

Geollery: A Mixed Reality Social Media Platform



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COMPUTER SCIENCE
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Introduction

Social Media



Motivation

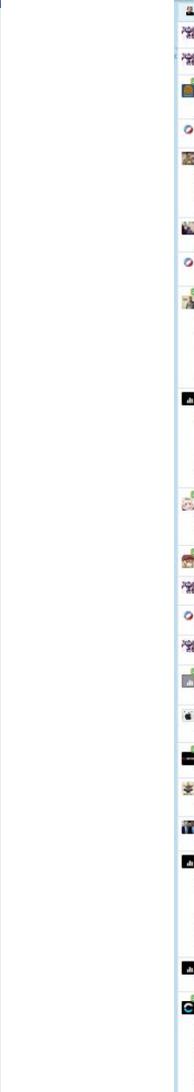
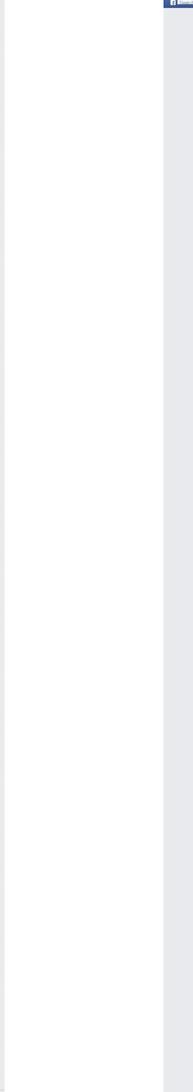
Social Media + XR



Motivation

Social Media + XR

image courtesy:
 instagram.com,
 facebook.com,
 twitter.com



Motivation

Pros and cons of the classic



Motivation

Pros and cons of the classic



Related Work

2D Geospatial Visualization

PhotoStand:

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CHI 2008 Proceedings · Works In Progress

Placing Flickr Photos on a Map

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ABSTRACT

In this paper we investigate generic methods for placing photos uploaded to Flickr on the World map. An example of our methods can be organised in a browsable or pin-pointed on a map to identify similar examples

April 5-10, 2008 · Florence, Italy

Content Visualization and Management of Geo-located Image Databases

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Abstract

In the last years, several algorithms and platforms for photo sharing have been developed. Usually, in order to index huge quantities of images for a fast and intuitive retrieval, additional textual tags attached to the pictures are considered. In this paper, we present a set of solutions for an effective management of geo-located images, i.e. pictures equipped with tags indicating the geographical coordinates of acquisition. This brings towards an intuitive content visualization and management of large geo-located image databases.

Keywords

Image categorization, geo-located images, interfaces

ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous. H3.1. Content Analysis and Indexing: Indexing methods.

Introduction

Among the social networking platforms, those ones that

can be organised in a browsable or pin-pointed on a map to identify similar examples

every photo in practice, the major ones. Flickr content merits location still gets a point and results automatically. We test this data

ABSTRACT

PhotoStand enables the use of a map query interface to retrieve news photos associated with news articles that are in turn associated with the principal locations that they mention collected as a result of monitoring the output of over 10,000 RSS news feeds, made available within minutes of publication, and stored in a PostgreSQL database. The news photos are ranked according to their relevance to the clusters of news articles associated with locations at which they are displayed. This work differs from traditional work in this field as the associated locations containing the news photos are associated with the articles automatically without any human intervention such as tagging, and that photos are retrieved by location instead of just by keyword as is the case for many existing systems. In addition, the clusters provide a filtering step for detecting near-duplicate news photos.

1. INTRODUCTION

A demo is presented of PhotoStand (see also the related NewsStand [9, 17, 21, 29], TwitterStand [6, 24], and STEWARD [12] systems) which is an example application of a general framework we are developing for retrieving multimedia data (e.g., text, images, videos) using a map query interface from a database of news articles, photos, and videos [4, 5, 18–20] and similar in real-time which differentiates it from Google where static photos are retrieved which rely on human geotagging). The photos are associated with news articles (geotagging). These feeds are processed by the NewsStand system which constantly polls them, downloads the new articles that they contain, performs a variety of tasks on the new articles that they contain in a PostgreSQL database. This is motivated by their popularity in indexing spatial and temporal data [4, 5, 18–20] and distributed domain [28].

