SonicSG: From Floating to Sounding Pixels

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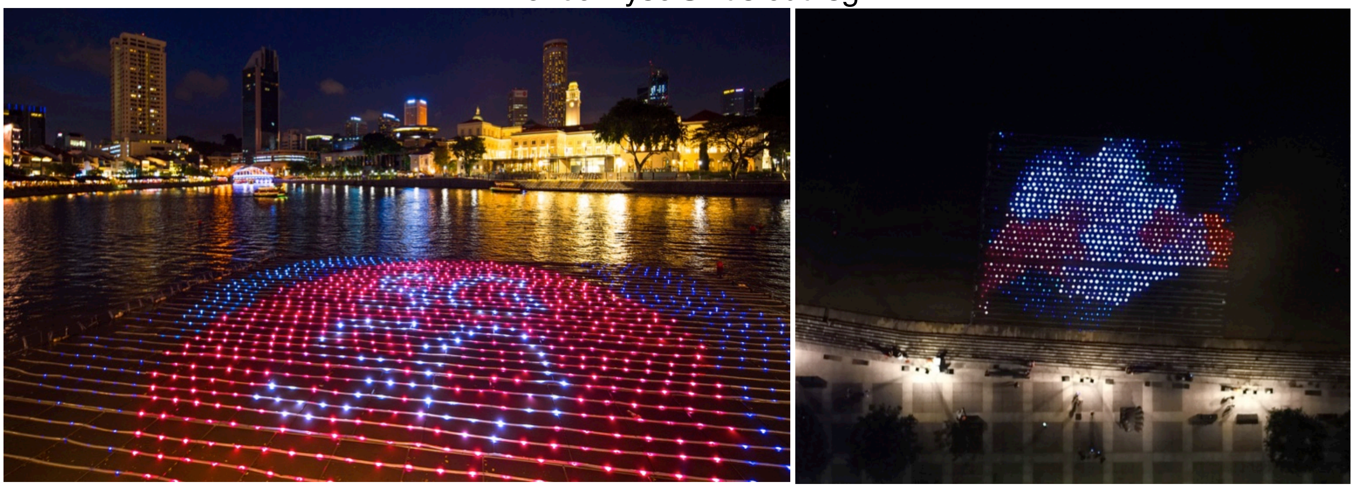

Figure 1. Perspective and aerial view of the SonicSG installation

ABSTRACT
SonicSG aimed at fostering a holistic understanding of the ways in which technology is changing our thinking about design in high-density urban city and how its creative use can reflect a sense of place. The project consisted of a large-scale interactive light installation that consisted on 1,800 floating LED lights in the shape of the island nation. These lights were individually addressable through the network and used to generate light and sound effects. The field of light was extended with “sonified personal pixels” that were created by the audience through personal mobile devices. These personal pixels generated a light and sound “texture” that connected visitors to the light field in the river and to each other. In this paper, we describe the design concept, prototyping and, implementation of as well as the user reactions to this interactive public light installation.

CCS Concepts
• **Applied computing→Arts and humanities;** *Media arts; Sound and music computing*

Keywords
Urban Lighting, Placemaking, Sonification, Experience Design, Interactive Public Installation, Smart City

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1. INTRODUCTION & RELATED WORK

A trend toward overcoming traditional barriers between designers, artists and audiences has been growing in the worlds of design, art and music for decades now. Marcel Duchamp argued that the audience completes the work to construct meaning even in ways the artist may not have specified exactly (Duchamp, 1957). Nicolas Bourriaud (1998) brought the term “relational art” into common, albeit contentious, usage. For him, this meant that a social interaction was necessary for the work to create its meaning. It had a fundamentally temporal nature to it, and it could not be consumed in private like a painting, a book, or television show could. Prior art, for example music (before telephonic and recording technologies were introduced) was generally consumed socially. However, relational art focuses on the social interaction, where participants themselves are responsible for the temporal unfolding of the work. The role of the artist in such works is more of a facilitator through creating the opportunity, the space, the occasion, or an object around which social interaction takes place. SonicSG has a kind of “double ontology” (Bishop, 2012) with both a visual/sonic/interactive aesthetic dimension situated in an urban recreational river walkway, but it is at the same time about the connectedness and interdependence, inviting a direct embodied experience that re-enacts the co-creation of a community. It is simply impossible to have a complete experience the piece alone. In the large body of public light installations (Seitinger & Weiss, 2015), this paper contributes with:

