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THE DESIGN AND EVALUATION OF AN INTERACTIVE “SOAPBOX” PLATFORM FOR CIVIC ENGAGEMENT

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ABSTRACT

This thesis presents an interactive Soapbox platform, which utilizes the networked public displays to encourage local citizens to participate in civic engagement. The Soapbox is comprised of three subsystems: Soapbox for speaker, Soapbox for audience and Shoutbox. Soapbox for speaker allows people to deliver a speech to the public. It also receives and displays the feedback sent by the audience. Soapbox for audience enables users to watch a speech and give feedback to it, such as thumbs-up, thumbs-down and report. The feedback will be synchronously sent to all connected public displays. Shoutbox is seen as an input tool that runs on personal devices, to edit comments and share them on the public displays. With Shoutbox, the local citizens can express their opinions and exchange ideas with the speaker and other audiences. In addition, the audience can also give thumbs-up or thumbs-down through Shoutbox.

The Soapbox platform was evaluated in both the lab and the field. In the lab study, twelve participants were recruited to implement the prepared tasks and evaluate the system by filling a questionnaire generated by AttrakDiff. Apart from that, we conducted a short interview about their feeling of using the system. In the field trials, we deployed four public displays at the campus of the University of Oulu for seven weekdays, during which we conducted 28h observations and interviewed 21 participants (seven speakers, fourteen audience members). The respondents were also asked to evaluate the system through a semi-structured questionnaire. In total, 23 speakers tried and experienced the system, and 39 audience members joined Shoutbox and sent 92 comments.

We studied users’ behaviors when they interacted with the Soapbox platform. The evaluation shows that the users are curious and positive about trying Soapbox platform, and they can quickly grasp how to use it. The honey pot effect made a significant difference in increasing the number of speakers and audiences participating in civic engagement. The questionnaire results show that the Soapbox platform is perceived as a simple, practical, straightforward, predictable, stylish, attractive, inviting, appealing and motivating system. The chi-square test shows that during a speech, females tend to give more encouraging comments to speakers than males. We argue that the Soapbox’s design as a practical and stylish tool is very appropriate for its purpose, and believe that the interactive Soapbox platform can effectively attract more citizens to participate in the civic engagement.

Keywords: Urban computing, ubiquitous computing, public displays, civic engagement, in-the-wild research, lab study, user interface design
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FOREWORD

This thesis was carried out at the Center for Ubiquitous Computing, Department of Computer Science and Engineering, University of Oulu, Finland. It was started in June 2015 and finalized in August 2016.

First, I would like to thank my supervisor, Dr. Hannu Kukka for providing inspiring and valuable guidance for the work throughout the whole thesis process, and I really appreciate it. I also would like to thank my second supervisor, Dr. Marko Jurmu for technical support. Besides, I would like to thank Jilin Yang for his effort in the middleware part. In addition, I would like to thank Dr. Jorge Goncalves for his advice on improving the design. I am grateful to the research group for providing the testing hardware and environment.

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Oulu, 22.08.2016

Kai Wang
### ABBREVIATIONS

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<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>SNS</td>
<td>Social Network Sites, websites where people can publish contents and communicate with others</td>
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<tr>
<td>TMCE</td>
<td>Technology-Mediated Civic Engagement</td>
</tr>
<tr>
<td>SCSD</td>
<td>Smart Citizen Sentiment Dashboard, a device that helps citizens to convey their mood about the urban life</td>
</tr>
<tr>
<td>HCI</td>
<td>Human-Computer Interactions, the field of studying how users interact with computers</td>
</tr>
<tr>
<td>HD</td>
<td>High-definition, a kind of video form that have higher resolution and better quality than standard-definition</td>
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<tr>
<td>QR code</td>
<td>Quick Response code, a label that contains some readable data</td>
</tr>
<tr>
<td>MoSCoW</td>
<td>A prioritization method, M = “Must Haves”, without which the project cannot performance normally; S = “Should Haves”, the success of the study does not rely on them, but we can get the maximum benefit; C = “Could Haves”, which can be easily left out without affecting the study; W = “Won't Haves”, which are not necessary in the project</td>
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<tr>
<td>UX</td>
<td>User Experience</td>
</tr>
<tr>
<td>HTML</td>
<td>Hyper Text Markup Language, which is used for describing web documents</td>
</tr>
<tr>
<td>CSS</td>
<td>Cascading Style Sheets, a language that makes web documents stylish</td>
</tr>
<tr>
<td>API</td>
<td>Application program interface, a set of protocols, rules and tools built for software applications</td>
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<tr>
<td>ACK</td>
<td>Acknowledgement, a positive message from the receiving host with transmission control protocol</td>
</tr>
<tr>
<td>TCP</td>
<td>Transmission Control Protocol, a kind of reliable internet protocol</td>
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1. INTRODUCTION

In this thesis, a creative solution to civic engagement in public space is presented. This solution comes from citizen journalism and new urban technologies, which allow citizens to express their opinions freely to the public space and attract more people to participate in the civic engagement. With the interactive platform, people can deliver a speech that will be shown synchronously on the linked public displays. For example, if one user utilizes the platform to make a speech at the campus of the University of Oulu, people who stand near the public displays in other locations, like Oulu library, the city center of Oulu and shopping mall, will be able to hear and watch the speech. In addition, a virtual 3D service will be provided to users to experience the entertainment of virtual world. The combination of physical world and virtual 3D Oulu [13] form the final hybrid dual-reality platform called “Soapbox”. This thesis will focus on the design and evaluation of the physical part of the whole system.

1.1. Motivation

New types of urban computing technologies have been utilized in modern urban landscapes. For example, public displays are increasingly being deployed in public area to provide computing platforms for communities and public social activities [1]. Nowadays, these public displays are equipped with high-speed wireless networks and various types of sensors, which help to build the bridge between physical and virtual worlds, and have the potential to change people’s behavior in urban spaces. In the city of Oulu, there exist several public interactive displays, which are called UBI-hotspots (Figure 1). These hotspots can be used for urban computing studies with Oulu citizens in a sufficient scale since they are typically placed in locations like the city center, libraries, or streets with heavy traffic. Deploying these UBI-hotspots makes it possible to provide researchers and developers with versatile computing platforms, and to establish an interactive system with informative and useful services, such as news, maps and games, which bring lots of benefits and convenience to local citizens [1].

Figure 1. UBI-hotspots in Oulu.
While plenty of people focus on applications for a single screen, some new applications started to make full use of a network of public displays [2, 3]. The researchers use public displays as directional signs to provide navigation services to local users, thus helping them to find right directions, especially in emergency evacuation, like responding to a terrorist incident. This kind of service takes advantage of the networked public displays instead of a single display and it can be called network effect [6], which is the result of connecting public displays in different locations. Taking this one-step further, this property of public displays can help people make more connections since human beings have biological requirements for communicating with others [4]. Apart from the connections with other people, social networks that develop in different communities have many other important functions, such as emotional support, job searching, information about current affairs and political debate. Today, people are closely connected in cyberspace via new digital media [5, 6], so it is crucial to make social impact on spaces with open displays.

With the growth in the Internet and new computing technologies, a new communication platform is changing people’s social life. Although the popularity of social network sites (SNS) is growing fast, some researchers are faced a new problem: Do these web applications contribute to the society by giving users chances to become informed and participate in the public activities more often, or are they able to distract people from civic engagement in case of social unrest? Reliable evidence shows that SNS can have a positive effect on civic engagement [7]. In the presidential election of U.S. in 2008, the Obama campaign utilized the online network site (my.barackobama.com) to recruit volunteers from the whole country to support his campaign. In the same year, over 20,000 Facebook users from Canada created a group to fight against a government policy about bill payments [19]. It seems that the way people use the new digital media can make a difference, as argued in [7]: “it is the particular ways in which individuals use media instead of the media itself that can affect individuals' social life and engagement”. According to the survey in [8, 9], 70% of young age adults (18-25 years old) think that the Internet is the most useful platform where they can search political information, for example public affairs and political news. With the continuous growth in both the availability of public displays and the use of free Internet (Wi-Fi), it is natural for researchers to explore whether the new kind of communication platform can offer opportunities for encouraging local citizens who are familiar with the new technologies to take part in civic engagement.

Citizen journalism is a significant concept that makes it possible for ordinary citizens to express their opinions about the reality and tell the story on their own side. Usually, with the help of the new media tools, ordinary citizens are easily able to upload text, images or videos to the Internet in order to report some events on the ground. It is well known that “Arab Spring” [10] has aroused people’s interest in citizen journalism. New media technologies gave citizens the opportunity to express themselves in a political way, inform other citizens of corruption of the government, organize protests and fight against injustice, and make their voices heard by citizens in the whole country. Therefore, we can say that these new digital media technologies can motivate citizen journalism. Thinking further about these technologies, three important additional factors have to be considered. First, it is important for us to think about both how public displays are being currently used and how they can be used in novel and interesting ways. Second, new ways of
engagement generated by new technologies are so apparently different from traditional ones that some citizens may resist them. Finally, there exist some potential negative impacts, like information overload, unsuitable public topics and the devaluing of participation, which might arouse controversy.

From the development of citizen journalism and new digital media, many researchers have claimed that the new technologies enable free speech, social participation and political activities in ways that did not happen before [11]. However, more and more researchers have become interested in applying citizen journalism tools to the offline world, which means that we should build installations and situated technologies that enable citizens to make their voices heard. These new urban technologies make it possible to facilitate new forms of technology-mediated social participation in real augmented public space.

When bringing these installations and technologies to the offline world, one major challenge for the deployment of public displays in this setting is that how to design friendly and effective interactions with the new forms of platform. Live is the best method for people to interact with others in real time since speakers can let other viewers hear their mind and in turn check out how people react to their broadcast [12]. With the development of high speed Internet, more and more people start to watch video via media tools. Facebook Live is a popular platform that allows users to start a live video and create innovative ways to interact with other users (called viewers on Facebook). In order to enable effective communication, therefore, we apply live property to the new interactive platform, thus finally bringing civic engagement into a technologically mediated stage.

1.2. Scope and Objectives

New media plays an important role in civic engagement through three intertwined ways, including promoting cyber activism that resulted in street activism, encouraging different kinds of political expression such as the mobilization of protests, and providing platforms for citizen journalism so that people can express themselves freely. Social media has helped create more opportunities for civic engagement. For example, users can find others who hold the similar political opinions with them on Facebook or other social websites. According to the literature [14, 15], many artists and researchers around the world have started to envision new urban media architecture situated in outdoors, applying urban technologies to interactive systems that provide public platforms to support new forms of technology-mediated civic engagement (TMCE). A good example of such deployments is presented in [16], which describes the installation of Smart Citizen Sentiment Dashboard in the streets to enable citizens to express their mood. Further, studies presented in [17, 18, 19, 20] describe how to design technology-mediated human-computer interactions (HCI) and set up spatial configuration in urban space.

The scale of public displays will significantly affect how citizens interact with them because people who pass by the displays will be influenced by the surroundings of the displays and large-scale media facades. For example, people might feel embarrassed when strangers see them interacting with a large display. Urban computing contains a wide range of disciplines, including computer science, psychology, urban planning and sociology. Therefore, when we design the Soapbox for public space, we should consider both the public urban setting and citizens’ privacy. Furthermore, with the increase of mobile and smart devices, the
collaboration between personal devices and public displays becomes important in supporting urban systems.

The long-term goal of the Hybrid Dual-Reality [24] Soapbox project is to continue the research in civic engagement with current media technologies. In this thesis, the system will be evaluated on a campus testing. In future, this goal will be reached by introducing a disruptive installation into central locations in the city of Oulu in Finland, and by providing a free and accessible platform for local citizens to make their voice heard as they see fit. In this way, we can see the Soapbox as an Urban Probe, which is a lightweight and inspirational approach for the research in urban computing [21]. It is important for us to understand how people interact with the Soapbox platform in this study; therefore, we will focus on the following two research questions:

RQ1: How are speakers and audiences experiencing and interacting with Soapbox platform in public space?

RQ2: Can the Soapbox platform promote civic engagement?

The installation of the physical Soapbox is shaped as a typical square box, on which people can stand and make a speech in public space. The idea of the construction originated in the real Speaker’s Corner in a park of London [22], where many famous individuals, including George Orwell and Karl Marx, as well as other citizens, would deliver a speech to the audience and make their voice heard. A study [23] shows that audience members who attend the speech in Hyde Park are active negotiators that may argue with the speaker and other audience members about some issues, instead of passive receivers who would only hear the speech. It is apparent that the speaker’s corner can effectively promote citizens’ participation in civic engagement in the public sphere.

The main objective of this thesis is to develop an interactive platform for civic engagement. Technically, the Soapbox mainly consists of three parts: a smart board that can detect pressure, a HD camera that can record video and voice, and a public display for providing speakers with an interactive platform on which they can submit their speech information and deliver a live speech to the audience in real time. When a person stands on smart board, the Soapbox will recognize him/her and trigger the interactive system. After submitting the speech information (speech topic and speaker’s name) to the server, a speech will be delivered synchronously to a network of the large digital display surfaces called UBI-hotspots, situated in the city center of Oulu. The communication technology gives speakers an opportunity to broadcast their thought to dislocated audience through new digital mediation, which means that the speech can be delivered to a city-scale audience. In addition, the audience can scan a QR code embedded in the UBI-hotspots to send their comments or questions to a speaker through the Soapbox system.

A unique feature of the Soapbox is that it merges the physical world and the Virtual 3D Oulu. For example, people who physically stand around the public displays in the city center of Oulu can listen and watch the speech delivered from the virtual world. The dual reality system provides a speaker a much wider audience, as people within the virtual model can watch the speech and communicate with the speaker who is physically using the Soapbox. This approach enables people in the virtual world to build their own avatar with a unique appearance and take it to the Soapbox, and have it broadcasted to both the physical and virtual space. To the best
of our knowledge, the platform will be the first true dual implementation of a public speaker’s corner.

The thesis will make many contributions. First, it offers an interactive platform for citizens to deliver a speech in public space. This enables more citizens to participate in civic engagement. Second, the combination of physical and virtual worlds is the first concept that is introduced into the public speaker’s corner, which will provide pioneer experience for later related studies. Third, the thesis presents the design and implementation for a web application architecture on public displays. This architecture is a creative solution to the communication between all linked public displays. No matter how far several displays are located away from each other, they can exchange text, video and audio information with low latency. Lastly, we learnt some lessons from in-the-wild deployments of the project, which will convey some useful tips for later studies.