The three major processing modules of NewsStand are its cleaner module, which extracts the text, images, and videos, as well as discards irrelevant objects in the feed; its geotagger [7, 8, 10, 11, 14], which extracts locations mentioned in the article; and its relevance module, which ranks the news articles based on their relevance to the clusters of news articles associated with locations at which they are displayed. This work differs from traditional work in this field as the associated locations containing the news photos are associated with the articles automatically without any human intervention such as tagging, and that photos are retrieved by location instead of just by keyword as is the case for many existing systems. In addition, the clusters provide a filtering step for detecting near-duplicate news photos.

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PhotoStand: A Map Query Interface for a Photos

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articles, enabling them to be as windowing or simple point which groups articles about the Stand database system is its processing modules by assigning NewsStand's user interface enabling what we term *top-k window* handles about 50K articles per database of articles currently co- the sense that PhotoStand uses NewsStand, while TweetPhoto uses TwitterStand [24]. In addition, it strates the database querying capability as its capability to do similarity where the first step in the similarity on the text associated with the photo involves use of the actual image feature enable detecting near duplicates, then a natural complexity of comparing even photo.

The rest of this paper is organized as follows. Section 2 discusses related work. Section 3 introduces how captions are used to identify near-duplicate image detection, extraction scenario and some underlying interaction while concluding remarks are given in Section 4.

2. RELATED WORK

Most of the work in associating geographic images has dealt with images that contain involves tags generated by humans (often the associated article in the case of news) device built into the camera (e.g., Flickr) nately, user generated tags are not always s precise latitude-longitude coordinate values require additional human intervention to id although gazetteers do help. We limit oursel accompany news articles and use the text contents of article documents to help us find These feature vectors are often sufficient to documents and the images that they refer to. ture vectors can be used to help us find relevant

