Combining Mobile, Tangible and Virtual World Platforms to Support Participatory Campus Planning

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ISS '16, November 06-09, 2016, Niagara Falls, ON, Canada
ACM 978-1-4503-4248-3/16/11.
http://dx.doi.org/10.1145/2992154.2996775

Abstract
Urban planning, and campus planning in particular, can benefit greatly from technology that fosters and leverages collaborative, participatory planning which includes all affected stakeholders. Interactive surfaces such as tabletops and walls, and spaces such as 3D environments are examples of such technologies. Our research aims to explore and assess the appropriateness and effectiveness of such technologies in participatory campus planning. We present here a prototype system that combines the tangible and multi-touch surfaces with a virtual world platform to provide a participatory planning approach for campus development projects.

Author Keywords
Participatory urban planning; interactive tabletops; virtual environments; tangible interaction; multitouch interaction; mobile technologies.

ACM Classification Keywords
H.5.2 [Information Interfaces and Presentation]: User Interfaces—*Input devices and strategies*, *interaction styles*; H.5.3 [Information Interfaces and Presentation]: Group and Organization Interfaces—*Collaborative computing*.

Introduction

Our research explores participatory urban planning with 3D and tangible media. We present a prototype system that uses an interactive tabletop with tangible and multitouch interaction in combination with a virtual world platform to create a more complete participatory planning approach for campus development projects, using Ryerson University in Toronto, Canada, as a first practical example.

Universities in densely populated urban areas often face severe spatial problems in their expansion and evolving processes. Ryerson University, an urban metropolitan university is also facing challenges and thus is exploring means of expanding its physical capacity, while at once constrained by geography. Its physical location in the busy downtown Toronto core creates considerable challenges in meeting the needs of its users, both in optimizing navigation throughout the whole of the campus and in adding sufficient physical space to account for classroom, lab space, and residential requirements for a university of its size. Thus, space is a particular challenge for Ryerson: specifically, the inability to grow "out" as it is courted on four sides by dense urban development. As a result, Ryerson is looking into ways that space can be added— by growing vertically, creating spaces that serve a number of purposes, and placing people first.

In expanding and growing Ryerson's campus, participatory planning will be imperative. Participatory planning follows the idea to let relevant stakeholders—from business owners, city planners, to residents—participate in the planning and shaping of urban environments. Successful collaborative planning promotes trust-building and educative endeavours, employs unbiased and inclusive processes, and uses methods that empower local citizens and facilitate growth [7].

This research project develops a participatory approach for the future planning of Ryerson's campus and its social ecology. The project merges mobile computing and social media, 3D virtual environments, and tangible, tabletop interaction technologies. The central question driving our research is: how can we leverage mobile, virtual and tangible media technologies to motivate community participation in campus planning?

We aim to make a difference in two ways: firstly, by using a holistic social ecology approach that includes communication, safety, health and ecological aspects; secondly, applying a synergetic model that combines novel tools and interaction techniques for community urban planning consisting of mobile and media, tangible and tabletop interactions, and virtual worlds.

Related Work

This literature review provides an overview of the methods that have contributed to our prototype: traditional participatory planning, virtual worlds, interactive tabletops and mobile participation.

Traditional Participatory Planning Methods

Traditional methods of participatory planning have been challenging for planners as they require the physical presence of participants [4] and dominant voices often control the conversation [6]. As a result of these difficulties, neighbourhood groups have traditionally been inactive in planning processes [1]. The emergence and establishment of mobile phones, improved GIS data, and integration of virtual environments and interactive tabletops have challenged the shortcomings of traditional methods [4].

Virtual Worlds
Virtual world platforms developed by massively multiplayer online games (MMOGs) such as Second Life, allow users to both participate in, and visualize an environment. These virtual three-dimensional (3D) public spaces promote a new form of civic engagement. Unlike traditional workshops that require the physical presence of participants, virtual world platforms allow participants to take part in workshops remotely [3]. They permit anyone with access to the internet to log-in and join other participants in virtual environments that may be models of their communities.

For example, researchers at Tufts University in Acton, Massachusetts used Second Life to increase public understanding of their plan [3]. This "Master Planning" involved the use of Second Life to develop computer visualizations of various locations. Similarly, researchers at McMaster University in Hamilton, Ontario, are using macGRID— a 3D simulation research platform that uses avatar virtual worlds and mixed reality systems— to encourage community participation in the planning and re-design of Hamilton [8]. This platform is used for a number of purposes, such as demonstrating proposed developments.

Virtual world platforms are beneficial for a number of reasons. Because they are constructed in three dimensions, they allow average residents to comprehend and engage with virtual worlds and their constructed environments— something that in the past could only be done with physical models of cities and 3D perspective drawings [3]. Virtual world platforms are particularly attractive to a young demographic of technologically savvy individuals who enjoy gaming platforms. As a result, these platforms become useful for engaging students, many of whom make up the Ryerson community.