- A case study to explore the synergetic collaboration between design, media art and technology
- Conceptualization, design and implementation of a large-scale public art installation where technology acts as a catalyst in the background

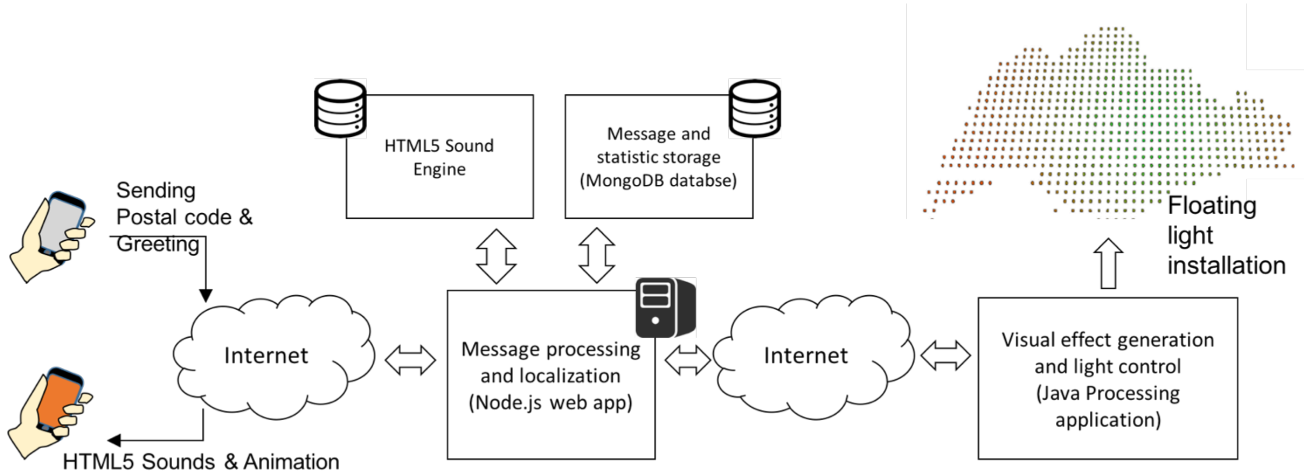

Figure 2. Components and Information flow of SonicSG

2. SONICSG

2.1 Design Concept

Overall SonicSG was aimed at engaging its audience by creating a sense of wonder, curiosity and collective experience, based on cutting-edge technology. It encompassed human experience as a whole, including all of our senses to encourage meaningful interactions (Huber et al., 2015) among and with the environment around us.

The focal point of the work was a 21x27 metre 1,800-LED display that floated on the water nestled in a gentle turn of the Singapore River known as "the belly of the carp" (Figure 3). A map of Singapore glistened in the water, and visitors of the adjacent urban walkway were invited to participate in the work by pointing their mobile device browsers to sonic.sg. There they entered the postal code of their Singapore neighbourhood. After writing a birthday wish and submitting it, a pebble-drop ripple of light emanated from their neighbourhood location in the floating light display. This effect provided immediate feedback and public evidence of their participation, creating a connection between the audinece and the work.

Another "layer of connectedness," in the audience was then established by turning the their mobile phones into a distributed array of "sonified personal pixels." Each phone slowly pulsed a color and tone unique to their neighbourhood at a rate that was a function of the number of other participants from the same neighbourhood. As participants moved around and explored the installation, a light and sound texture was created among the audience, reflecting both the dynamic diversity of neighbourhoods and the unified tapestry they collectively comprise as a nation.

2.2 Implementation

2.2.1 Light Field

iColor Flex LMX LED lights were used to create the 21x37 meter light field. These were 36 flexible strands of 50 large, individually addressable, full color LED nodes. Each node was able to produce a maximum of 6.56 candela of light output while consuming a 1W of power. The light strands were connected to a power supply with an inbuilt Ethernet controller that allowed for individual nodes to be addressed.