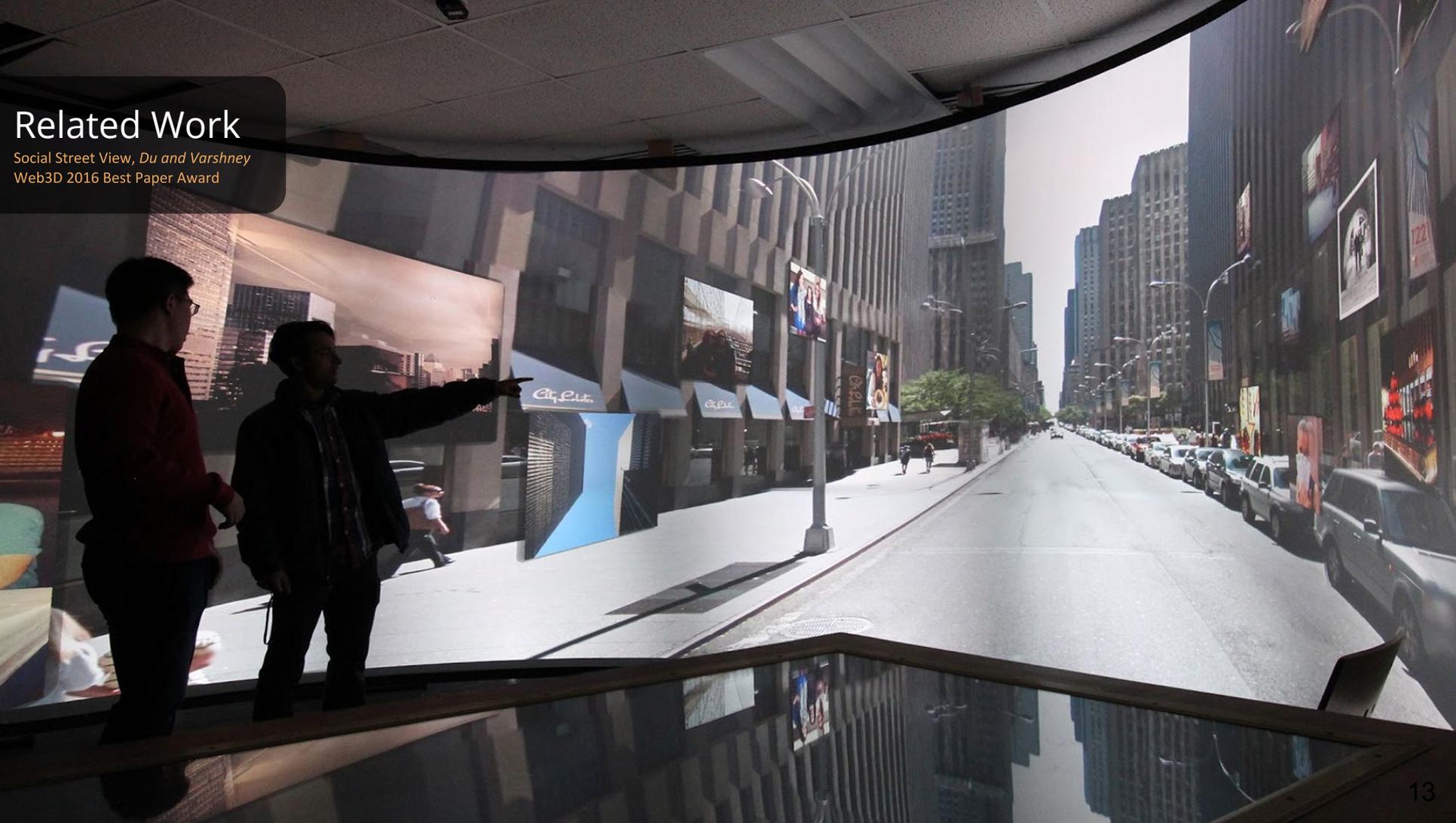
Related Work

2D Geospatial Visualization



Related Work

Social Street View, Du and Varshney
Web3D 2016 Best Paper Award



Related Work

Social Street View, Du and Varshney
Web3D 2016 Best Paper Award



Related Work

Social Street View, *Du and Varshney*
Web3D 2016 Best Paper Award



Related Work

3D Visual Popularity
Bulbul and Dahyot, 2017



Related Work

Immersive Trip Reports
Brejcha et al. UIST 2018



Related Work

Facebook Spaces, 2017



What's Next?

Research Question 1/3

What may a social media platform look like in mixed reality?

What's Next?

Research Question 2/3

What if we could allow social media sharing in a live mirrored world?



What's Next?

Research Question 3/3

What use cases can we benefit from social media platform in XR?

Geollery.com

A Mixed-Reality Social Media Platform
geotagged social media

3D buildings with 360° images

geotagged framed photos

Greetings!

Hi, friends!

Hello!

geotagged street art

virtual avatars and live chats

geotagged virtual gifts

Geollery.com



Real-time Texturing



Our system allows users to see, chat, and collaborate with remote participants with the same spatial context in an immersive virtual environment.

Conception, architecting & implementation

Geollery

A mixed reality system that can depict geotagged social media and online avatars with 3D textured buildings.



Extending the design space of

2

3D Social Media Platform

Progressive streaming, aggregation approaches, virtual representation of social media, co-presence with virtual avatars, and collaboration modes.

Conducting a user study of

3

Geollery vs. Social Street View

by discussing their benefits, limitations, and potential impacts to future 3D social media platforms.