Interactive Tabletops
Interactive tabletops offer a new mode that allows planners to explore design ideas and implement complicated projects, while also including the community in the planning process. Recently, there has been a shift in urban planning to the implementation of interactive and tangible interfaces [9]. These interfaces are beneficial in a number of ways. They facilitate active and interactive participation by allowing participants to express their suggestions and better understand the implications of different housing types and other infrastructure. They also act as a mediator by allowing participants to discuss planning by placing objects, modifying and commenting, rather than in a confrontational face-to-face manner.

For example, a participatory workshop involving an urban planning project of the Caserne Bossut in the city of Pontoise used an interactive tabletop to facilitate discussion surrounding new construction that was replacing 90% of the existing buildings [9]. By placing objects such as roads to decide on future locations and by using a sketching tool, participants used the interactive tabletop to illustrate their ideas and develop their own vision of their community. Another example was the Augmented Urban Planning Workbench, which integrated 2D drawings, 3D physical models, and digital simulation into a single tabletop information space in order to support the urban design process [5]. The system was used in an urban design class at MIT's

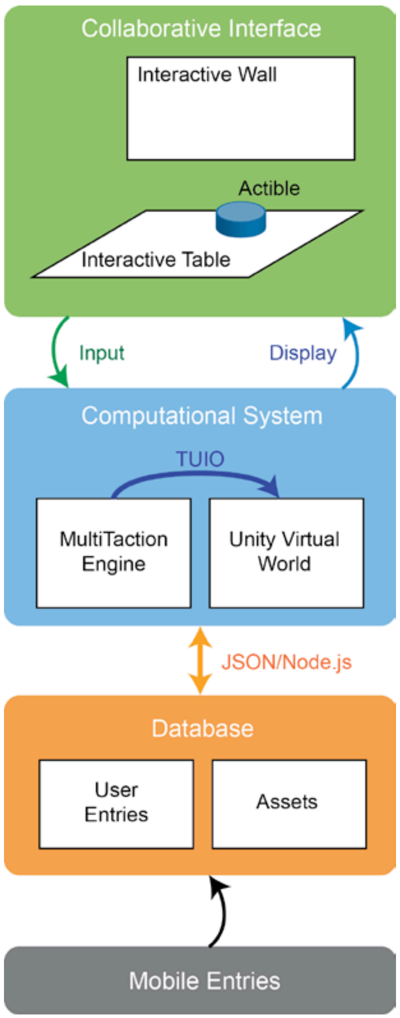

Figure 1: Diagram showing the setup of the prototype system.

School of Architecture and Planning. Although the planning process in this case did not involve community members, student designers found that the layering of physical and digital representations supported the creation of more informed designs.

Mobile Participation

Mobile participation has included the integration of web-based participation into mobile phones, which further aims to use mobile devices to broaden citizen participation through the connection to other users and offers the ability to generate and share information [4]. This method demonstrates sufficient promise, largely due to the wide proliferation of smartphones and ownership across social groups, thus increasing the chance that participants from a wide range of demographics have the opportunity to participate equally in the planning process. Mobile apps are also far cheaper to develop than computer programs. Their various functions allow participants to simply walk around a neighbourhood, take pictures, and record comments without having to worry about the technological details of the app [6]. Crowdsourcing, then, of proposed urban or campus changes and improvements, may be highly conducive in the university environment, as it is expected that the user groups have a correspondingly higher rate of cellphone ownership and therefore ability to participate.

Mobile apps are easily appropriated by certain groups because they require little training [6]. This allows citizens with little spatial and planning background to get involved. Rather than relying on the physical presence of participants at traditional meetings, mobile apps also allow more freedom on the part of the user by allowing them to participate remotely. Therefore, mobile participation represents a major advancement, largely because it gives individuals the chance to discuss locations while physically there and saves time and money by not needing a professional facilitator [6].

While each of these methods offers sufficient promise, they also have certain limitations. For example, using technologies for participatory planning can result in quantitative data that over simplifies findings and loses the detailed and insightful opinions of community members [2]. Our work aims to overcome these limitations and support the campus planning process through a combination of methods, integrating mobile data collection with collaborative interaction through interactive tabletops and virtual worlds — allowing for both quantitative and qualitative data to be collected.

Participatory Campus Planning System

Our prototype system combines mobile participation to collect feedback on a university campus, with a 3D virtual environment displayed on an interactive tabletop and wall displays to allow community members to collaboratively re-design the campus space (see Fig. 1).

Community members first use a web-based form on their mobile devices to submit their comments about the campus, relating to categories such as safety, accessibility, green space, etc. For each comment, they must provide a brief description of the problem they wish to address. These comments can be entered as users navigate the campus space, with the location determined using GPS and geolocation, and are then stored in a database and visualized within the 3D virtual environment. For example, a student walking home late at night might enter the comment "This corner is too dark. I don't feel safe." and flag it as a

Figure 2: Users interacting with the interactive tabletop and wall display. The tabletop shows a map view, while the wall display shows a perspective view of the urban space.