1.3. Structure

The structure of the following thesis is organized as follows: Chapter 2 describes the related work about technology-mediated civic engagement, beginning with the general theory of civic engagement. Chapter 3 focuses on the architecture and design of Soapbox. Chapter 4 explains the evaluation process of the study, including lab study and field trials. Chapter 5 presents the results and findings of the study, with a focus on the log data, observations, interviews and questionnaire data. Chapter 6 focuses on the discussion. It covers the achievement and the lessons that we learnt from the field. Finally, Chapter 7 presents the conclusions.
2. TECHNOLOGY-MEDIATED CIVIC ENGAGEMENT

This chapter surveys previous work done in the field of public displays and civic engagement. The first section introduces the background of civic engagement. After this, some good examples of collaborations between public displays and personal devices are presented. In the third section, some notable projects and studies from the field are presented. The last section concludes with the comparative analysis of the listed projects and technologies used in the Soapbox project.

2.1. Civic Engagement

When talking about civic engagement, there exists a question: why do people participate in civic life? One of the reasons is that different people have different reasons to get involved in social activities that they are interested in. It is difficult to predict the form of social participation even if we know a handful of variables [25]. The other critical reason is that the forms of participation are so various and what performs well in one place often does not work in another. Civic engagement is a public activity that can make a difference in our life or even change the world [26]. To explain the concept better, we present more details about civic engagement in this section. First, we focus on the traditional forms of civic engagement and some famous public speeches are presented as well. Second, we talk about how to use the new digital technologies to promote civic engagement.

2.1.1. Traditional forms

There are many different forms of civic engagement. For example, people can participate in it as individuals, or join an organizational involvement [27]. The individual volunteerism is very helpful when some community members and students work together. Organizational involvement usually aims at supporting an existing organization such as the labor union and protecting the rights of the workers. Civic engagement can directly support solutions to an issue, or work with some organizations to express different opinions. Civic engagement can be divided into three categories: electoral, civic and political voice [28]. For example, electoral participation is a normal democratic activity in many countries, with the goal of electing a leader for the state or nation [29]. Civic engagement can also be organized in a creative way. For example, public issues can be rendered through an artistic lens [28].

However, the most famous and powerful civic engagement is participating in a public speech. In 1913, Emmeline Pankhurst gave a speech “Freedom or Death”, which was seen as a strong and significant statement of promoting women’s suffrage. In 1942, Mahatma Gandhi made a speech “Quit India” in order to force Britain to set them free. In 1963, Martin Luther King delivered his famous speech “I have a dream” aiming at resisting racial discrimination and calling for a real democracy, which promotes national debate and discussion on the racial problem. Therefore, we can infer that a great speech can not only increase our awareness of public issues, but also change the policy of the country and finally change the whole country.
2.1.2. New technology and civics

Some investigations show that young people today are less and less involved in any forms of civic engagement [30]. One of the important reasons is that many young people have no chance to experience civic life when they are at younger age, which results in their lost interest in the later civic engagement. For a country, it is crucial to get young people to participate in civic engagement but it is difficult as well. Therefore, we need to find some new ways to arouse their interests. Video games are very popular among teens; therefore, it is significant to study how to make the games have social impact. In the study of [30], they surveyed civic gaming experiences among teens and tried to find whether these experiences would also promote civic engagement in real life. Results show that new media can more or less affect teens’ awareness of civics, but it is in an indirect way.

Some scientists are considering how to encourage citizens to participate in civic engagement to resolve the social conflicts [36]. It is important to provide validated guidance to the citizens via social media because plenty of people are involved in social networks. Advocates regard this new media technology as a valuable opportunity that can promote citizen participation in politics [31]. However, critics believe that the technology-mediated social participations are necessarily shallower because people do not have face-to-face contacts [32, 33, 34, 35]. With the development of social media, many people start to express their opinions on blogs, Facebook and Twitter. The growing participation in civic engagement motivates response and even discussions among internet users [36]. In a word, new media technologies allow individuals to generate significant content with different forms such as text, image, audio and video, and enable the readers to discuss with them.

2.2. Collaboration around Public Displays

Although public displays are common in urban spaces, people choose to ignore them because of their low utility [37]. This phenomenon validates Mark Weiser’s prediction that computers would disappear in the 21st century [39]. Some engineers try to change the situation by increasing the amount of public displays but it does not work since it goes against the theory of calm computing [38]. However, we think that public displays should not disappear in this way because they are not fully used yet. Nowadays, public displays are closely located and connected [40], which offers us the soil to think about innovative ways to take advantages of them.

In [41], the network effect of public displays is utilized to encourage users to create content on displays according to their own will, which helped increase participation in interacting with the public displays. Since public displays are deeply embedded in the situated locations, we should also study whether the situation will affect the participation in interacting with public displays [42, 48]. In the future, public displays should be able to adjust their contents to the environment in which the displays are deployed and to the actions of users around them. Then, people will not regard the public displays as useless devices and they can acquire the information based on their current situation.

In our Soapbox project, we hope to utilize a network of public displays to attract people to participate in civic engagement. As we know, it is difficult for multiple users to interact with one public display at the same time because the screen size is limited. However, personal devices can be seen as secondary interactive displays that
can be used to collaborate with public displays. Several projects have enabled people to collaborate with the same display. The CoLab project allowed users to edit content with their own computer and share it to a public display [43]. Another example project is MMM [44], which allowed multiple editors to interact with each other on the same displays by providing an independent input device for each user.

Some researchers have studied how collaboration technologies could entice users to interact with shared displays. They found an important result that the active input device could be toggled by a predefined access protocol [45]. Users can benefit from this technology because it enables them to work together to implement some important work, such as editing a published paper. With the Pick and Drop protocol [46], we can guarantee that users can gather data from multiple devices and then transfer the data to a shared public display. Another study [47] also studied the boundaries between private and public work by developing applications for collaboration on shared public displays. This collaboration study contributed to a deep understanding of how the new technology was evaluated, and of the effect that it has on social participation. However, there also exist many shortcomings during the collaboration, such as new interaction problems [49].

Large displays are large and pervasive enough for collaborations between groups of users on different locations. The BlueBoard [50] gave access to individuals’ personal pages so that people can easily exchange their information (i.e. resume, project pages) through the application. Developing such applications for collaboration use is not easy and we need more efficient tools and frameworks that are accessible to most developers. DiamondSpin [51] enables developers to make the prototype of applications that support collaborations of personal devices and public displays. This research focused on the design of user interface and interaction techniques especially for multiple users. In order to encourage people to collaborate on public displays, researchers [52] examined many ways to structure collaborative activities with personal devices. Other researchers [53] also explored appropriate ways to help users have a better shared understanding of public displays and personal devices.

### 2.3. Academic Research

Public displays for social use have been a hot research field from around the 1990s. Some of the papers that have good vision of the future use of public displays were published around the late 2000s. These studies provide us with rich experience in the design and evaluation of interactive systems on public displays. Therefore, in this section, an overview of public display research is presented.

#### 2.3.1. Hole-in-Space

From the early 1970s, many researchers started to create telecommunication art, such as telephone lines, and study the performance of telecommunication [57]. This work was limited to audio, telefax message and images. However, a video communication project called Hole-in-Space [58] was done successfully and made a stir in people’s life. Hole-in-Space enabled a live video and audio connection between Los Angeles and New York City (Figure 2). A passer-by near the public display in LA would hear and see what happened near the display in New York City, and speak with each
other, which was the same to the people around the display in the Lincoln center. Since the satellite cost was high, it only ran for three days and would not keep 24-hour connection. Lincoln center and Broadway are very public places where people often gather and look forward to seeing something new, which was a valuable experience and revelation in the settings and deployments of later public display research projects.

The project was a great evolution in the field of telecommunication as well as public displays. After watching the video documentation captured then, we found an opportunity to see the communication between people in different locations and decided to apply this to the current public displays in urban space. With the window metaphor, people in different locations were connected and interacted with the remote users, which can be called “remote effect” [59, 60]. Remote effect plays an important role in a network of public displays since it is the base of communications and collaborations.

![Figure 2. Hole-in-Space project in LA and NYC.](image)

### 2.3.2. Telemurals

A further study of the audio-video connection between public displays is Telemurals [54]. The project made it possible for two remote spaces to connect with each other through an interactive wall (Figure 3). During the study, Telemurals was able to capture the audio as well as video from a person and then the images were rendered and merged together, and finally displayed on the interactive wall in each space. The highlight of Telemurals is the communication, which was implemented via the transformation of audio and images. It was different from traditional media spaces because it was designed for casual and social use instead of task-oriented use [55, 56]. Based on speech recognition techniques, users could send and receive audio signals in the form of text showing on the wall.

In Figure 3, the orange image stands for the participants who stood in the local space and the red image refers to participants who were at the remote end. When the images of two participants overlap, the superimposed part would turn yellow. This rendering design had two advantages: 1) it enabled researchers to count how many people participated in the study and how they interacted with the system in public space; 2) it protected the privacy of the participants by just showing the outline of the body. When the conversations stopped, the images would fade and participants would not worry that their images stayed there. One interactive design is that people were able to select the commitment level with the system, which means that the more
effort they made, the more information they would see in both spaces. After the deployment of Telemurals, the interactive walls became an important place for social gatherings and people often express their opinions with each other.

![Figure 3. Participants in two connected spaces interacting with each other via Telemurals.](image)

The study brings many benefits to later researches. First, it is a good example showing that video communication in public can attract people’s attention and enable attitude expression, for example, the gestures and texts generated by the participants showing their feeling about the conversations. Second, synchronization is important in video communication. People would have a bad experience if they saw stuck images for a long time. Third, equipment placement should make participants feel comfortable. In the Telemurals project, a big challenge was that participants felt not being noticed by remote users because of the big camera offset.

### 2.3.3. The Opinionizer

Brignull and Rogers [17] developed a system called “The Opinionizer” for public displays, which allowed people to express their opinions on a shared public display. People were able to edit their words with a keyboard and the words would be projected to the shared displays. The key purpose of the system was to provide an open platform for people to exchange opinions, but it was not obligatory for all people. This design made people feel comfortable and not worry about social embarrassment. Since the study was conducted in the wild, people could use the prototype at any time without limitations.

Moreover, the system encouraged people to create and share content on public displays for public views, thus promoting more conversations and discussions. Further, researchers also expected that people who shared the content would discuss with other persons who stood beside them in the real world.

The Opinionizer gives us some implications for designing the Shoutbox that are used for sending comments in the Soapbox system. It tells us that when designing a similar system, we should 1) consider how to control content sharing so that people will view the suitable content, and 2) make sure that the content will renew automatically so that people will not feel boring about the same content. The study provides an important implication that an interactive system should encourage users to participate in social activities.
**2.3.4. Ubinion**

A more thematic study was conducted in [61]. The prototype used in the study, called Ubinion, was an interactive system that allowed young people to create content and leave feedback about civic issues around the City of Oulu. With the user interface of Ubinion (Figure 4), young people were able to choose a layout to edit their opinion and take a photo, then leave it to the system. In addition, the content of the discussion could be shared to the social networks in the form of images. The testing of the study was evaluated in a youth fair event [62], and later was conducted at downtown. Based on the observations, interviews and the log data, the study evaluated how to encourage young people to get involved in the civic engagement and what they thought about the current issues. The feedback was classified into several categories to study what kind of topics the young people were interested in. This is a typical study of combining public displays and civic engagement, which gives us the implications for designing effective user interface and interactions for technology-mediated civic engagement.

![Figure 4. The user interface of Ubinion on public displays.](image)

**2.3.5. Other related research**

Many existing studies are quite similar to Ubinion. E-Campus [65] was built and deployed for students to edit and share content on “in-the-wild” public displays, and students were able to subscribe to content categories they were interested in. DISCUSSION IN SPACE (DIS) [63] was designed to collect users’ opinions and promote participation in civic discussions about the local urban planning project [64]. With the DIS system, local citizens were able to send their feedback by SMS from their personal devices. Instant Places [66] made it possible for users to get content from Flickr and send messages via their smartphones. Müller et al. [67] deployed two prototypes (News and Reminder) on public display to provide topical news and contextual reminders to the students and university staff. The system provided a straightforward mechanism [67] for submitting new information and it highlighted the updated content, which is also reported in [68].

In general, socialization is an important feature for designing applications or service on public displays. To achieve this purpose, we should utilize networked displays instead of a single display to support distributed groups of users to interact with the system. A challenge for these studies is to protect users’ privacy, or ideally give them access to the control of privacy [69].
2.4. Comparative Analysis

The Hole-in-Space project was the first prototype that enables video communication between two remote cities, but it could not be used continuously. Telemurals enabled users to communicate with each other on interactive walls by video and audio recognition, but the walls would get messy if too many people interacted with it. Opinionizer combined multiple devices with shared public displays to share content, but it did not support video communication. Ubinion was designed and deployed to encourage young people to participate in civic engagement by sharing their opinion, but it did not work with multiple devices. Table 1 summarizes the comparison of the presented work and the Soapbox. From Table 1, we can see that our system not only supports all the above requirements but also has two new features. The first new feature is that Soapbox can be activated by smart sensors, thus increasing users’ experience and interaction with the public display. The other unique feature is that it merges the physical and virtual 3D world, which can be seen as a “dual-reality” system.