System Overview

Geollery Workflow

```
parse_str($url);  
if ($query) {  
    $query = array_replace($qs, $query);  
    $queryString = http_build_query($query, '', '&');  
} else {  
    $query = $qs;  
    $queryString = $components['query'];  
}  
} elseif ($query) {  
    $queryString = http_build_query($query, '', '&');  
}  
  
$server['REQUEST_URI'] = $components['path'].('' !== $queryString  
$server['QUERY_STRING'] = $queryString;  
  
return self::createRequestFromFactory($query, $request, array(),
```

- * Sets a callable able to create a Request instance.
- * This is mainly useful when you need to override the Request class
- * to keep BC with an existing system. It should
- * other

System Overview

Geollery Workflow



2D polygons and metadata from OpenStreetMap



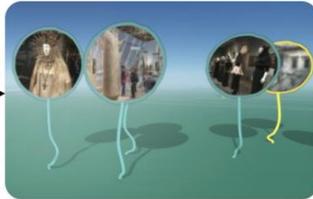
shaded 3D buildings with 2D ground tiles



added avatars, clouds, trees, and day/night effects



internal and external geotagged social media



virtual forms of social media: balloons, billboards, and gifts



Geollery fuses the mirrored world with geotagged data, street view 360° images, and virtual avatars.