After exploring a variety of waterproofing methodologies, including vacuum formed housings, cast silicon casings, and 3D printing, we settled on deploying the lights within customized extrusions of clear PVC hosing used in the medical and food service industry. We worked directly with a contract manufacturer to design a hose extrusion that was both large enough to encase the lights and at the same time flexible enough to be easily workable on site. The layout of the lights was designed such that it created an evenly dispersed grid composed of equilateral triangles. This layout accommodated the most even movement of the light effects across the field of lights. In total, the installation is comprised of 1,800 LEDs strung through about 1 kilometer of PVC hose. The light field covers an area of about 567 square meters.

2.2.2 Software Platform

The software implementation of SonicSG was divided into three main components: (1) the mobile user interface for user interaction (UI), (2) the central processing, storage and content generation (server) and (3) the control unit for interfacing lights and visualization rendering (controller). Figure 4 shows the components and the information flow of SonicSG.

Mobile user interface for user interaction (UI)

In order to relieve the visitor of the burden of installing a mobile application, we decided to use a web-based user interface for interactivity. Since the majority of smart phones are equipped with basic HTML5 features such as web audio, vector graphics and canvas, this did not limit the features of the system. The interface allowed visitors send their postal code (6 digit number) and a message (free text) to SonicSG. Once the message was received, the field reacted with a light "ripple" expanding from the location of the visitors' postal code. Their phones received a multimedia reply, consisting of an animation and a sound response unique to their postal code. Furthermore, a summary of statistics of the messages received to date and a thank you note was displayed on the phone.

Central processing, storage and content generation (Server)

The central processing unit is further divided into three components, a processing unit, the HTML5 sound engine and a database. The processing unit is implemented with a Node.js web server, which is suitable for real-time applications, especially in situations where multiple concurrent requests happen. The server generates the web UI for user interactions and implements a web

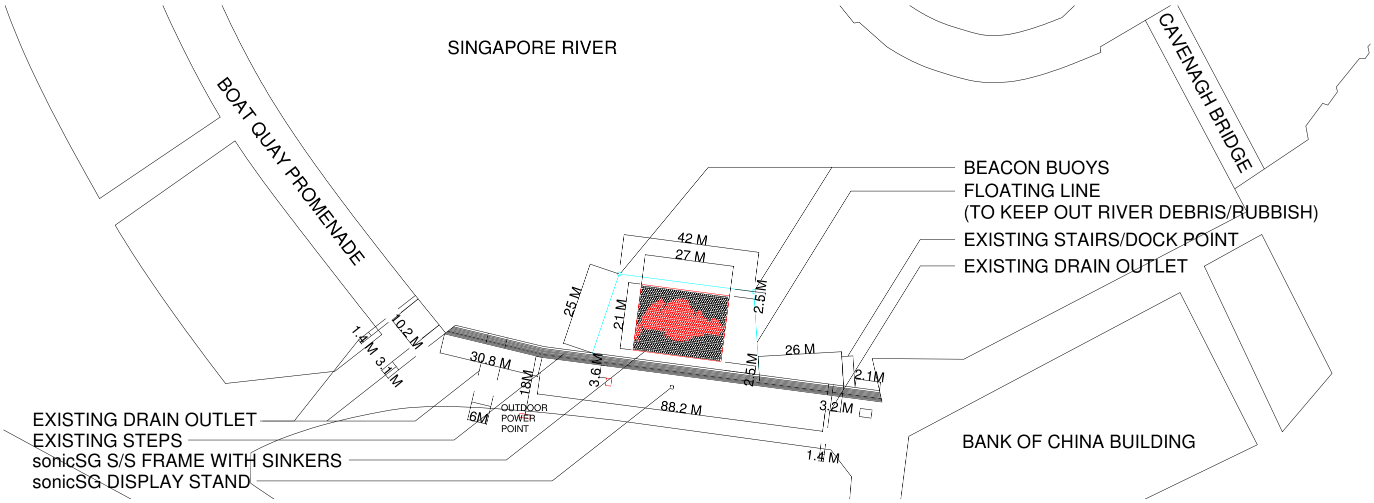

Figure 3. SonicSG site map

socket service so that visitor messages can be delivered to the controller without delays. This is crucial for SonicSG because we wanted to provide an immediate response to enhances the sense of connectedness to the piece. The server is responsible for identifying the visitors' districts from their postal codes, which are then used to determine the specific sound and light pattern individual devices will generate (Section 2.2.3). In addition, the server records the raw messages and statistics.