Table 1. Comparison between the presented work and the Soapbox

<table>
<thead>
<tr>
<th></th>
<th>Hole-in-Space</th>
<th>Telemurals</th>
<th>The Opinionizer</th>
<th>Ubinion</th>
<th>Soapbox</th>
</tr>
</thead>
<tbody>
<tr>
<td>Video communication</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td></td>
<td>✗</td>
</tr>
<tr>
<td>Collaboration with multiple devices</td>
<td></td>
<td></td>
<td>✗</td>
<td></td>
<td>✗</td>
</tr>
<tr>
<td>Content sharing</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Encouraging civic engagement</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Merging virtual 3D world</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✗</td>
</tr>
<tr>
<td>Activating systems with sensors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✗</td>
</tr>
</tbody>
</table>

Regarding the sensors that were used for activating the system, we have many choices. As discussed in the previous section, we need a smart sensor to detect the humans. After reading lots of literature, we summarize all possible sensors that we can use in the system, which are shown in Table 2. Based on the analysis of the advantages and disadvantages, we selected two effective and efficient sensors for human’s detection, namely, camera and Wii Balance Board. The camera will be used to detect human’s motion and play an audio signal, thus attracting people’s attention to the Soapbox system. Wii Balance Board can be used for detecting human’s pressure when a person stands on it. The system will be activated once it detects the pressure.
Table 2. Analysis of sensors

<table>
<thead>
<tr>
<th>Sensor</th>
<th>Description</th>
<th>Range</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camera</td>
<td>To detect movement of humans</td>
<td></td>
<td>Low cost; High sensitivity to detect movement</td>
<td>Might cause wrong detection, such as an object’s movement</td>
</tr>
<tr>
<td>Wii Balance Board</td>
<td>To detect pressure</td>
<td></td>
<td>High sensitivity to detect pressure</td>
<td>Low battery</td>
</tr>
<tr>
<td>PIR Arduino</td>
<td>To measure infrared (IR) light radiating from objects</td>
<td>Up to 20 feet (6 m)</td>
<td>High sensitivity to detect movement (Human)</td>
<td>High chance to cause wrong detection</td>
</tr>
<tr>
<td>CO₂ sensor</td>
<td>To detect the CO₂ gas near it</td>
<td></td>
<td>Sensitive to the density of CO₂</td>
<td>It may take long time to detect the changes of density of CO₂</td>
</tr>
<tr>
<td>Sound sensor</td>
<td>To detect sound</td>
<td></td>
<td>High sensitivity to detect sound</td>
<td>Not available in public space</td>
</tr>
<tr>
<td>Bluetooth</td>
<td>To detect nearest Bluetooth devices</td>
<td>Up to 10 m</td>
<td>Low cost</td>
<td>The speaker has to bring a personal device with Bluetooth</td>
</tr>
<tr>
<td>Ultrasonic sensor</td>
<td>To detect the distance between the closest object and the sensor</td>
<td>From 2 cm up to 3 m</td>
<td>High sensitivity to detect distance</td>
<td>High chance to cause wrong detection</td>
</tr>
</tbody>
</table>

In the following chapters, the design and implementation of Soapbox are presented. To begin with, the requirements of the system are analyzed and the design of architecture is presented. Designing an interactive system for public displays is a complex process: ideating the requirements, making a prototype, building the user interface and analyzing the implementation. The implementation of human detection and lock mechanism are explained in detail. Furthermore, this chapter presents two versions of Soapbox: a fullest implementation for later use and a simplified implementation for the current study, and it explains why the simplified version of Soapbox is used in the evaluation. After that, the methodology and process of the lab study and field trials are presented. Then, based on the quantitative and qualitative data, the results and findings are discussed.
This chapter presents the design and implementation of the interactive Soapbox platform on public displays. The chapter begins by giving two example usage scenarios individually from speakers and the audience to illustrate the functional requirements of the architecture. Then, we analyze the system requirements at five aspects. In the following section, the architecture of Soapbox is presented by explaining the distributed structure and adaptation sequence. Subsequently, the design of Soapbox is presented from ideating the functions to building the user interface. Then, the core components in the implementation stage are presented. In the final section, the implementation is analyzed and the final version of Soapbox used in the testing is presented.

3.1. Example Usage Scenario

Soapbox is an interactive platform aiming at promoting civic engagement. People who use the Soapbox to deliver a speech are called “speakers” in the study. Those who watch the speech, or give feedback (e.g. pressing like or dislike buttons, sending comments) to the speech in front of the large displays, are called “audience”. In this section, two individual usage scenarios are described to explain how a speaker and the audience interact with the displays.

3.1.1. Speaker’s usage scenario

Tom is a student who studies education in the University of Oulu. He likes talking with others about current affairs and education issues. One day he is on his way to attend a class but a female cough sound catches his attention. He realizes that a new machine called “Soapbox” is placed in the campus lobby. Tom slows down and walks around the Soapbox to check what it is. Then, he finds the instructions shown on the screen. He notices that the Soapbox is a platform that can deliver a speech to the public. Curious and excited, Tom steps on the smart box in front of him.

After standing on the smart box, the instruction page disappears and the home page of Soapbox is shown on the display. Tom presses the “Start” button and the web page turns to a speech info page. He has to fill in his speech topic and his name before starting his speech. Tom thinks about it for a while then clicks on the input field, after which a virtual keyboard appears on the display. He carefully enters all the required information and presses “Submit” button.

After the speech info is sent to the system, the speech finally starts. At the beginning, he is shocked by the scene from other places. He notices that he can check passers-by from three different locations and his selfie video is shown on the screen. With the selfie video, he grooms himself and says hi to the camera. After three or four greetings, some users finally notice him and stop before the other displays.

At the same time, Tom starts talking about his speech topic. During his speech, he finds that the audience is increasing. On his display, he can see that he gets lots of thumbs-up and few thumbs-down. Fortunately, nobody reports his speech, which means his topic is suitable for the public. In addition, he notices that some audience members send encouraging messages (e.g. “good job”, “great speech”, etc.) to him. Moreover, some others even ask him questions about his speech. In the meanwhile,
he answers all the questions and doubts. Finally, the speech is finished and Tom obtains lots of applause. He says “Bye” to the audience and clicks the “End” button. After the speech, Tom gets off from the white box and goes for the lecture.

3.1.2. Audience’s usage scenario

Lucy studies computer science in the University of Oulu. One day she finishes a difficult class and is ready for going back home. Walking along the campus main lobby, she is attracted by the voice from a public display. She walks close to the display in order to find out what the person is talking about. Taking a good look at the display, she notices that the speaker named Tom is delivering a speech to the public. Lucy is interested in the topic, so she decides to stay and listen to the speech.

Lucy watches the display carefully and thinks that Tom’s opinion about the topic is good. She wants to express her opinions. Suddenly, she finds that there are three buttons (“Like” button, “Dislike” button and “Report” button) below the video. She presses the “Like” button and the number of likes increases on the screen. More and more passers-by stop and stand around the public display. Lucy looks around and greets to other audience members.

However, Lucy also feels confused about some points of the speech. She hopes to ask some questions but she does not know how. On the right corner of the display, she notices that a QR code is embedded in the display and the tips on the display says, “Scan the QR code and send comments”. Lucy takes out her smartphone and scans the QR code. Then she goes to an online website called “Shoutbox”. In the front page of the website, she is asked to offer her age and gender information to the system before she can send a comment. She fills in all the information and submits it. After about one second, she enters to the comment page. In this page, she finds that she can give thumbs-up or thumbs-down to the speech. Below the speech information, she notices two input fields, which requires her name and comments. She enters a fake name and her questions, and then presses the “Submit” button.

After the comment is sent to the server, it is shown on the display immediately. Lucy feels surprised about it and more strikingly, Tom answers her question in seconds. Other audience members find this and ask Lucy how to send comments. Lucy teaches them and the comment list starts refreshing frequently. In the meanwhile, Lucy also discusses with other audience members about their doubts and Tom’s answers. Then, the spot becomes a little noisy, but luckily, Tom cannot hear it. After the speech is over, the audience members warmly applaud Tom and some even show a thumbs-up gesture to the camera. Although the video is shut down, some audience members including Lucy, still stand there and continue the discussion.

The usage scenarios presented above explain how users with social civic interests can benefit from the Soapbox platform in their daily life. The synchronization between the Soapbox and audience displays makes it convenient for users to communicate with each other in real time. In Tom’s case, the Soapbox gives him a good opportunity to express his opinions and the feedback from the audience encourages him to continue the speech. For Lucy, the web applications on audience displays and the mobile phone enable her to send questions and discuss with those who share the same interest with her.
3.2. Requirements Analysis

**Functional requirements** define the functions of Soapbox platform. From the usage scenarios, it is not difficult to classify the functionalities of the platform. In the system, we should consider the functional requirements at two aspects: speaker and audience. Figure 5 shows the use case diagrams of Soapbox platform. For a speaker, s/he is able to submit the speech info before the speech is delivered to the public. In addition, the system should enable users to decide when to start and when to end the speech. Meanwhile the speaker can get feedback such as thumbs-up and thumbs-down, and the comments sent from the audience. Furthermore, considering that the system might be very popular among local citizens, it should be possible for speakers to reserve a speech. Lastly, the speaker should be able to check the speech schedule in case of booking conflict. The audience can watch a speech on the public displays. If they think the speech is good, they can give thumbs-up to the speaker; otherwise, they can give thumbs-down or even report the speech if the topic is not suitable for public delivery. What’s more, audience should be able to send comments or questions through the system, thus communicating with the speaker and other audience members in real time. Similarly, the audience can check the upcoming speeches, and then choose to participate in their interested topics. Finally, the system should give the audience access to the previous speeches in case that some audience members miss a speech.

![Figure 5. Use case diagram (left: speaker; right: audience).](image)

**Performance requirements** have a crucial impact on whether the system works well in the following evaluation, and it builds a foundation for the performance testing. In the Soapbox system, we argue that response time must be as fast as possible when speaker and audience are interacting with the system. To make the speech proceed smoothly, communication between Soapbox, middleware and audience displays should be performed with low latency. One solution is to ensure that they work in the same network environment (in our case, the open panOULU WiFi). Finally, the public displays should be able to clear all previous speech information once the speech is finished since the passers-by may feel confused if no speech is being delivered but the comments and other feedback are still there.
User interface requirements offer guidelines for designing a user interface. The icons on the public display should be self-descriptive and easy to understand. There should not be confusion between icons of different functionalities. If speakers or the audience gets confused about the meaning of icons, it will weaken user experience (UX) and finally stop local citizens from using the Soapbox. An excellent user interface should define the color scheme in advance. Since the target user might include elderly people, the icons should be designed as big and clear as possible.

Usability requirements define whether users can achieve the quantified objectives effectively and efficiently. Apart from the ease to navigate, the usability of Soapbox should rather be intuitive than require memorizing. It should be easy and quick for speakers to start a speech, and for the audience to send comments. For smooth workflow, there should have few or even no user errors when a speaker is delivering a speech or an audience is submitting a comment.

Security requirements protect users’ privacy. The communication between Soapbox, middleware and public displays should be safe and one-off. The system should not record any personal information of speakers and the audience members, especially name, birthday and photos. When a speaker is reserving a speech, all the passwords generated by the system should include at least one capital letter and numbers. It is better to use a personal device to send comments, and then the audience will not worry about being noticed when editing their comments.

3.3. Architecture of Soapbox

This section presents an overview of the designed architecture of Soapbox. The key components of the Soapbox architecture are described with detailed interactions. Furthermore, we explain the adaptation sequence among each component. Lastly, the structure of the whole platform is presented.

3.3.1. Design of architecture

The Soapbox architecture comprises of components both in physical and virtual worlds. It incorporates different components that are required in order to offer support for communication, synchronization and distributed data storage. In this section, only the key components for the Soapbox composition are presented. The architecture of the whole system is illustrated in Figure 6. As is shown in the figure, the relationship between each composition is marked with a sequence, and it will be explained in the following.

The process begins when a user is detected, i.e. when a user stands on the smartboard (Wii balance board). The board detects weight (1) of a user. Then, the Soapbox system is activated (2). While interacting with the UI for speaker, a user can submit his/her speech information to the middleware and start a speech (3). The video stream of the speaker will be synchronized (4) and shown on all linked displays. Further, video streams from all linked displays will be synchronized and displayed on the Soapbox screen as well.

When an audience member scans the QR code on the display s/he is watching a speech on, s/he will be directed to a mobile website called “Shoutbox”, which enables the audience to send feedback (5) to the speaker through the middleware. The middleware is responsible for synchronizing all the feedback and showing it on
the speaker’s display as well as linked audience displays. In addition, if someone starts a speech with the virtual Soapbox, the video stream will be sent to the middleware and displayed on all linked displays in the physical world. The feedback will also be broadcasted to the virtual Soapbox through middleware, which achieves the support for dual reality (6). Since this thesis focuses on the design and evaluation of the “physical” Soapbox, the structure of the “virtual” Soapbox is not discussed in this thesis.

Figure 6. Soapbox architecture.

3.3.2. Soapbox structure

From the perspective of narrow definition, only the composition that speakers interact with is called Soapbox. However, generally, the whole project is named Soapbox. In this section, the Soapbox structure is explained as a whole, excluding the virtual 3D world. A successful interactive system on public displays processes information in the structure that is physically distributed and with which users can interact with it in real time and with low delay. These factors, as well as the user experience, add more complexity to the Soapbox structure.

The designed architecture contains a three-tiered structure, which is composed of the following levels: resource level on the bottom, control level in the middle and communication level on the top. The structure of different levels is illustrated in Figure 7. The resource level includes the Soapbox speaker’s display, linked audience displays, and personal devices such as smartphones with which users can access the web applications in control level. The control level comprises the communication interface that enables receiving and sending messages. The Soapbox speaker’s display offers the user interface that speakers can control during a speech. The audience displays are located in different places, and they utilize the middleware API to connect with the Soapbox and mobile devices. The communication level mainly consists of the middleware, which is deployed on the top of the distributed system. This level enables the web applications on different devices to connect and scale. In this level, the messaging is asynchronous, thus protecting users’ privacy. When a
speaker is delivering a speech, the speech data is sent from the Soapbox to the middleware, and the middleware distributes it to the audience displays. In the meanwhile, comments from the audience are distributed to the Soapbox and audience displays through the middleware.

![Figure 7. Distributed Soapbox structure.](image)

Each interaction with the user interface can be seen as a trigger. Figure 8 explains how different adaptation triggers work between different devices. The first message is the most important trigger in the system because the other messages are triggered after a speech is started. When a speaker starts a speech, a message is sent to the middleware and the audience displays receive the message.

After scanning the QR code, a message is sent to the middleware for requesting to join Shoutbox. Then, the middleware responds to the personal devices with speech info if successful. In other words, if no speech is being delivered, the audience cannot join the Shoutbox successfully, with an alert saying “No speech yet”. When a comment is sent to the middleware, it is distributed to the Soapbox and audience display in real time. What’s more, the audience’s personal device will get a response if it is submitted successfully.

On the audience displays, three buttons are designed for giving feedback to a speech. When an audience presses any of these buttons, a message is sent to the middleware and then distributed to the Soapbox and audience displays. Finally, when a speaker ends his/her speech, the middleware receives the message and sends a signal to audience displays and the Shoutbox. In a word, the Soapbox architecture is designed by the following factors:

- **Reliability**: Soapbox performances well with persistence, publisher confirms and delivery acknowledgements.
- **Availability**: Soapbox should be freed once a speech is over; then, it becomes available to new users.
- **Flexibility**: messages can be exchanged and routed before arriving at queues.
3.4. Design of Soapbox

This section presents the user interface design of Soapbox, which is mainly comprised of three parts: Soapbox for speaker, web application on the audience displays, and Shoutbox. First, the design process is presented. Second, we explain how each part of Soapbox is designed and why they are designed in this way.

3.4.1. Design process

Many findings from HCI for public displays show that simply satisfying usability and utility might not be sufficient for designing public displays [59]. Excellent design for public displays can attract users’ attention and motivate them to interact with public displays. Designing for an interactive platform is a creative process that takes several steps. Figure 9 illustrates the design process that offers the guideline for the design. The steps presented below guide us to transfer our creative ideas to a practical product.

The first step is the ideate phase. Following the MoSCoW method and requirements listed in the previous section, we start to ideate the requirements and draw sketches for the system. The purpose of ideating is to present the functions of Soapbox and describe the flow of the final system. After figuring out the layout, we begin building the prototype of Soapbox. The prototype plays an important role in the design process because we can get quick response from the team and then move
on to build a real working system. As designers, we must have a clear idea of how we want the system to work and how we hope the audience to interact with the system. Further, building a prototype makes it easier for us to understand user behavior in the real world. In the case that there exist some problems with interaction with the prototype, then it is time to review the previous stage and make some revisions until it validates the expectations. After that, we move on to the build stage. In this stage, we start to program to implement the functions and user interface designed in the prototype stage. During the analysis phase, we test and analyze all the web applications in the team by discussing whether they meet the requirements of the Soapbox. The iterative design helps us to go back one or two phase to make quick changes, which is very effective and efficient in design approach.