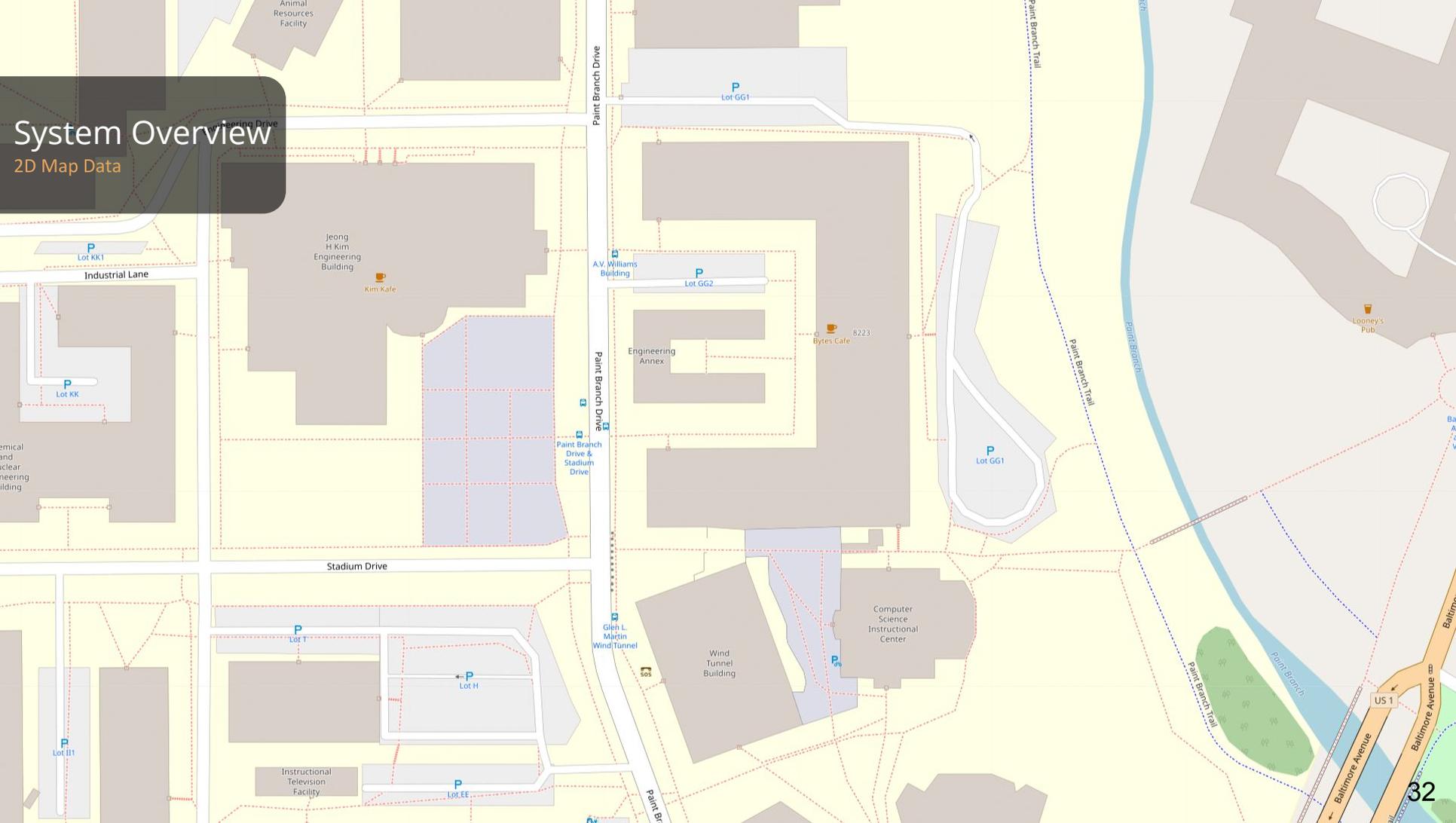
System Overview

Given (latitude, longitude)