Control unit for lights and visualization rendering (controller)

The controller was responsible for retrieving messages from the server, the rendering the necessary animations and the dispatching of them to the light field. The controller was implemented using a Java processing API along with custom libraries for handling web sockets and interfacing with Philips iColor Flex LMX LEDs. The controller switched the light field with a "heat map" based on the number of messages received from each district and a greeting image. Once it received a message from a visitor, the heat map was updated, and a 'ripple' animation originated from the visitor's district and expanded through the display.

2.2.3 Sonification

For SonicSG, participants identify their home neighbourhoods with the postal code. Different neighbourhoods were associated with different sounds of different pitches that would then pulse at a slow period depending on the number of people simultaneously participating. Neighbourhoods that were well represented pulsed slightly faster than others. Neighbourhoods were also associated with colors that pulsed on device displays along with the sound.

The "data" connectivity of the mobile internet, the performance capabilities of ubiquitous smart phones, and new standardized audio capabilities built in to browsers were all used to create new possibilities for distributed audio experiences. SonicSG visitors brought their own interactive sensing device, sound synthesizer and audio speakers (i.e. their mobile phones) that the design team used to create a collectively generated spatial immersive sound experience.

Instead of sending possibly many separate channels of audio simultaneously to collocated devices which could overburden wireless networks, the server sends low bandwidth information about when and how many people have joined, and the participant's role in the ensemble. The individual phones then use this data, possibly in combination with client sensor and/or location information, to synthesize a unique individual 'pixel' of sound as part of the whole sonic display. Synthesis is done using the jsaSound library and the newly established audio browser standard Web Audio API. We used the term "sonic pixels" to describe this kind of client syntheses creating a collective display.

ADiffusion is an HTML5 client/server platform we developed for supporting collective spatial sound works (Wyse, 2015).

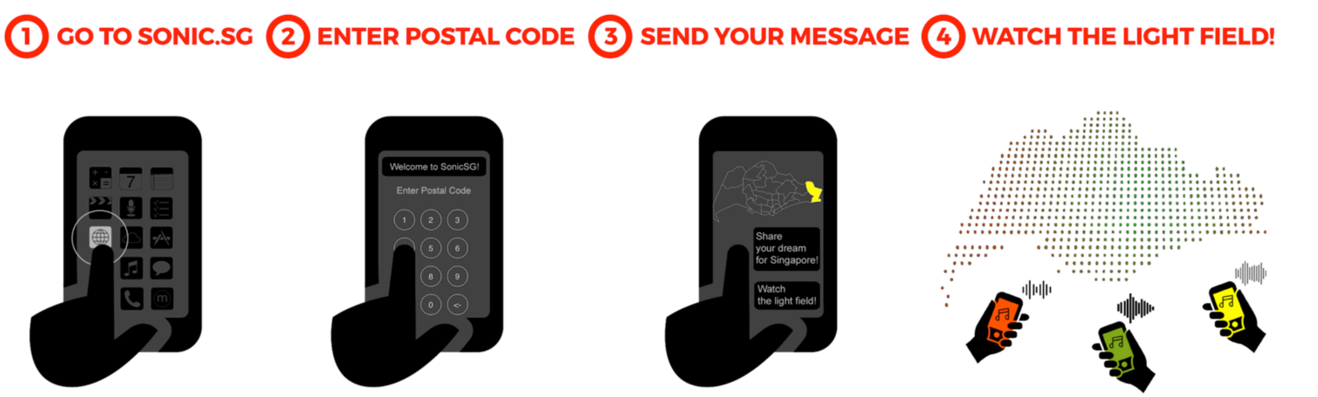

Figure 4. SonicSG interaction

ADiffusion is modelled on a "chat room" architecture, wherein people join a community by simply navigating their browsers to a web page. It is designed for collocated audiences that can all hear the different audio streams emanating from nearby devices in an auditorium, gallery, or at an outdoor event.

2.2.4 Practical Challenges

The initial installation method was to deploy the pre-fabricated modular frame and to subsequently install the rubber hose lines. However, the on-site conditions deviated both from the as-built drawings as well as the preliminary site measurements the design team had recorded. The water/tide level was also higher than anticipated which required adjustments of the prefabricated frame. The results was a much longer than planned installation process on site.