![Figure 9. Design process.](image)

There is no strict start point for the design process of our system, but the ideas and requirements of each stage are crucial for us to build a long-lasting system for public spaces. Without a clear guideline, we might set the team up with setbacks and delayed progress for a long time. The design process motivates us to keep focused and stay on the schedule. Following the steps, we figure out what should be done in each phase and put the hard work forward accordingly.

### 3.4.2. Ideate requirements

In section 3.2, we analyzed the functional requirements of Soapbox, all of which are essential in our study. However, they are prioritized to make the immediate contributions to the study. According to the MoSCoW method, a prioritization technique is used in project management and software development, in order to reach the progress on the importance that the study places on the goal of each stage. “Must haves” means that the requirements are critical to the project delivery timebox and without them, the study would fail. “Should haves” explains that the requirements are vital but not necessary for the current delivery. “Could haves” shows that the requirements are good but not necessary, and it could enhance user experience (UX). “Won’t haves” means that the requirements are seen as lowest-payback items. In this section, we divide all the requirements into three groups with the prioritization (Table 3) and the “Won’t haves” are not discussed in the study.
Table 3. Priority of functional requirements

<table>
<thead>
<tr>
<th>Priority</th>
<th>Functional Requirements</th>
</tr>
</thead>
</table>
| Must haves   | 1. The System can detect humans;  
2. The system have an interactive user interface;  
3. A speaker can start and end a speech, and the speech can be delivered to all audience displays in real time;  
4. A speaker can submit his speech topic and name;  
5. An audience can give thumbs-up and thumbs-down to a speech, and even report the speech if it is not suitable in public; a speaker can see these feedback;  
6. An audience can send comments to a speech, and the comments can be sent synchronously to the Soapbox and all public displays. |
| Should haves | 1. A speaker can book a speech and deliver a reserved speech with Soapbox;  
2. A speaker or an audience can check the speech schedule;  
3. The Soapbox will be locked for ten minutes when a reserved speech is about to start; in other words, five minutes before and after a reserved speech, others cannot use the Soapbox except the speaker who reserve the speech;  
4. If a speech is coming, the speech information should be pushed to the audience displays in the form of advertisements;  
5. A speaker can book a speech on his personal devices. |
| Could haves  | 1. Users can browser previous speeches;  
2. An audience can send a voice message to a speaker;  
3. A speaker can choose to save his speech or not. |

Based on these requirements, we begin to draw sketches of the system. Sketches generate ideas quickly, helping us see and feel how the system will work. In addition, sketches offer a unique space that can help us think differently and explore alternative ideas without risks. Early in the design process, it is essential to see a variety of ideas, and then we can choose the best solution. With sketches (Figure 10), the whole team can discuss about the design effectively and efficiently because they give everyone the permission to think about and challenge ideas presented in the sketches.

Figure 10 illustrates the ideas from two sides: speakers’ side and audience’s side. For speakers, the instructions that explain how to use the Soapbox make it easier to start a speech. When the Soapbox system is activated, a speaker can choose to start it now or book a speech for later. If he/she chooses to start now, the speaker just need to submit the speech topic and name, then the speech starts immediately. If speakers choose to book a speech, they can select a speech time in the future. After submitting the speech information, a password is popped up and they have to remember the password because it is the access key for the later speech. For audiences, they can watch a speech and give feedback on audience displays. In addition, if they scan the QR code, they will visit a mobile web application, with which they can book a speech, send comments and check the upcoming speeches.
Figure 10. Sketch of Soapbox.

3.4.3. Prototype

An excellent prototype can typically simulate many but not all aspects of the system, and it might even look very different from the final system. However, we can still get many benefits from prototyping. First, as designers, we can get significant feedback from the target users at the beginning of the project. After comparing whether the built system matches the requirements and specification, we can ensure that the system will function as intended. Second, prototyping allows us to estimate the project accuracy and predict whether we can reach the milestones successfully in each stage. Third, it also provides an overview of visual design of the system, bringing lots of convenience for developing the real user interface. Lastly, the method decreases the difficulty and cost of changing a finished interactive system. In this section, three kinds of prototypes for three platforms in the whole system are presented.

Vogel and Balakrishnan (2004) presented a list of design principles and a framework for interactive displays in public spaces, and demonstrated these ideas
through an interactive prototype. When designing prototypes for the whole system, we follow these design principles (Table 4).

Table 4. Design principles of Soapbox

<table>
<thead>
<tr>
<th>Principles</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Notification</td>
<td>The system on public displays should be able to notify the passers-by that the display is interactive.</td>
</tr>
<tr>
<td>II. Comprehension</td>
<td>During the process of interacting with the system, users can gradually understand the meaning of the contents on public displays.</td>
</tr>
<tr>
<td>III. Immediate usability</td>
<td>The system should motive users to learn how to use it through exploration and observation.</td>
</tr>
<tr>
<td>IV. Privacy</td>
<td>Users can control whether they want to show their personal information on public displays and what is to be shown.</td>
</tr>
<tr>
<td>V. Merging public and personal information</td>
<td>The system should provide a protective semi-private interaction space for users, and then users can utilize the public displays to implement some personal tasks.</td>
</tr>
<tr>
<td>VI. Short-duration fluid interaction</td>
<td>Do not design complex and long interactions for public displays. Users should be able to access the systems quickly, especially without login and log-out activities.</td>
</tr>
<tr>
<td>VII. Shared use</td>
<td>Individuals can collaborate with other users; in other words, people share the displays for personal use.</td>
</tr>
<tr>
<td>VIII. Calm aesthetics</td>
<td>Since the interactive displays are deployed in the public space, the displays should not affect people’s normal life, which means that the displays should be appropriately reactive in balance.</td>
</tr>
</tbody>
</table>

The prototype of Soapbox is presented in Figure 11. According to Principle I and II, the instruction page is designed for users in order to notify them that the display is interactive and teach them how to use the system. After the system is activated, users can start a speech directly (Principle VI) or book a speech. The icons and text are easy to understand and users are able to book a speech quickly without any confusion (Principle III). When a speaker submits his/her reserved speech information, the system will generate a password in a pop-up window. Next time within his/her speech time, they can enter the password and start the reserved speech.
Figure 11. Prototype of Soapbox.

Figure 12 shows the prototype on the audience displays. Users can scan the QR code and join the shoutbox, allowing them to send comments to the system and discuss with each other (Principle V and VII). In addition, the comment can be anonymous and audience can choose to use their real names (Principle V) or fake names if they want do so, which protects their personal information (Principle IV).

Figure 12. Prototype for audience displays.

When designing a system for civic engagement, the first thing we need to consider is how to enable more people to interact with the public displays. It is impossible to enable several users to directly interact with one public display at the same time, for example sending comments through a virtual keyboard provided by the public display. Therefore, it is crucial to find other tools to collaborate with public displays. Personal devices such as smart phones can share complementary properties with public displays (Table 5). Looking at the screen size, public displays typically have large screens which provide a good view for users to share things, but are not convenient for input messages and not suitable for protecting users’ privacy while
typing something. Considering this very problem, we introduce personal devices which can be regarded as effective and efficient input devices to the system.

Table 5. Comparison between public and personal devices

<table>
<thead>
<tr>
<th></th>
<th>Public device</th>
<th>Personal device</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screen</td>
<td>Large size</td>
<td>Small size</td>
</tr>
<tr>
<td>View</td>
<td>Public</td>
<td>Private</td>
</tr>
<tr>
<td>Input</td>
<td>Hard to input</td>
<td>Easy to input</td>
</tr>
<tr>
<td>Amount</td>
<td>Limited</td>
<td>Limitless</td>
</tr>
</tbody>
</table>

Today’s personal devices (e.g. tablets, mobile phones) have good networking and computing abilities, making them feasible for the audience to send comments and give feedback through their personal devices. Figure 13 illustrates the prototype of Shoutbox working on personal devices. The design is based on Principle IV, V and VII. In Figure 13, we can see that the Shoutbox consists of three parts: join Shoutbox, book speech and check schedule. When the audience presses “JOIN SHOUTBOX” button, they will connect to a current speech and send feedback and comments to the speech. In addition, the platform also allows people to book a speech and check the upcoming speeches that are reserved by others. The collaboration of public displays and personal devices improves user experience and usability of Soapbox.

3.4.4. Build user interface

Frontend development involves different components, including HTML that describes web documents, CSS that makes the user interface stylish and JavaScript code that implements the functions. The process of building a real user interface on public display is not accomplished in one action. Continuous integration of user interface and functions enables us to get the code to the final implementation. Every
time we reach a stage, the whole team would check the whole demo and offer proposals to improve the system. Then, we can make some changes to the user interface without risks. The idea originates from agile software development, which encourages early delivery, adaptive planning and rapid response to change.

Building a user interface is a process that starts with implementing simple functions and iteratively improves the evolving versions until it is ready for testing. In the first version of the demo, we only enabled the communication between Soapbox and audience displays, which means that we only finished the user interface of starting a speech directly. The initial implementation provides a framework with which we can develop the system further. Then, based on the suggestions given by the research team, we added functions that allowed users to submit their speech information and book a speech. The second iteration includes most of the required functions of the system.

After that, we were asked to add a lock mechanism to the system in case that someone starts a direct speech before a reserved speech. Further, in the third iteration, we need to exhibit all reserved speeches to the speakers so that users will not overlap the reserved speech. What’s more, we designed an instruction page for the users in order to guide them to use the system in a right way. The third iteration is almost the demo in Figure 14, but we still modify some minor changes in this version. For example, we removed the functions that enable users to send the password to their email via the system-provided email client because it gives users access to other applications on the public displays, which is a threat to the Soapbox system. Furthermore, we changed the lock time and added the amount of online users to the system. These changes are made based on the testing during the development. Implementation of iteration is a process to redesign and rethink what the system should look like. During our iterations of Soapbox, senior researchers who have rich experience in the study of usability raised suggestions and gave feedback on the interface and UX. GitHub is used in the study to enable the version control.

Figure 14 presents the fullest implementation of Soapbox. However, this version was not used for the evaluation. The reasons that we do not use it for the lab study and campus testing, and what the final version looks like, are explained in section 3.6. With the Soapbox shown in Figure 14, speakers can book a speech easily. If there exist reserved speeches, the system will notify the users of the time left before the next speech and the user interface will automatically lock for five minutes before the next speech. Only the speaker with the right password can unlock the system.

The password is generated randomly and automatically by the Soapbox system after a speaker fills in their speech information and selects a speech time. The password is composed of capital letters, lowercase letters and numbers, which ensures that any two reserved speeches will not share the same passwords. The initial background image is chosen from a British film “The King’s speech”, which encourages people to overcome psychological and physiological barriers like stutter in order to speak in public and have their voice heard. In a word, the implementation of this version of Soapbox builds reliable foundations for the lab study and field trials.
The user interface on audience displays is illustrated in Figure 15. The left figure is a web page that informs people of the next speech, which is designed like an advertisement. This page will be pushed to the public display ahead of an upcoming speech. The background of the advertisement is a short silent video derived from “The King’s speech”, which adds an extra layer of thoughtfulness. The right figure is taken from the audience display. The layout is divided into three parts: speech video area, Shoutbox area and buttons for feedback. Elements with similar functions are
placed to the same area, for example, the QR code and the comment contents are concentrated in the Shoutbox area. The clear regional division makes it easier for audience to understand the functions of each individual element of the layouts.

Figure 15. User interface on audience displays.

Figure 16 illustrates the user interface of Shoutbox. Based on the prototype in section 3.4.3, we designed and implemented the system using jQuery Mobile framework, which allows us to develop a highly branded interactive web application compatible with different size of devices such as tablets, smartphones and personal computers. Buttons placed in the home page are designed with clear icons and texts. The thumbs-up and thumbs-down buttons in the comment page can be clicked for one time because we want to avoid the abuse of them.

Figure 16. User interface of Shoutbox.

3.5. Implementation of Soapbox

This section offers an overview of the core components of implementation stage. The flowchart of the system is described in the first part. Then, the implementation of human detection and lock mechanism are presented. Lastly, the details of designing adaptive user interface and integration of middleware are explained.
3.5.1. Overview

The user interface design discussed in section 3.4 cannot work without the implementation of the middleware. The frontend makes it possible for speakers and audience to touch and experience Soapbox directly. If the user interface cannot arouse people’s interest and let them access the system easily, the study will fail even if the backend is powerful. Conversely, if the middleware does not provide the required APIs, the frontend will become useless no matter how good the design is. Therefore, only when the frontend and middleware cooperate with each other, can the whole system performance well. In addition, visual design is not the exclusively work in frontend development. In this project, the design of the logic and flow path of Soapbox (Figure 17) also make a difference.

![Flowchart of Soapbox](image)

Figure 17. Flowchart of Soapbox.

The functions of the user interface such as buttons and speech information are implemented with JavaScript. The code runs on the local computer, which enables fast and intuitive user experiences because web pages do not need to refresh all the time. The flowchart presented in Figure 17 illustrates the functionalities of the Soapbox system. When the Soapbox is activated, the system connected to the middleware would send a request to see whether there are any reserved speeches today. If yes, a notification would pop up on the screen to tell users how long is left until the next speech, which avoids the conflicts of speech time. If no, speakers can start a speech directly without reservation. In addition, speakers only need to enter and verify the password if it is their turn to give a speech. The main purpose of this design is to ensure that the Soapbox works normally in the case that plenty of people use the platform. The validation of password and the success of booking a speech are processed in the middleware. After sending this information to the middleware, the local client would receive a message that includes the results of validation.
3.5.2. Human detection

Two kinds of sensors are utilized to detect humans in this study. One of them is Wii Balance Board (Figure 18) regarded as the pressure sensor, which is discussed in Chapter 2. Although the Wii Balance Board is originally designed for game controller, it has been used as a proven and reliable tool to measure pressure. The most essential feature is that it provides open APIs for developers to control the connection and communications between the board and computers. As an extension to the Wii mote library, wiiboard-simple enables us to use Wii Balance Board in the project efficiently. Wiiboard-simple provides APIs for reading and transferring force pressure data and with the library, we can connect the board with computers easily via Bluetooth. Considering that our target users who deliver a speech in public are mainly adults, we set the threshold of weight to be 30kg, which means if the smartboard reads that the weight is over 30kg, the Soapbox would be activated. With the detection logic and wiiboard-simple library, we implemented the program and deployed it on a Mac mini.

Figure 18. Detecting humans with Wii Balance Board.

