

Carl Christian Tscherning and Knud Poder. Some geodetic applications of clenshaw summation. *Bolletino di Geodesia e Scienze Affini*, XLI(4):349–375, 1982.

Thomas Knudsen
National Survey and Cadastre
kms.dk
thokn AT kms DOT dk

Imprint - Volume 10

Editor in Chief:
Tyler Mitchell, Locate Press - info@locatepress.com

Proceedings Editor:
Gary Sherman, GeoApt LLC - gsherman@geoapt.com

Acknowledgements
Gary Sherman, LaTeX magic & layout support
Various reviewers & writers

The *OSGeo Journal* is a publication of the *OSGeo Foundation*. The base of this journal, the LaTeX 2ε style source has been kindly provided by the GRASS and R News editorial boards.

Journal online: http://www.osgeo.org/journal

OSGeo Homepage: http://www.osgeo.org

Mail contact through OSGeo, PO Box 4844, Williams Lake, British Columbia, Canada, V2G 2V8

9 771994 189002 00

ISSN 1994-1897