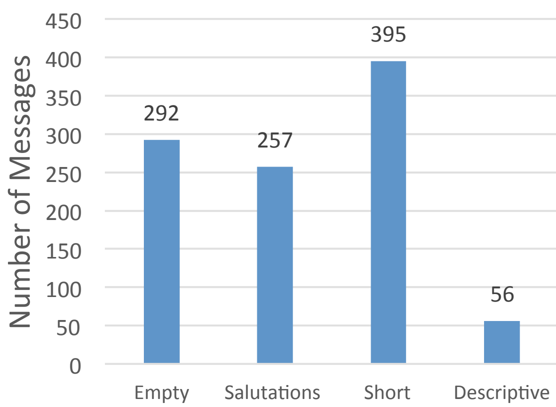

Figure 5. Number of messages categorized by length

3. REACTIONS FROM PUBLIC

SonicSG was open to public from 7pm to 10pm every day for a period of 30 days, starting in early December 2015 and ending in early January 2016. During this period, we recorded 1,606 visitor responses, which were analyzed based on length and content. There were only 31 occurrences of the same visitor sending repeated messages.

Based on length, there were four categories of messages:

- Empty messages: messages sent with only the postal code and no text.
- Salutations (one word): salutations were one-word messages such as "*Hi*", "*Hello*", "*Happy*", "*Dream*", etc.
- Short messages (two to 10 words): short messages consisting of meaningful greetings, such as "*Hey beautiful Singapore! Stay fresh*", "*Happy SG*", "*Happy New Year!*", "*Wish to travel around world*", etc.
- Descriptive messages (more than 10 words): descriptive messages were longer messages with multiple wishes and greetings. For example, "*may all Singaporean have a blessed New Year with good health and happiness always*", "*We wish you a Merry Christmas (3X) ~ and a Happy New Year 2016!!! ^^ Love All*", "*I wish for a world with less conflict and hatred. I wish for a world filled with compassion and love*", etc.

Figure 5 shows the number of messages sent from each length category.

3.1.1 Message Contents

Out of the total messages, 98 were gibberish (random character strings), such as "*Ghhg*", "*Gfder*", etc. and seven messages contained vulgar and explicit language. The other messages can be classified into the following three categories:

- Wishes for Singapore's future (Singapore): in our UI, we asked visitors to share their dreams for Singapore. Therefore, many greetings for Singapore were motivated by this request. A few examples of these messages are "*Happy B'day SG*", "*Making Singapore a smart city*", "*Socially conducive space with total cohesiveness*", etc.
- Wishes for self, family or friends (Personal): this category contained messages meant for loved ones. For example, "*I want to be healthy*", "*to be happy!*", "*successful wedding in April 2016*", "*I wish my son to grow up to be a good boy*" can be included in this category.
- General greetings and others (other): general greetings that were not directly intended for Singapore's future and other general messages. Examples include "*a sunny snowy Christmas!*", "*World Peace*!", "*Happy Holidays*", etc.

Figure 6 shows the number of messages sent in each content category. Additionally, there were 16 occurrences of visitors revealing their identity (i.e. signing the message at the end with their name). We also noticed four messages with religious contents, such as (may Singapore become "*a nation that loves God and His people*"). The majority of the messages were in English, except for 44 massages written in Chinese (the user interface was only provided in English).

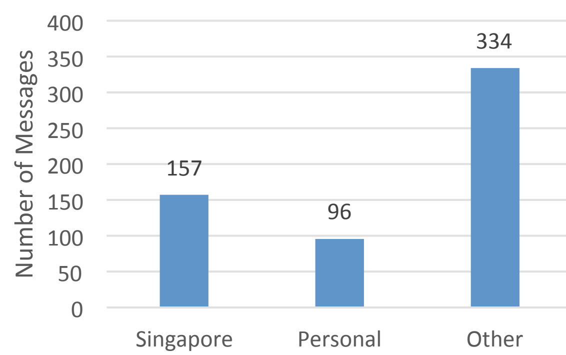

Figure 6. Number of messages categorized by content

SonicSG was conceived to reflect the idea of a diversity, which comprises a unity. Thus the overall effect of the sonic pixels was designed to be immersive – participants were not surrounded by a sound system, but were literally within it. The experience of the sound and light texture changed as people moved around the installation. The neighbourhood affiliation of the sound and light generation meant that individuals could actually identify others from their neighbourhood in Singapore. This effect was experienced collectively as a textural whole.

4. ACKNOWLEDGMENTS

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