The other sensor is a camera, which is used for motion detection (Figure 19). The reason why we added this feature is that during the observations, we found that some people who were playing with their phones while passing by ignored the display. Every time the camera detects a passer-by, the display plays a sound. We implemented a five-minute delay to the audio cue, in order to prevent the sound from becoming overly irritating. As for the sound, in our previous study [70], we found some audio signals that can attract attention and entice interactions on public displays. Although the study shows that female voice is the most effective audio signal, we choose the second popular audio signal - earcon, a cough female sound (ahem) that can raise users’ attention. The reason why we do not choose that female voice is that it is English instead of Finnish. Since the Soapbox system will be deployed in the city center of Oulu for longitudinal in-the-wild testing, passers-by might not understand English. Therefore, the earcon that will not confuse people is selected. The motion detection program is embedded in the instruction page and hidden from the user interface because we do not want people feel embarrassed when
they are tracked by the camera. In order to protect users’ privacy, the video stream is not recorded.

![Motion detection with camera.](image)

**3.5.3. Lock mechanism**

To avoid deadlock, we implement a lock mechanism. In a concurrent computing process, a deadlock occurs when two actions compete for the same resource at the same time, and either of them can finish it. Similarly, in our situation, when a speaker starts a speech without reservation and soon it is another speaker’s turn to make a speech because he/she booked a speech in advance. Will the first user stop his speech immediately when next speaker arrives? It would not make sense to force the current speaker to end his speech early, not to make the other speaker with an existing reservation wait until a slot opens up. Therefore, to solve the potential conflict, a simple lock mechanism is introduced.

![Lock mechanism for Soapbox.](image)

**Figure 20. Lock mechanism for Soapbox.**

The basic idea is to lock the system some time before and after a reserved speech time, and unlock it after that (Figure 20). Here, we define the lock time as ten minutes, beginning five minutes before the reserved speech time. The Soapbox will
be locked until the speaker who books the speech unlocks it manually. The private key (called password in the demo) is generated by the system when a speech is booked. If the speaker cancels the reserved speech or does not appear to unlock it, the system will unlock it automatically five minutes after the reserved speech, thus other speakers do not have to worry about the lock. With the implementation of the lock mechanism, speakers do not need to worry about occupying others’ speech time any more.

3.5.4. Responsive user interface

In software development, the phrase “responsive UI” refers to a user interface that can adapt to individual users based on the context of use and the operating platform. Today’s development tools and technologies make it possible for developers to create immersive personalized experiences when interacting with the system on different devices. Instead of tailoring disconnected designs to the growing personal devices, the user interface of Soapbox is more flexible and adaptive to render the content. For example, the Shoutbox is not limited to the device size or the browsers because the jQuery Mobile plugin is applied to the design.

An excellent responsive user interface design is comprised of three technical parts: fluid grids, media queries and adaptive images, which are included in the design of Soapbox. The user interface for speakers is developed with HTML5 and CSS3, thus adapting to the screen perfectly in both landscape and portrait position. Therefore, when we change the screen position from landscape to portrait (the reasons why we change it are presented in section 3.6), the user interface still looks good. When we started the design work for Shoutbox, our first thought was how to make it adaptive to different sizes of screens since the audience would visit the websites on their personal devices. After comparing different design frameworks, we found that jQuery Mobile is the most suitable tool for Shoutbox because it enables users to access web sites or apps on all smart devices such as tablets, smartphones or even desktop devices, which can be described as responsive.

3.5.5. Integration of middleware

The middleware of Soapbox enables the speaker and audience to interact with the user interface. The middleware not only requires considering the communication problems, but also needs to know how to avoid throwing errors at users. The integration of middleware composes of three segments: Soapbox for speaker, user interface on audience displays, and Shoutbox for audience. The middleware provides several APIs for the user interface. They share the same form and sequence, namely defining a new API object, connecting to the middleware and registering the object. For example, when merging the user interface of Soapbox and the middleware, we must follow this method:

```javascript
var Soapbox = new Soapbox();
Soapbox.connect(function () {
    Soapbox.register();
});
```

All the requested functions such as “like a speech”, “dislike a speech” and “submit speech info” are implemented in the connect function. This also works with
the audience displays and Shoutbox. Video synchronization is implemented in the connect function as well. For example, when merging the user interface on audience displays and the middleware, the method of broadcasting video stream is presented as follows:

```javascript
navigator.getUserMedia(
  {
    video: true,
    audio: true
  },
  function(stream) {
    hotspot.addStream(stream);
  },
  function (error) {
  });
```

In general, communication between the user interface and middleware is similar to the positive acknowledgment (ACK) in transmission control protocol (TCP). When the user interface sends a message to the middleware, it will also receive a response message from the middleware whether successful or not, thus establishing a reliable connection. The response message is crucial for the user interface because it decides what to respond to the users, which directly affects the user experience.

### 3.6. Analysis

Before starting the evaluation, we made some significant changes to the Soapbox system. Although the required functions are implemented, it does not necessarily mean that the implementation is perfect for the lab study and campus testing. The first great change of the Soapbox system is the layout of the user interface. The previous fullest implementation in section 3.4.4 is designed from the premise that the speaker’s display will be placed in landscape position (Figure 21).

![Figure 21. Comparison between landscape (left) and portrait position (right).](image)

According to Figure 21, we can find that when the public display is placed in landscape position, the speaker has a narrow view of on-the-spot audiences; however, if it is rotated for 90 degrees, the horizon becomes much wider. The portrait position makes it easier and more convenient for speakers to communicate with the audience face to face because the Soapbox is deployed in public space. As
discussed in section 3.5.4, the user interface of Soapbox is responsive; therefore, when the Soapbox display changes to the portrait position, the web pages are adaptive to the “new” display. In addition, some users reflect that the portrait position makes the Soapbox look like a mirror, which can relieve their stress.

Another big change of Soapbox is that we remove all functions related to booking speeches because people have to finish too many operations before they start a speech, which might increase difficulty in using the Soapbox. In addition, speakers may feel confused about starting a new speech and starting a reserved speech, especially for those who want to start a speech without reservation. Considering that the Soapbox system may not have overloaded users, the booking function seems not necessary. When a new system is introduced to the public space, it is better to make it as simple and accessible as possible, then most of the citizens can use it without obstacles.

Figure 22 illustrates the final implementation for lab study and campus testing. In this version, we also make some minor changes. For example, speakers do not need to switch languages anymore because both English and Finnish are used in the context. Furthermore, the layout of video and comments changes from horizontal to vertical. Finally, we add some warning feedback to speakers. When a speech is reported for certain times, the blue background (in the middle of the third image of Figure 22) will start sparkling with yellow color. In addition, if the speaker continues and the number of reports increases, the sparkling color will change from yellow to red. The basic idea of this change is to remind people not to deliver unsuitable speech in public space.

![Figure 22](image)

**Figure 22.** The final version of Soapbox for testing.

The user interfaces on audience displays is very similar to the implementation presented in section 3.4.4. To make users notice the changes of the feedback such as the number of thumbs-up, thumbs-down and report, we added floating animation effects to these icons and texts, thus enhancing user experience. Since the booking function is removed from the Soapbox client, it is also removed from Shoutbox,
which means that users cannot check speech schedule or book speeches from Shoutbox. In order to study the audience’s behavior during the evaluation, we ask users to fill in their age and gender before they join Shoutbox. Users do not need to worry about their privacy because they do not need to provide their real names and the information is anonymous. In Figure 23, we can see that Finnish language is added to the context as well. Additionally, when an audience member presses the “like” or “dislike” button, the color of the buttons will change.

![Figure 23. The final version of Shoutbox for testing.](image)

1. Home page  
2. Press "like" button  
3. Send comments

These changes were implemented to make the interaction between Soapbox and Shoutbox clearer. Previously, a speaker could book a speech and check upcoming speeches via both Soapbox and Shoutbox, which may become confusing. With these improvements, the functions of Soapbox and Shoutbox become separate - the former is used for delivering a speech and the latter for sending comments, thus resolving any potential misunderstandings. The final version of the whole Soapbox system (including Soapbox, user interface on audience displays, and Shoutbox) enables us to begin evaluation. In the following chapter, the study method and deployment are presented.

In the following chapter, the lab study and field trials are presented. The goal of lab study is to find out the potential usability problems and collect qualitative data to evaluate user experience. Field trials are then implemented to fully study users’ behavior and interaction with the system.
4. EVALUATION

This chapter describes study methods and evaluation process of the Soapbox system. To begin with, the research methodology used in the study is introduced. After this, the lab studies are described in detail. In the final section, the process of field trials is presented.

4.1. Research Methodology

In general, there are three kinds of research approaches in academic study: descriptive research that tells what is happening, relational research that focuses on whether two factors are connected, and experimental research aiming at finding out whether a manipulated factor will directly influence other factors. In our research, the descriptive research method is used to find out how speakers and audience interact with public displays for civic engagement. Lab study is effective and efficient for usability testing. However, with the recent growing ubiquitous computing infrastructure in public, more and more researchers are moving their user studies from lab to the public space, which can be called “in-the-wild” study. Since urban computing systems are closely tied to their environments of use, and to the people who live in the environment, it is important to know how people interact with public displays in the nature setting. The Soapbox system in general and the work done in this thesis heavily rely on lab usability testing and field trials (in-the-wild evaluation). This means that after the Soapbox prototype is implemented, we first evaluated it in a laboratory setting and finally moved it to a real world setting. In this section, firstly, the descriptive research is simply introduced. Then, the usability lab and “in-the-wild” study are presented.

Descriptive research utilizes elements from both quantitative and qualitative research methodologies. Different from inferential statistics trying to find out cause and effect, descriptive research tells us “what is”. In descriptive research, we need to focus on human behaviors, for example, we can investigate these questions in the Soapbox system:

- How do people react to the system when seeing it?
- How does a speaker interact with the Soapbox when he/she stands on the Wii Balance Board?
- What is the feedback (like, dislike, comments and report) for each speech?

Descriptive studies can involve collections of qualitative data such as interviews data, observational data and questionnaire data, or it can describe categories of quantitative data such as age, gender, speech information and audience comments. While in-depth descriptive research with small amounts of data can still yield significant results and findings. Since descriptive research is aimed at finding out how users interact with the Soapbox system for civic engagement, it is important to use observational and survey methods (questionnaire and interview) to collect descriptive data.

With the database maintained by the Soapbox system, we can obtain summary data such as all speeches, all comments and other feedback from the audience. Usually, survey research contains more details and information than descriptive research because we need to draw some inferences after that. Descriptive research includes a certain number of variables for analysis, which can be employed for
analyzing the correlation between different variables. For example, in the Soapbox system, we can test the relationship between age and comments, gender and comments. Further, descriptive research is able to report a general summary of a single variable such as all speech topics. In general, descriptive research utilizes data collection methods and analysis tools to report the central tendency, relationship and variation of a system. The most significant advantage of descriptive research is that it combines the correlational statistics and characteristic summary, which focuses on different types of research questions and outcomes.

4.2. Lab Study

In order to test the usability of Soapbox, we set up two public displays in the Ubicomp lab. One of the public displays that is placed in portrait position is used for running the Soapbox client to deliver a speech, and the other one placed in landscape position is regarded as the interactive platform for audience. As is seen in Figure 24, evaluation sessions are conducted by two participants: one participant acts as the speaker, and the other plays the part of audience. During the session, participants were asked to carry out pre-defined tasks. For the purposes of the study, they were not allowed to ask us how to deal with the tasks but should speak their thoughts out when they came across problems. This method is called “think aloud protocol”, which is used to collect data in usability testing.

![Figure 24. Two participants interacting with the Soapbox system.](image)

For different roles, they had different tasks. The speaker was asked to activate the Soapbox system and start a speech. Content of the speech was prepared by researchers and given to the speaker before the test started. During the speech, the speakers were required to not only read the provided speech, but also notice the feedback from the audience, for example answering questions. When a speaker finished the speech, s/he was asked to end the speech. The predefined speech content is as follows:
“Why education is important? Firstly, it can bring confidence to us. We can achieve nothing if we do not trust ourselves. Education is the best way to bring self-confidence in us. Second, it ensures us a brighter future. Educated people usually lives happy life and they have a bright future because they have more job opportunities. Education can motivate our talent and skills as well. Finally, it can spread awareness in the world. People with higher education will have a wide knowledge of the world and not just blindly follow others when they meet problems. With the understanding of everything on their own, an educated person can explain the logic and reasons behind any happening to those who have no idea of what it is.”

At the same time, the participant acting as audience was ready and waiting for a speech in front of the other display. After a speech started, the audience participant was asked to finish the following tasks without instructions:

1. Watch the speech
2. Give thumbs-up to the speech
3. Give thumbs-down to the speech
4. Report the speech
5. Send a comment to the speech
6. Ask the speaker a question.

During the testing, we watched how the participants interacted with the displays and took notes of their behaviors and thoughts. After finishing all the required tasks, we interviewed the participants with several semi-structured questions. When the interviews were done, the participant acting as a speaker and the participant acting as audience would exchange their roles and experience the system again, and complete another questionnaire and interview afterwards. The basic idea is to let each participant test the Soapbox system both from as a speaker and a member of audience, in order to provide them with a comprehensive understanding of the whole system. After that, the participants were asked to fill in a questionnaire generated by AttrakDiff (Appendix 1) to evaluate the system.

After two rounds of testing for each group, we finally showed a video demo (Figure 25) about the virtual Soapbox and asked the participants whether they would like to use it. The reason why we did not ask users to operate the virtual Soapbox is that the virtual part and the middleware are not implemented for testing yet. When the participants had an overall view of the virtual Soapbox, we asked them which part they prefer, physical or virtual part. After these final short interviews, one group testing was done and chocolate was given to them as a reward. Altogether twelve volunteers participated in the lab study and all the results will be summarized in Chapter 5.

Figure 25. Virtual Soapbox demo.
Despite lab testing being an efficient method to identify problems, it is not sufficient to study users’ behaviors because the testing environment is limited and private compared to public space. Further, lab studies are usually conducted for only a few hours, and fail to evaluate the impact of the surroundings in public space. However, we cannot say that “in-the-wild” study is absolutely better than controlled lab testing because it requires extended time and resources to conduct in the real world. Therefore, in this thesis, the “in-the-wild” study was deployed to explain how people interact with Soapbox system and whether the system can promote civic engagement.

4.3. Field Trials

In the work of [71], researchers posit that urban computing systems are closely tied to the environments where they are deployed and to the people who interact with them in the environments. As is mentioned in [72], in-the-wild deployment is a good way to study the interactions between urban computing applications, the local citizens, and the environment. When deploying urban systems in public space, we should have a good understanding of the public space and not ignore the real world context.