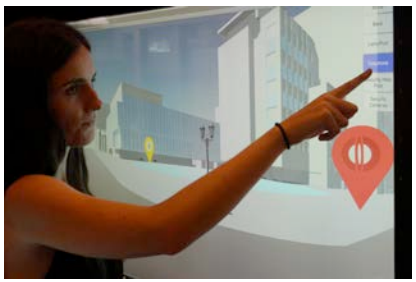

Figure 3: A user interacting with the wall display. The flags in the virtual space show comments and suggestions

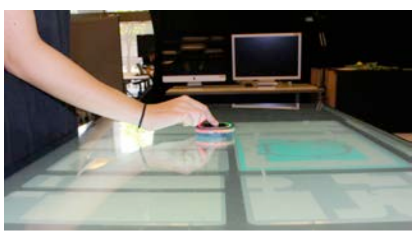

Figure 4: An actible being used by a user on the tabletop surface.

safety concern. Their comment then appears as a small red flag within the virtual environment at the location where it was set. The flags in the virtual environment are colour-coded based on the category (e.g., red for safety, green for green space, etc.). In future, the mobile application will present a top-down map view of the campus with the user's location indicated by a marker. A menu will be available for users to flag areas that require attention and submit suggestions for changes. Users will also be able to submit pictures along with their comments.

Community members can then interact with the system through the tabletop and wall display setup (see Fig. 2). The tabletop surface shows a top-down map view of the urban space being re-designed, while the wall display shows a 3D perspective view of the same space (see Fig. 3). The flags showing community members' comments can be seen in both views. Users interact with the system through multi-touch interactions on the tabletop and wall displays, as well as through the manipulation of tangible objects on the tabletop. Two kinds of tangible objects are used for the tabletop interaction: a passive tangible object shaped like a camera controls the view shown on the vertical display, while a set of active tangible objects (called Actibles) are used to select and place assets in the virtual environment (see Fig. 4). The Actibles provide a small integrated display and can be used both on and off the tabletop surface. Users first browse a menu of virtual assets (e.g., lamp posts, benches, trees, etc.) on the Actible, make a selection, and then place the Actible on the table to position the asset within the virtual environment. The Actibles allow flexible binding of tangible objects to many different assets. This helps to avoid the need for large numbers of dedicated asset tangibles, while also minimizing the tabletop screen real estate used for asset selection. Multitouch interactions on the tabletop and wall displays are also used to select and edit the virtual assets, e.g. to scale items or fine-tune their positioning.

The prototype system makes use of MultiTaction Ultra-Thin Bezel Cells (MT553UTB) for the tabletop and wall displays, which are able to interpret touch and fiducial marker input (MultiTaction Codice markers). The Actibles are hand-held devices that employ LG G smartwatches as their core, contained within a 3D printed custom case that includes additional hardware to support interactions such as stacking, rotating, shaking, and bumping. The virtual environment is implemented using the Unity 3D game engine and all Unity related events are coded using C#. Both the table and wall show the same instance of the Unity environment by using two separate in-game cameras that capture the scene from different angles. Touch and fiducial input data is interpreted using a Unity Asset called TouchScript. Communication of data between the Actibles and the Unity instance is done through a JavaScript node server using Socket.IO data. A Unity asset called Socket.IO for Unity was used to convert the JSON package data from the socket server into data that is compliable with the Unity engine.

Future Work

The prototype system will be first presented at an open-house event at Ryerson University in October 2016. This venue will be used to recruit participants from various parts of the Ryerson community (e.g., students, faculty, staff) for a focus group study on the prototype. Our aim is to gain insights about the system design and to gauge its usefulness and applicability to the continuous re-design of Ryerson's campus environment. We have scheduled three focus group sessions of about 12 to 15 participants each. During each session, the prototype will be introduced and participants will be invited to use it. During and after the interaction, participants will be asked to discuss their thoughts and opinions about the prototype and provide feedback to researchers.

Conclusion

With our approach we aim to assist Ryerson university planners in integrating a participatory campus planning approach that involves all stakeholders in the process. By making use of a holistic participatory planning design process, we hope to allow users to not only discuss their visions, but also execute them. We also hope this system will reach more people, attracting students and other stakeholders who otherwise may not have been involved in planning. More generally, we believe this approach has the potential to help urban and campus planning by developing a process that combines the advantages of each method, while accounting for their challenges. In doing so, we aim to provide an approach for planners to follow when attempting to integrate a diverse range of participants into planning.

Acknowledgements

This project has been supported in part by the Ryerson Faculty of Communication Design's Creative Innovation Fund, the Social Sciences and Humanities Research Council, the Canada Foundation for Innovation, and the Ontario Ministry for Research and Innovation.

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