After analyzing the feedback from the lab study, we changed the tips of scanning QR code so that users could understand how to send comments. Then we conducted a more realistic study in the populated areas in the campus of the University of Oulu, such as along busy walkways (Figure 27). When someone passed by the Soapbox display, it would play the auditory icon “ahem” to attract their attention. People who sat down near the Soapbox just ignored the sound intentionally because the continuous audio in public spaces was regarded as noise. During the field trials, we used four displays (46” full-HD LCD panels with overlaid touch screen), including the Soapbox display and three audience displays, which were deployed at four different locations throughout the campus (Figure 26) so that a display was deployed near all major faculties of the university. Therefore, when speakers started a speech with Soapbox, they would get the walkways’ view before the three audience displays, thus making them feel that they were talking with a real audience instead of a lifeless screen.

![Figure 26. Deployment in the campus.](image)

The “in-the-wild” study ran for seven weekdays. A navigation map was placed on each audience display to show directions to the actual Soapbox for users who want to deliver a speech themselves. In Figure 27, we can see that many passers-by were interested in the new devices, especially the Wii Balance Board. An encouraging
sticky note, which read, “Step on me” was placed on the Wii Balance Board to motivate passers-by to experience the Soapbox system.

![Figure 27. Users interacting with Soapbox.](image)

We collected many sets of data in the local database, such as the number of users stepping on the smartboard, inputted speech information, the number of online audience and the feedback from audience. When a user feels being observed by someone, s/he will perform differently, for example, more efficiently or more conscientiously. To solve this problem, we should stay invisible to users while they are interacting with the system. As invisible researchers, we conducted observations (28 hours), during which we stayed at secluded places near the displays to make sure that passers-by would not feel that they were spied on. In addition, semi-structured interviews (n=21) were conducted when passers-by finished interacting with the displays and had moved away from them. In this way, other passers-by would not think that they would be interviewed once they used the system.

After each interview, the participant was asked to fill in a short questionnaire to evaluate the usability and user experience of the system. Based on the survey of user engagement in [73], we designed a questionnaire for our study. The questionnaire (Appendix 2) is composed of five attributes of engagement, including 1) perceived usability, 2) aesthetics, 3) endurability, 4) novelty, and 5) involvement. Each attribute consists of two items, which was rated by the users with a 5-point scale. Finally, we gave each interviewee a chocolate as a gift. The results and findings of the log data, interviews and questionnaire are presented in the next chapter.

In the following chapter, the results of quantitative and qualitative data analysis are presented. This chapter describes usage statistics on each display. The speeches and comments are classified into several categories based on the content. Moreover, the chapter presents the result of observations, interviews and questionnaire. Then, the effect of speech topic, the audience feedback and the honey pot effect are discussed. The chapter also simply compares the physical and virtual Soapbox.
5. RESULTS AND FINDINGS

This chapter describes the results and findings of the lab study and field trials. It serves as an important evidence to answer the research questions posited in Chapter 1. First, the results of the statistical analysis of quantitative data are presented. Second, the results of in-situ observations, interviews and questionnaires are described. In the final section, a brief comparison of physical and virtual Soapbox is discussed based on the lab study in Chapter 4.

5.1. Quantitative Data

This section gives a summary of the log data saved in the local database during the field trials. It begins with presenting the usage statistics of Soapbox, including the speech information and feedback from the audience. Then, the taxonomy of speeches is presented. In addition, the details of the audience feedback are discussed and the taxonomy of comments from audience is presented.

5.1.1. Usage statistics

No users were recruited during the in-the-wild testing. All speakers and audience who interacted with the Soapbox system did this on their own accord, without being encouraged by the invisible researchers. During the seven weekdays’ study, 23 speakers delivered speeches with Soapbox and 39 audience joined Shoutbox via scanning the QR code on other three audience displays. The total speech time is about 79min (average time: 3min 24s per speech). Table 6 summarizes the audience feedback from three audience displays and the Shoutbox.

Table 6. Usage statistics per interaction and per display

<table>
<thead>
<tr>
<th>Interactions</th>
<th>Total</th>
<th>Audience Disp1</th>
<th>Audience Disp2</th>
<th>Audience Disp3</th>
<th>Shoutbox</th>
<th>Avg/display</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thumbs-up</td>
<td>284</td>
<td>47</td>
<td>169</td>
<td>31</td>
<td>37</td>
<td>71.0</td>
</tr>
<tr>
<td>Thumbs-down</td>
<td>18</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>11</td>
<td>4.5</td>
</tr>
<tr>
<td>Report</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>-</td>
<td>0.7</td>
</tr>
<tr>
<td>Total</td>
<td>304</td>
<td>50</td>
<td>174</td>
<td>32</td>
<td>48</td>
<td>25.4</td>
</tr>
<tr>
<td>Avg/interaction</td>
<td>101.3</td>
<td>16.7</td>
<td>58.0</td>
<td>10.7</td>
<td>16.0</td>
<td>-</td>
</tr>
</tbody>
</table>

From Table 6 we can see that the 23 speeches obtained 284 thumbs-up (87% on audience displays and 13% from Shoutbox), eighteen thumbs-down (38.9% on audience displays and 61.1% from Shoutbox) and two reports (all came from audience displays). The reasons that the percentage of thumbs-up on audience displays is much higher than that on Shoutbox is because with Soapbox users can press “like” or “dislike” button only once but it is not limited on audience displays, which might result in abuse of the feedback buttons (thumbs-up, thumbs-down and report). Further, there is no report button on Shoutbox, so all reports during the
testing come from the audience displays. Since most of the speeches were positive, the speakers did not get too many thumbs-down. In addition, audience display 2 has much higher interactions than the other two displays because it was placed near a cafe restaurant. As for the thumbs-down, it shows that the personal devices are more popular than the displays when users want to give thumbs-down to a speech. One possible reason is that people feel embarrassed to give negative feedback in public because they might annoy those who like the speech. More details and findings about the audience feedback are discussed in section 5.1.5.

5.1.2. Taxonomy of speeches

The speech topic can provide some clues about the speakers’ interaction with the system. After seven days deployment time, we conducted thematic analysis of the speech topics. For this purpose, we started to review all the submitted speech information and identified the categories that contain all speeches. To begin with, we agreed on five categories differentiated by the topic itself. This enabled us to understand what kind of topics people want to deliver in public with Soapbox. The six overarching themes that we identified were entertainment, culture, habits, live, education, and topics without a subject.

The entertainment category contains 17% of all submitted speeches. From this category, we can see that there were many parties during June in Oulu. For example, a speaker talked about Middle Summer activities on Nallikari beach. Generally, the topics like “Party tonight!”, “My waste time on mobile games”, “Who plays clash of clans?” and “Back 2 mad” can be classified to this category. The culture category occupies 13% of the speeches. It seems that people like to talk about their hometown and culture in public. “Welcome to Paris”, and “Juhannus” are typical examples of speech topics in this category. The habits category and education category were less popular with each individually occupying 9% of all speeches. For example, “I like Sauna” belongs to habits category and “Finnish is difficult to learn!” is a good example of education category. The live category contains 22% of the speeches. This category shows that some people tend to use the Soapbox as the Facebook live so that they can broadcast something. The topic “A song for you” was a representative example in this category. The last and most popular category was topics without a subject, which contains 30% of all speeches. The trend indicates that many users do not know what to say. Typical topics like “Hey there!”, “lōwqem”, and “Moi” were given in the category. We tried to figure out what “lōwqem” means, but it turned out to be some random letters.

Based on these six categories, we had a general understanding of what kind of topics the users would like to talk about; however, they do not describe much about the motivations behind using the Soapbox. To enhance the classification, we came up with a second method that focuses more on sociology and psychology to explore the speakers’ motives. Finally, we agreed on the second layer of classification that includes six categories: self-introduction, performance, raising awareness, playing with technology, socialization and advertising information.

The self-introduction category occupies 5% of all speeches. It makes sense that an individual does not want to talk too much about himself/herself in public, especially without any purpose. Usually, it takes only a few sentences for speakers to introduce themselves before they start their speech, but seldom would just introduce
themselves during the whole speech. “Olen Pekka” is the most typical topic in this category, but this participant only took about 47 seconds to deliver his speech.

The performance category contains 5% of the speeches as well. Since many live applications are popular, some users also hope to utilize the public displays to broadcast their live performance. Unfortunately, since the field trials was conducted in June when many students were away from the campus, we only received one topic related to the performance - “A song for you”, which is also mentioned in the first layer of classification.

The raising awareness category was the most popular with 30% of the speeches. The results correspond with the initial idea, namely making our voice heard and raise people’s awareness of some issues. The motivation here was to spread the knowledge to the public, such as “Why jogging?”, “My waste time on mobile games” and “History of South China sea”.

The playing with technology category contains 26% of all speeches. As mentioned above, some speeches did not include any clear topics, such as “Hey there!”, “löwqem” and “Moi”. We argue that it was because users just wanted to play with the new technology and tested its features. In this case, the Soapbox was regarded as a toy for some users.

Lastly, the socialization category and advertising information category both occupy 17% of the speeches. For socialization category, users can communicate with strangers in different locations on the Soapbox system since socialization plays an important role in human’s life. “Party tonight!” and “Who plays clash of clans?” were classified to this category. As to advertising information category, public displays are an effective and efficient place to broadcast information, such as “Back 2 mad” and “NISO members: attention!”

5.1.3. Taxonomy of comments

Analyzing the 92 comments posted through Shoutbox during the field trials, we concluded that the comments could be grouped into five categories. The conclusion gave us an overview of how audiences participate in public speeches. The five categories that we identified were encouragement, question, greeting, offensive words and irrelevant comments.

Encouragement was the most popular category occupying 63% of all submitted comments. A trend can be seen that audiences were in favor of public speeches because the majority of them sent positive comments to the speaker, such as “Well done”, “Hyvä”, and “The speech is impressive”. Further, there were some comments that directly encouraged speakers when they felt nervous, for example “Be relax” and “Speak slow”. These comments were meant to support speakers and encourage them to continue their speeches.

The question category contains 8% of the comments. When audiences felt confused, they would send a question to the speaker, such as “Can you explain the disadvantages?”, and “What does Juhannus mean?” In addition, there were several questions that encouraged speakers to continue the speech, such as “Why not continue singing?”, or “Can you talk more about jogging?”

The greetings category contains 21% of the comments. When first time logging in the Soapbox system, many audience members would say hello to the users, such as “Terve!”, “Hi” and “Kippis!” This was a good way to start a conversation with the speaker and other audience members.
The offensive words category occupies the least (3%) of all comments. After analyzing these offensive comments, we found that only one of them was related to the topic, which was “I don’t think so”. The other offensive comments were very offensive without any reasons or opinions. Typical comments like “Bullshit” was classified to this category.

The irrelevant comments category contains 5% of comments. These comments were very irrelevant to the speech; in other words, audience who sent these comments might not focus on the speech. For example, some audience just talked with other audience via Shoutbox. “Hello, bold” was a typical example. In addition, some comments were focused on the Soapbox system while a speaker was delivering a speech. “The system is awesome!”, “Soapbox?”, and “I like this system” are typical examples of comments in this category.

5.1.4. Effect of speech topics

Based on the local database, we found that different categories of speeches received different amounts of comments (Figure 28). Figure 28 shows that in the first classification method, the entertainment category got the most comments (29%), and in the second classification method, the raising awareness category received the most comments (47%) from the audience. Choosing a good topic is important, because it may affect whether the public will pay attention to the speech. For example, the longest speech in the field trials was “My waste time on mobile games”, which lasted for 9min 27s and received 31 comments. Instead, seven speeches without any themes did not receive any comments from the audience. Therefore, we can conclude that a good topic can encourage people to involve in the speech, and in turn, the audience’s engagement will motivate speakers to talk more about the topics.

Figure 28. The percentage of comments for each speech category with two different classification methods.

5.1.5. Effect of audience feedback

During the field trials, 39 passers-by (male: 23, female: 16) joined Shoutbox and sent 92 comments to sixteen speeches. Among these 39 audience members, the majority (95%) pressed the thumbs-up button and sent comments, while 28% pressed the thumbs-down button. Furthermore, 26% of audience pressed both buttons and 3% did not press any feedback buttons and did not send any comments, either. As is
shown in Figure 29, it illustrates the comments category sent by males and females. The chi-square test showed that females gave more encouraging comments to speakers than males ($X^2 = 10.04$, $df = 4$, $p$-value = 0.03976 < 0.05).

Figure 29. Comments grouped by category and gender.

With the user interface on audience displays and Shoutbox, audience can send feedback to a speech. According to Table 6, we can see that the amount of different interactions (e.g. giving thumbs-up, giving thumbs-down and reporting a speech) varies a lot. We ran a one-way ANOVA to verify which interaction is the most popular. The ANOVA result ($p=0.048<0.05$) shows that the audience preferred to give thumbs-up rather than give thumbs-down or report the speaker only if the speech was suitable for public space. This result also indicates that the audience were encouraging speakers to deliver a speech continuously.

5.2. Qualitative Data

In this section, the qualitative data is presented. The section begins with describing the results of in-situ observations. After that, the results of interviews of lab study and field trials are presented. The last section presents the results of questionnaires.

5.2.1. In-situ observations

We conducted 28 hours of in-situ observations during the field trials, i.e. two hours (11.00AM to 1.00PM) for Soapbox and two hours for audience display every day. During the study, two researchers manually observed 105 interactions with Soapbox and another 105 interactions with audience displays. We recorded users’ gender during the observation in case that the gender might make a difference on the study. For people who passed by the Soapbox, we observed their direct interactions such as stepping on Wii Balance Board, submitting speech info, starting a speech and ending a speech. For those who passed by the audience displays, we observed different direct interactions such as scanning QR code, sending comments and pressing thumbs-up/thumbs-down/report buttons. Apart from these direct interactions with the displays, we also observed some indirect interactions such as glances and gestures. Additionally, we observed the social context (i.e. alone, in a group, etc.) in which users interact with the system.

During the observation, we found that most glances were short, which only lasted for few seconds. However, when people were in a group and passed by a display, they had a higher chance to stop and discuss the display, or even approach it and interact with it. When a passer-by was alone and the walkway was busy, the passer-by would just move on without interacting with the display; but when there were few
people near the displays, a passer-by would probably stop and check the content on the display, and some even stepped on the smartboard and started a speech. Since we added the audio signal to the system, people walking and playing with their phone would look up and see what happened when they heard the sound from the Soapbox. It is interesting to see that some groups of users stepped on the smartboard one by one to try the Soapbox. Although their interaction was short without any speech, the behaviors indicate that people were curious about the new public setting. In addition, some users kept stepping on and off the smartboard to see what happens, and some of them started a speech but some just walked away after the trial. Some users who were waiting near the displays would walk around the Soapbox for many times instead of stopping in front of the display. Since there were not many people in the campus, a speaker would shake his/her hand and keep saying hello to the camera for a certain time in order to attract people’s attention while making a speech until someone stopped and communicated with him/her. Some speakers would press the end button if nobody showed response to them.

As to the potential audience, they behaved a little different from the users who passed by the Soapbox. When there was no speech, a note saying, “No speech yet, please wait” seems not to work well because some curious audience still scanned the QR code and pressed the buttons (i.e. thumbs-up, thumbs-down and report buttons) on the audience displays. When there was a speech, a passer-by would stop and say hello to the camera because s/he could see and hear what happened on the other side. Some passers-by felt surprised when they saw someone saying hello to them on the audience displays. In addition, during a speech, many audience members would first press the buttons instead of scanning the QR code. When they noticed that someone was scanning QR code and sending comments successfully, they would do so as well, which can be called imitation. Still, some passers-by just glanced at the display for a few seconds even if a speech was being delivered. The most interesting behavior was that a girl passed by a display and found her friend making a speech, and then she stopped and kept pressing the thumbs-up button for a long time, which is one of the reasons that audience display 2 has much higher interactions than other displays. In total we observed nineteen users (twelve males and seven females) scanning the QR code. In general, more females stopped in front of the displays. It shows a trend that females were more willing to interact with the audience displays but males preferred to use their smartphones. It was common that some users just pressed the buttons without a stop when they passed by the audience displays. Moreover, a few audience members did not know how to send comments to the Shoutbox, and they looked around the screen and just clicked everywhere on the screen in order to trigger a virtual keyboard.

5.2.2. Interviews

To begin with, we evaluated the Soapbox system in the Ubicomp lab with twelve participants (six males, six females) recruited randomly from the University of Oulu. Eight of the participants have technical background and four of them are non-technical. During the lab study, we conducted small-scale interviews with five questions for both the speakers and audiences (see Table 7).
Table 7. Interview questions for lab study

<table>
<thead>
<tr>
<th>For speakers:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1: Do you find any problems while using the system?</td>
</tr>
<tr>
<td>Q2: Is there anything in the user interface you do not like or would you change something?</td>
</tr>
<tr>
<td>Q3: Was there anything about the system you specifically liked?</td>
</tr>
<tr>
<td>Q4: What do you think the feedback from audience, like thumbs-up, thumbs-down, report and comments?</td>
</tr>
<tr>
<td>Q5: If the system were deployed in the city center, would you like to deliver a speech? Why?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>For Audience:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1: Do you find any problems while using the system?</td>
</tr>
<tr>
<td>Q2: Is there anything in the user interface you do not like or would you change something?</td>
</tr>
<tr>
<td>Q3: Was there anything about the system you specifically liked?</td>
</tr>
<tr>
<td>Q4: In the future, will you join Shoutbox when someone is delivering a speech? Why?</td>
</tr>
<tr>
<td>Q5: Do you like the way to communicate with the speaker and other audience? Why?</td>
</tr>
</tbody>
</table>

As to speakers, the results of the interviews are as follows: regarding question 1, ten respondents did not find any problems while using it, and two respondents complained that the camera was too high for them so that they had to look up to the camera all the time. Nine interviewees did not find any problems with the user interface and thought that we did not need to change anything (Q2); however, three participants said that they hope to hear the audience’s voice. All participants were in favor of the function of viewing the comments and feedback from the audience (Q3), and two participants mentioned that it was easy to start a speech. Furthermore, regarding question 4, ten respondents thought that the feedback could encourage them to continue the speech but they prefer to see the positive feedback rather than the negative feedback such as thumbs-down and report. Besides, one respondent said that the comments and feedback from the audience would affect her mood no matter what it was, so she chose to ignore them, and one respondent said that he did not care about the audience feedback. Lastly, regarding question 5, three respondents thought that they would deliver a speech in the city center, and seven respondents said that they might use the Soapbox in the future but it depends on whether they had good topics. What is more, one respondent reported that he would use it if he loses something such as keys, and another respondent said that he would not use it in public because he is too shy to speak with strangers.

Concerning the audience, the results of the interviews are as follows: during the lab study, only one interviewee finished the task of sending comments in a short time; however, eleven interviewees spent lots of time on sending comments because they did not know where to enter the Shoutbox (Q1). What resulted in this situation was the fact that the previous tips “Scan me to join Soapbox” above the QR code was a little confusing, and they suggested that the tips should be more direct. Therefore, we changed the tips to be “Scan QR code to send comments” in the later field trials. Ten respondents thought that the user interface on the audience displays was clean and accessible, but two of the respondents reported that the system should enable them to input comments through the audience display (Q2). Regarding question 3, eight respondents stated that it was convenient to send comments by personal devices because it protected their privacy while typing something. Four respondents thought that the buttons were very impressive, especially the report button. As to question 4,
five respondents said that they would join Shoutbox in the future, and six respondents stated that they might join Shoutbox but it depends on the speakers and their topics; however, only one respondent reported that he would not participate in this kind of activities because of his personalities.

Furthermore, during the field trials, we conducted 21 (seven speakers, fourteen audience members) semi-structured interviews. Concerning speakers, four of them are females and three of them are males; five of them have technical backgrounds and two of them are non-technical. As to audiences, eight of them are males and six of them are females; ten of them have technical backgrounds and four of them are not technical. The interview questions are as follows (Table 8):

Table 8. Interview questions for field trials

<table>
<thead>
<tr>
<th>For speakers:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1: You just interacted with the “Soapbox”. What made you decide to stop and interact with the display?</td>
</tr>
<tr>
<td>Q2: Did you deliver a speech? If yes, how do you feel about it? If no, why did you not make a speech? What prevents you from making a speech?</td>
</tr>
<tr>
<td>Q3: Does this system encourage you to deliver a speech? Why?</td>
</tr>
<tr>
<td>Q4: What kind of topics do you like to deliver in public?</td>
</tr>
<tr>
<td>Q5: What do you think about the feedback on the display? Like thumbs-up, thumbs-down, report and comments?</td>
</tr>
<tr>
<td>Q6: Will you use this system AGAIN in the future? Why?</td>
</tr>
<tr>
<td>Q7: Do you have any suggestions to improve the system?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>For Audience:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1: You just interacted with the “Soapbox”. What made you decide to stop and interact with the display?</td>
</tr>
<tr>
<td>Q2: Would you like to deliver a speech in public? Why?</td>
</tr>
<tr>
<td>Q3: Do you like the way to communicate with the speaker and other audience? Why?</td>
</tr>
<tr>
<td>Q4: Does the system encourage you to join public speech? Why?</td>
</tr>
<tr>
<td>Q5: What do you think about the feedback on the display? Like thumbs-up, thumbs-down, report and comments?</td>
</tr>
<tr>
<td>Q6: Which kind of topics do you like to hear most? Why?</td>
</tr>
<tr>
<td>Q7: Do you have any suggestions to improve the system?</td>
</tr>
</tbody>
</table>

The results of the interviews for speakers in the field trials are as follows: regarding question 1, four respondents claimed that it was the curiosity that made them decide to stop and interact with the display, while three respondents stated that the “ahem” sound attracted their attention and the demo video on the instruction page encouraged them to interact. Six interviewees delivering speeches stated that it was a great experience to speak in public, and they just talked about something they wanted to say (Q2). One respondent reported that he started the system but nobody was there, so he quit his speech in a short time. All respondents stated that the system encouraged them to deliver a speech in public (Q3), with five respondents saying that it was because they could see all the feedback from the audience in real time and they could answer the questions immediately, and two respondents saying that it was because of the innovation of the new technologies. Four respondents said that they would like to deliver speeches related to different cultures to help people know more about the world (Q4), while two respondents preferred saying something funny in the public, and only one respondent stated that she would like to talk about politics in the
Regarding question 5, five respondents thought highly of the feedback because they could give quick responses to the audience based on the feedback; however, two respondents reported that they did not get any feedback but they were looking forward to it. Further, three respondents thought that they would deliver a speech in the future because they like talking in public (Q6), while four respondents thought that they might deliver a speech if they had good topics since these users did not want to talk about something meaningless. Lastly, regarding question 7, four respondents thought that the system was good enough, so it did not need any improvement, while two respondents reported that the touch screen was not sensitive and only one respondent reported that the sound from the display was too low to hear.

For the audience, the interviews results are as follows: regarding question 1, eleven respondents reported that they stopped because they found someone making a speech and they scanned the QR code based on the tips above the image, while two respondents stated that it was because their friends stopped, and only one respondent said that the speaker was his friend. Some respondents were not good at speaking in public, with nine of them saying that they would not deliver a speech in public, and three of them stating that they might make a speech if necessary, and two respondents saying that they would but they did not know what to say. All respondents thought it was a good way to communicate with the speaker and other audiences because the synchronization of the feedback was fast (Q3). All respondents stated that the system could encourage them to join public speech with several reasons (Q4): 1) it is convenient to get access to the Shoutbox; 2) the discussion between audiences can encourage them to join the speech; 3) the comments are anonymous; 4) the system works smoothly with low delay. Further, all respondents thought that without the buttons on audience displays and Shoutbox, nobody would use the system (Q5), and eight respondents also mentioned that they hope the speakers would make responses to their comments immediately instead of ignoring them. Regarding question 6, five respondents said that they preferred some interesting topics such as jokes and performance, while six respondents stated that they would like to hear positive opinions from the speech, and two respondents reported that they were interested in sending comments to current affairs, and only one respondent claimed that he was not sure. Regarding the final question, nobody gave any suggestions to improve the system because they thought that the system was accessible to them.

5.2.3. Questionnaires

Questionnaire is an effective and efficient survey tool to evaluate the usability and user experience of an interactive system. Since we conducted both lab study and field trials during the whole evaluation, we will present the results of the two questionnaires in this section.

In the lab study, the questionnaire was generated by AttrakDiff. AttrakDiff is a scientific survey tool that enables recording and measuring the attractiveness, the hedonic quality and the perceived pragmatic quality of an interactive system. Figure 30 illustrates the hedonic and pragmatic qualities of the Soapbox system. In the Figure, we can see that both the value and confidence of pragmatic quality (PQ: 1.79, confidence: 0.36) are higher than those of the hedonic quality (HQ: 0.99, confidence: 0.22), which means that the system tends to be more pragmatic. Additionally, the
Figure 30. Portfolio-presentation (N=12; PQ: 1.79, Confidence: 0.36; HQ: 0.99, Confidence: 0.22)

Figure 31 illustrates the average values of four dimensions (i.e. PQ, HQ-I, H HQ-S and ATT). It shows that the value of HQ-I (1.25) is higher than HQ-S (0.74), and the rating of attractiveness (ATT: 1.93) is between the above region and average region, which means that the prototype is attractive and impressive to users, but it still needs some improvement. This result is corresponding to the results of interviews in the lab study since users complained that it was difficult for them to send comments.

Figure 32 illustrates mean values of the word pairs that describe the Soapbox system. The results show that the Soapbox is perceived as a simple, practical, straightforward, predictable, stylish, attractive, inviting, appealing and motivating
system, which means that users have a positive experience while using the prototype. With Soapbox, people felt connected to others. Overall, the result shows that the Soapbox system is implemented with attractive design and practical functions.

Figure 32. Description of word-pairs of Soapbox.
During the field trials, a questionnaire with ten questions on a 5-point scale (1 = strongly disagree … 5 = strongly agree) was given to participants. Altogether, 21 questionnaires were collected. 86% of the respondents were aged between 21 and 30, and the remaining 14% were aged between 31 and 40. Figure 33 illustrates the average rating of each question. With regard to perceived usability, the participants thought that the Soapbox system was easy to use and the functions were sufficient for civic engagement. As to aesthetics, the results show that the design of Soapbox is attractive and pleasing. Further, respondents thought that it was worthwhile to deliver a speech with Soapbox and they would like to recommend it to their friends and family. Regarding novelty, the respondents agreed that the Soapbox could incite their curiosity and continue to use it. Lastly, the respondents thought that using Soapbox was fun and they felt involved during the speeches.

5.2.4. The honey-pot effect

The honey pot effect [17] was obvious in our study. This effect made a significant difference in increasing the number of speakers and audience in civic engagement. When a person started a speech, those who passed by the Soapbox would stop and see what he/she was doing (Figure 34). With regard to the audience displays, when an audience was watching a speech in front of a display, a passer-by had a high chance to stop and watch the speech. It seems that usually people are curious about new things. Even if they did not try it, they would see how others interact with it. As more and more people stopped and watched the speech, more audience scanned the QR code and joined the Shoutbox. In the realistic testing, if we take advantage of the
honey-pot effect, we will not need to worry about nobody interacting with the system.

Figure 34. The honey pot effect.

### 5.3. Comparison between Physical and Virtual Worlds

In the lab study, we showed a demo video of virtual Soapbox to the participants in the end of the session. They were asked to compare the physical demo that they just experienced and the virtual demo in the video. Although it was not equal to compare them in this way, we could have a rough understanding of users’ attitude towards the 3D world. According to the interview, 83% of the respondents said that as a speaker, they were willing to try the avatar while making a speech; however, they did not want to see virtual audiences because they thought it stupid to talk with lifeless objects. The remaining 17% stated that they would not use a virtual Soapbox to deliver a public speech because sitting at home is quite different from standing in the public speech corner and they could not feel the audience in the virtual world, which might discourage them to continue the speech.

As audience, all respondents reported that they would not watch a speech made by an avatar, not only because that the 3D world would increase the distance between humans, but also because that they could not focus on the speech with the scene in 3D world. These respondents also claimed that even if they would see the real face of the speaker, they still did not want to watch a speech at home alone since the atmosphere of discussion and debate is very crucial in civic engagement.
6. DISCUSSION

This chapter summarizes the main contributions of the thesis. To begin with, the achievement of objectives is analyzed and the research questions are answered. The second section discusses the public displays for civic engagement. Then, the lessons from the field trials are presented. After that, the limitations of the study are discussed. Finally, the chapter states the future work of the study.

6.1. Achievement of Objectives

Returning to the objectives and research questions proposed in section 1.2, we have achieved the primary objectives and made some contributions with this study. The main objective of this study is to develop an interactive system to promote civic engagement with current media technologies. Based on the analysis of requirements, we designed and implemented an interactive platform called Soapbox for local citizens in Oulu. With camera sensor and the Wii Balance Board, users can be easily detected and activate the system to deliver a speech. After two rounds of testing (lab study and field trials), the Soapbox platform turned out to be well designed and accessible to users. Speakers and audiences who participated in the field trials thought highly of the system and claimed that they would use Soapbox to attend civic engagement in the future. In case that plenty of citizens might use it to deliver a speech, we designed booking function and lock mechanism that was well integrated with the Soapbox platform. For both the design part and the technical part, the Soapbox is successful in achieving the objectives.

Regarding the research questions, we have to figure out how speakers and audience experience and interact with Soapbox platform in public space (RQ1). Results from the lab study show that for speakers and audience, the Soapbox is perceived as a simple, practical, straightforward, predictable, stylish, attractive, inviting, appealing and motivating system. Speakers with or without speech topics showed strong curiosity with the Soapbox system. Speakers tended to try the Soapbox in two situations: 1) when their friends were with them; 2) when there were few people near the Soapbox display. Some speakers would keep stepping on and off the smartboard to see what happens, and then start a speech. Usually, speakers would spend one to two minutes on saying hello to the audiences or trying to attract audiences’ attention. The evaluation showed that the speakers were fully involved in the speech and the experience of using Soapbox was quite fun. Furthermore, the audience felt surprised and stopped before the audience displays when they found someone saying hello to them on the audience displays, and with the honey pot effect, more and more passers-by would stop and see what was happening. During a speech, many audiences would first press the buttons instead of scanning the QR code. When they noticed that someone was scanning QR code and sending comments successfully, they would do so as well, which can be called imitation.

Regarding RQ2, we have found that the Soapbox platform can make a significant difference in promoting the civic engagement. During the field trials, speakers successfully delivered 23 speeches with the Soapbox platform, and 39 audience members joined the Shoutbox via scanning the QR code on one of the three audience displays. As a result, 92 comments were sent to sixteen speeches during the campus testing. In the public space of the campus, users’ motivation of using Soapbox were:
1) self-introduction, 2) performance, 3) raising awareness, 4) playing with technology, 5) socialization and 6) advertising information. Speakers felt encouragement when they saw the comments and feedback such as thumbs-up, thumbs-down or even reports from the audience, and they would continue speaking and discussing with the audience. The longest speech lasted for 9 min 27s and received 31 comments. The comments sent by audiences were identified by five categories: encouragement, question, greeting, offensive words and irrelevant comments, with 63% of comments encouraging speakers to continue the speech. The feedback tools such as the buttons on audience displays and the Shoutbox built a bridge between the speakers and audience to communicate with each other. Further, all respondents in campus testing stated that the system would encourage them to join public speech with several reasons: 1) it is convenient and easy to get access to the Shoutbox; 2) the discussion between audiences can promote them to join the speech; 3) the comments are anonymous; 4) the system works smoothly without high delay. Several audience members claimed that the synchronization of Soapbox enabled them to get instant responses from the speakers when they sent comments.

Generally, the study has achieved success in designing and deploying an interactive Soapbox platform for public space. The appealing visual layout and the implementation of detection function can attract attention and entice people to use it. The accessibility and real-time capability of the platform make it easier for the citizens to deliver a speech or participate in a speech. For the current implementation, the results and findings of lab study and field trials can serve as the only validation for the achievements of objectives and answers of research questions. As a conclusion, we believe that the acceptance from the speakers and audience proves the potential of the Soapbox platform.

6.2. Public Displays for Civic Engagement

By utilizing a network of public displays that are equipped with cameras, touch screens and computers, it is possible to design a socialized platform for citizens to participate in civic engagement, which is seen as non-technical tasks in the physical world. In our study, we not only focus on the design and building of the installations in the cyber world, but also more importantly merging these technologies with the physical world, which means building a situated platform in urban spaces that allow citizens to access it in order to express their opinions to the public. It is crucial to design an interactive and playful user interface because it can lower the barrier of participation and encourage people to take part in civic engagement. In our study, we succeeded in gathering numbers of speech topics from speakers and feedback from the audience. An important design element is that we took advantages of the collaborations between personal devices and public displays, and designed the Shoutbox for audiences to participate in a speech. Audiences were willing to give thumbs-up or thumbs-down to a speech through public displays or the Shoutbox. Live comments from the Shoutbox have been proven an effective and efficient way of participating in civic engagement. Deploying the Soapbox platform in a right spot can attract more attention and entice more interactions.

When designing the platform for civic engagement, one big problem is how to encourage people to deliver a speech or participate in a speech. First, we should attract people’s attention on the displays. In our study, the audio signal “ahem” and the new device (Wii Balance Board) are applied to the prototype to attract awareness.
Second, it is crucial to let the passers-by know that the public display is interactive. By showing a short instruction video on the display, users can easily understand how to interact with the system. Third, it is important to place the display partially above the average head height so that people can notice it from a distance. Fourth, we should create a comfortable atmosphere for users, for example, the public displays should be placed in a busy space where people walk around now and then, so that users will not feel different from others. Last but not least, to encourage people to start a speech quickly, the Soapbox system is designed with lightweight settings. People can easily deliver a speech with two steps: 1) submit speech information; 2) Press “Start Speech” button. The Soapbox system can also recover from mistaken operations automatically, for example, if a speech ends but the speakers forget to end the speech, it will automatically redirect to the instruction page in a short time. The user interface of Soapbox is clear and friendly to users, so that users will have an enjoyable experience with it.

During the interviews of lab study and field trials, many respondents expressed concern about the use of Soapbox. Some respondents believe that it is not a good idea to use it just for political speech because the society might get into trouble if the debate happens every day. Our initial idea of the Soapbox is not to create trouble but to increase civic engagement. Today, the civic engagement has a broader definition and it is not limited to serious topics such as political issues and current affairs. The Soapbox platform can be regarded as another form of social network that exists in public space, so it can be utilized for wider use. For example, companies can use it for product marketing; artists can use it for artistic performance; supermarket can use it for shopping guidance. We believe that other use of Soapbox, in a sense, can promote people to use it for a traditional civic engagement.

6.3. Lessons from the Field

Although the field study only lasted for seven weekdays, we still obtained much valuable experience and lessons and feel it necessary to highlight what we should notice in the later relevant study. The trial was conducted in-the-wild, and all passers-by were able to use it freely at any time. However, this kind of deployment also brought many problems. Since the hardware (Mac mini, camera and all cables) of Soapbox was totally exposed to the outside, some people would rotate the camera to focus on them when they were not captured with good position. It is difficult to solve this problem because different people have different height. One possible solution is to build a shelter for the hardware so that users cannot change them at will. Furthermore, when deploying in-the-wild study with public display, we must make sure that users cannot access or change any settings on the display device. This is the first lesson from the field, and other lessons are listed as follows:

**Playful design is important.** Many studies suggested that a playful design for systems on public displays would contribute to a successful civic engagement [61]. For the Soapbox system, the audience felt curious and playful when they first used the Shoutbox. However, the limited functions (sending thumbs-up, thumbs-down and comments) were not sufficient to support continuous interactions, which is why some audiences gave up Shoutbox in a short time. The simple and clear layout of the Shoutbox provided easy access to send feedback, but also made audience feel bored. In the later study, we should consider designing playful as well as accessible layout
for the systems, for example, we can add some continuous appealing “thumbs-up” animations to the Shoutbox.

Avoid display blindness. There are two kinds of display blindness: intentional and inattentional. Intentional means that people do not care about it and try to ignore it, which cannot be avoided. However, the inattentional blindness can be avoided by applying right technologies and deploying the display on the right spot. In our study, audience display 3 placed near the campus library faced this problem because the sunshine was so strong that people were unable to see the content clearly. No matter how we changed the position, it still did not work. Therefore, we moved the display to another place near the library. Further, we added the audio signal to the system, so that when a human was detected, the display would play the sound to attract people’s attention.

Maintenance matters. In-the-wild study does not mean that researchers can take a rest after the deployments; instead, we have to check the deployment every now and then. For our study, we did not know how long the battery of Wii balance Board could support the study, so we had to check the battery life every morning. We also had to refresh the web pages on all displays every day because the poor quality of Mac mini did not support the system running smoothly all the time. The maintenance of the system is important because we cannot predict what kind of accidents will happen. Only in this way can we guarantee that they system will work well.

Performance is King. A real time system should be able to share information with low delay. The users might lose interests if they spend too much time on waiting for the response. In our study, some audience felt angry and pressed the thumbs-up button heavily when they did not see the number of thumbs-up increased. This problem was caused by the touch screen, which would become insensitive randomly. The best solution is to change a new touch screen. However, our system still works quite well, with 73% of the respondents stating that the speech video was not stuck and was of high quality, and the feedback could be synchronized to all displays immediately.

6.4. Limitations

We fully acknowledge that the lab study and field trials have some limitations. Although we collected sufficient data for the thesis, the statistics used in the analysis might still be questionable. First, the problem with the field trials is that the testing space and users were limited because the study was conducted in the campus of the University of Oulu and many students were away from the university in summer. Since the user population mainly consisted of the office staff and college students, it is difficult for us to study the human behaviors of other ages of users such as children and elderly people who interact with the Soapbox. Similarly, we cannot analyze how people interact with the system in other situations such as rainy day, middle night and noisy street, etc., all of which might significantly affect the usage of the given system.

Second, the field trials lack the control of speakers and audience. As was mentioned in Chapter 5, some audience kept pressing the thumbs-up button during a speech, which became a challenge to analyze the correlation between speech topics and audience feedback. Therefore, we had to spend more time and energy to collect and analyze data from observations, interviews and questionnaires, and further compared the results of quantitative data and qualitative data. We nevertheless
believe that the results are valid and sufficient for answering the research questions in this thesis.

The third limitation is that the lab study cannot make participants experience the full system. Since many public displays were occupied by other studies, only one audience display was available for the lab study. Therefore, the speakers could only see one scene from the audience display, which made the Soapbox system look like an online chat application. However, we explained what the full Soapbox would look like to the participants and tried to make them feel as if it was a real speech.

The last limitation is that the testing time (seven weekdays) is too short for the field trials study. Within the limited days, we cannot collect enough data to analyze some factors’ effect on the study, such as gender, age and profession. Additionally, we are unable to analyze the effect of novelty with the limited data. Therefore, we assume that people would not try thumbs-down or report buttons when they felt the speech was good.

### 6.5. Future Work

This section discusses how to continue the study in the future. All the issues and work discussed here are aimed at improving the system and enhancing the results of statistical analysis.

The first urgent work is to deploy the Soapbox system to the city center. As we mentioned in the limitations section, we need to enlarge the testing space and make different kinds of people to interact with the system so that we will get reliable data to analyze the effect of gender, age and different contexts. Since most of the citizens speak Finnish in the city center, we need to translate all documents such as interview questions and questionnaire into Finnish. Deployment in the city center is much more complex than that in the campus, so more accidents such as breaking the displays or stealing cameras should be considered before we start the testing.

Second, we should think about how to get people to interact with Soapbox. People who are taciturn by nature might not be willing to make a speech in public. Here are some methods to encourage people to deliver a speech: 1) invite famous or interesting people to deliver speeches; 2) deploy the system in different places, such as supermarkets and shopping malls; 3) ask a helper to use the system at the start of the testing [17]. The basic idea is to show some live examples to the Oulu citizens so that they have a full understanding of Soapbox.

Third, if the Soapbox system is so popular that large numbers of citizens want to deliver a speech, we can start to use the fullest version of Soapbox mentioned in Chapter 3, with booking function and lock mechanism. Further, we can apply face detection to the system in case that some participants abuse the feedback buttons, such as thumbs-up, thumbs-down and report buttons.

Fourth, we should enable the Shoutbox to detect and control dirty words. Since the Soapbox system is deployed in the public space, the use of dirty words will have a negative effect on the children. In addition, the system should provide speakers with some pre-defined topic categories, so that they will not feel confused about their speech topics. Further, speakers should be able to change their topics during their speeches. Finally, some audience stated that they hope to send a voice message to speakers through their personal devices. Therefore, in the future, we can add the voice recognition techniques to the Shoutbox so that users will have a more playful experience.
7. CONCLUSIONS

In this thesis, we presented a study that designed and evaluated an interactive Soapbox platform for civic engagement. The Soapbox platform consists of three parts: Soapbox for speaker, Soapbox for audience and Shoutbox. With Soapbox, speakers can deliver a speech and the audience can send feedback to a speech. Unlike previous work focusing on the traditional media platforms, our work aims at merging the current new technologies with the traditional speech ways, so that more people will be able to deliver a speech and have their voice heard. The core architecture of the Soapbox is the communication and synchronization between different public displays. Further, the design and implementation of the Soapbox platform were presented. This thesis also presented the lab study and field trials that conducted in the campus of University of Oulu.

After analyzing the statistics of quantitative and qualitative data, we found some significant results. During the 7 weekdays’ field trial, 23 speakers delivered speeches with Soapbox and 39 audience joined Shoutbox via scanning the QR code on other three audience displays. The speech topics were classified based on two different taxonomy method, and the comments were identified with five different categories. With rich observational data, we recorded the details about how speakers and the audience experience and interact with the Soapbox system. With the interviews data, we had a deep understanding of the participants’ feeling about using Soapbox. Results from questionnaires show that the Soapbox platform is perceived as a simple, practical, straightforward, predictable, stylish, attractive, inviting, appealing and motivating system for civic engagement.

Our findings suggest that a good topic can encourage people to get involved in the speech and in turn the audience’s engagement will motivate speakers. Furthermore, we also analyze the relationship between gender and the comments category, and the results show that females gave more encouragement comment to speakers than males. Our findings also indicate that the audience members were trying to encourage speakers to deliver a speech continuously. The honey pot effect made a significant difference in increasing the number of speakers and the audience.

In general, the accessibility and real-time capability of the Soapbox platform make it easier for the citizens to deliver or participate in a speech. The study provided a solid step in promoting the field of civic engagement; therefore, we propose a new theory - technology-mediated civic engagement for further study. Since the current media technologies are developing faster and faster, we will continue and enrich the theory by bringing more new media technologies to civic engagement.
8. REFERENCES


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9. APPENDICES

Appendix 1. AttrakDiff questionnaire for evaluating user experience in lab study

Appendix 2. Questionnaire for campus testing
Appendix 1. AttrakDiff questionnaire for evaluating user experience in lab study

With the help of the word pairs please enter what you consider the most appropriate description for Soapbox.

Please click one item in every line.

- technical
- connective
- unpleasant
- conventional
- complicated
- unprofessional
- attractive
- impractical
- disagreeable
- straightforward
- tacky
- unpredictable
- premium
- integrating
- separates me from
- people
- presentable
- inviting
- creative
- bad
- clearly structured
- appealing
- cautious
- conservative
- captivating
- challenging
- discouraging
- ordinary
- manageable

In the following section we would ask you to give information about yourself and your own experience with the product.

Age

Gender

Education completion

Profession

Is there anything in the user interface you didn't like or would you change something? Please describe here.

Do you think that this system would motivate citizen democracy and civic engagement?

Do you have ideas how we could get people to use this system in public?
Appendix 2. Questionnaire for campus testing

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>No Opinion</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I felt frustrated while using Soapbox.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2. I could not do some of the things I needed to do with the Soapbox system.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3. The Soapbox is attractive.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. The screen layout of Soapbox was visually pleasing.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5. Delivering a speech with Soapbox was worthwhile.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6. I would recommend Soapbox to my friends and family.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>7. I continued to use Soapbox out of curiosity.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8. The content of the Soapbox system incited my curiosity.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>9. I felt involved while using Soapbox.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>10. This experience of using Soapbox was fun.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>