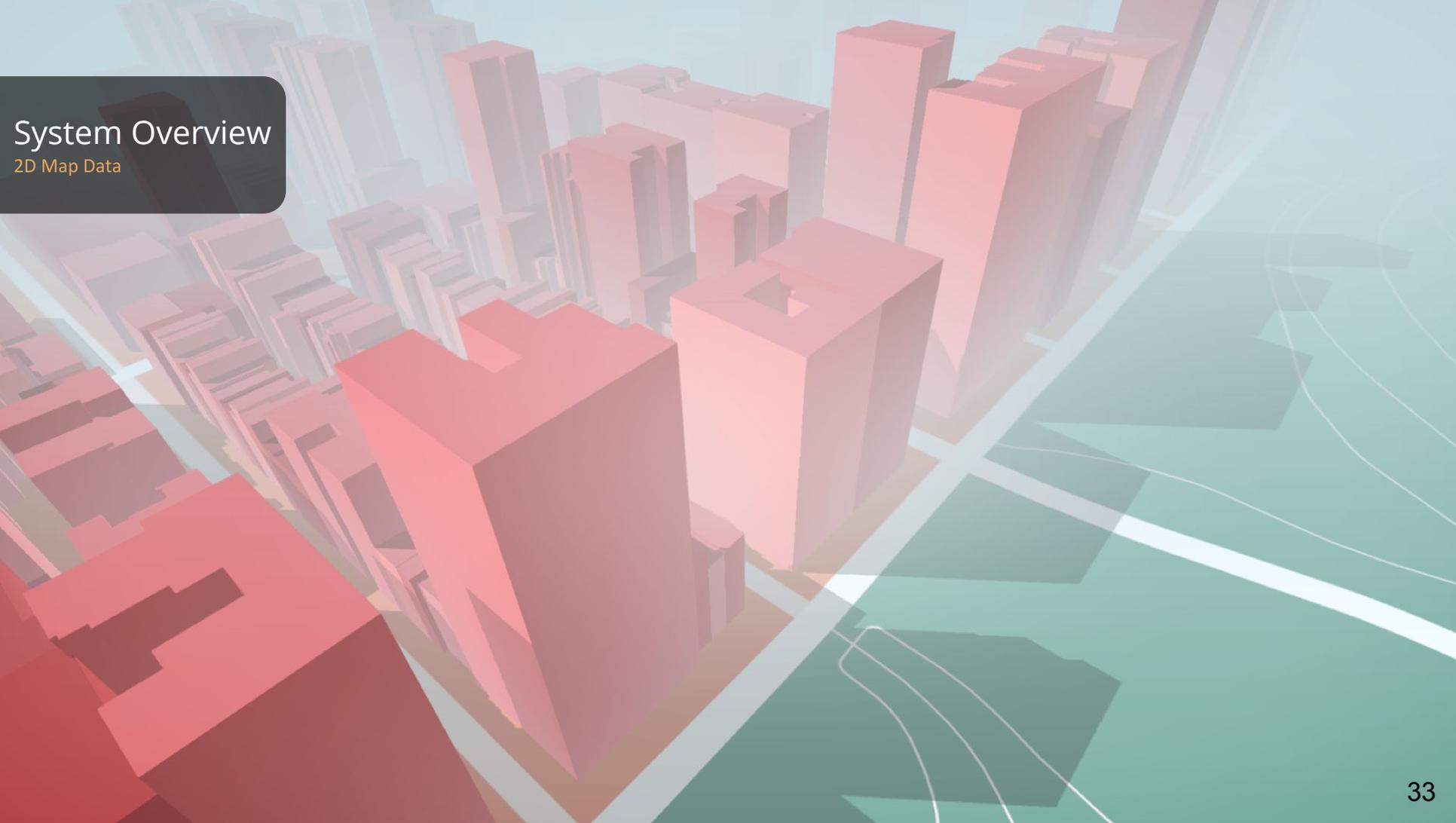
System Overview

2D Map Data



System Overview

2D Map Data



Female

Male

Other

System Overview

+Avatar



System Overview

+Avatar +Trees +Clouds



System Overview

+Avatar +Trees +Clouds +Night



System Overview

Street View Panoramas



System Overview

Street View Panoramas

System Overview

Street View Panoramas



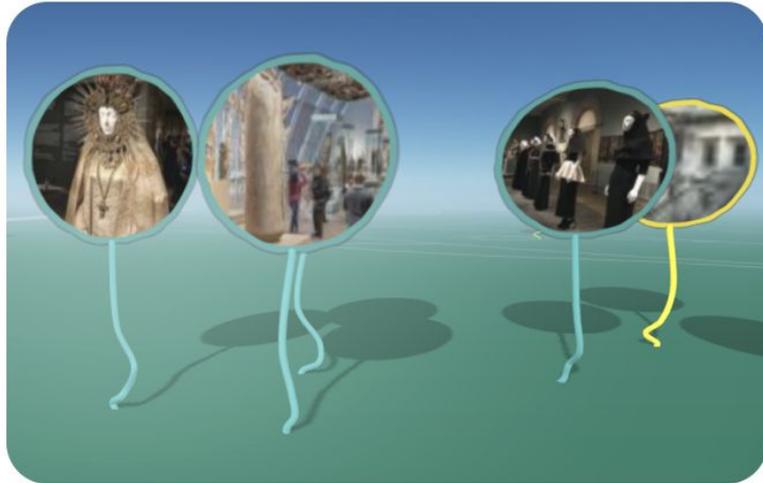
System Overview

Street View Panoramas



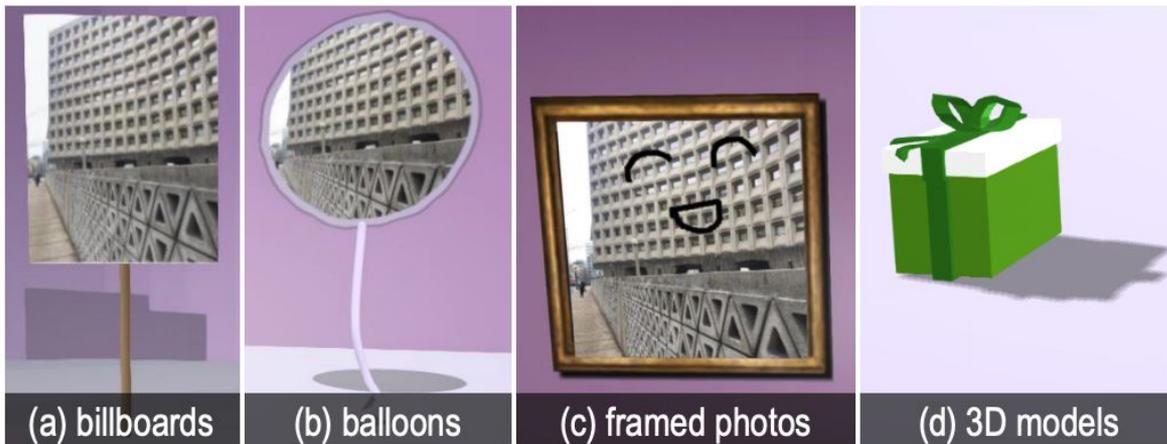
System Overview

Geollery Workflow



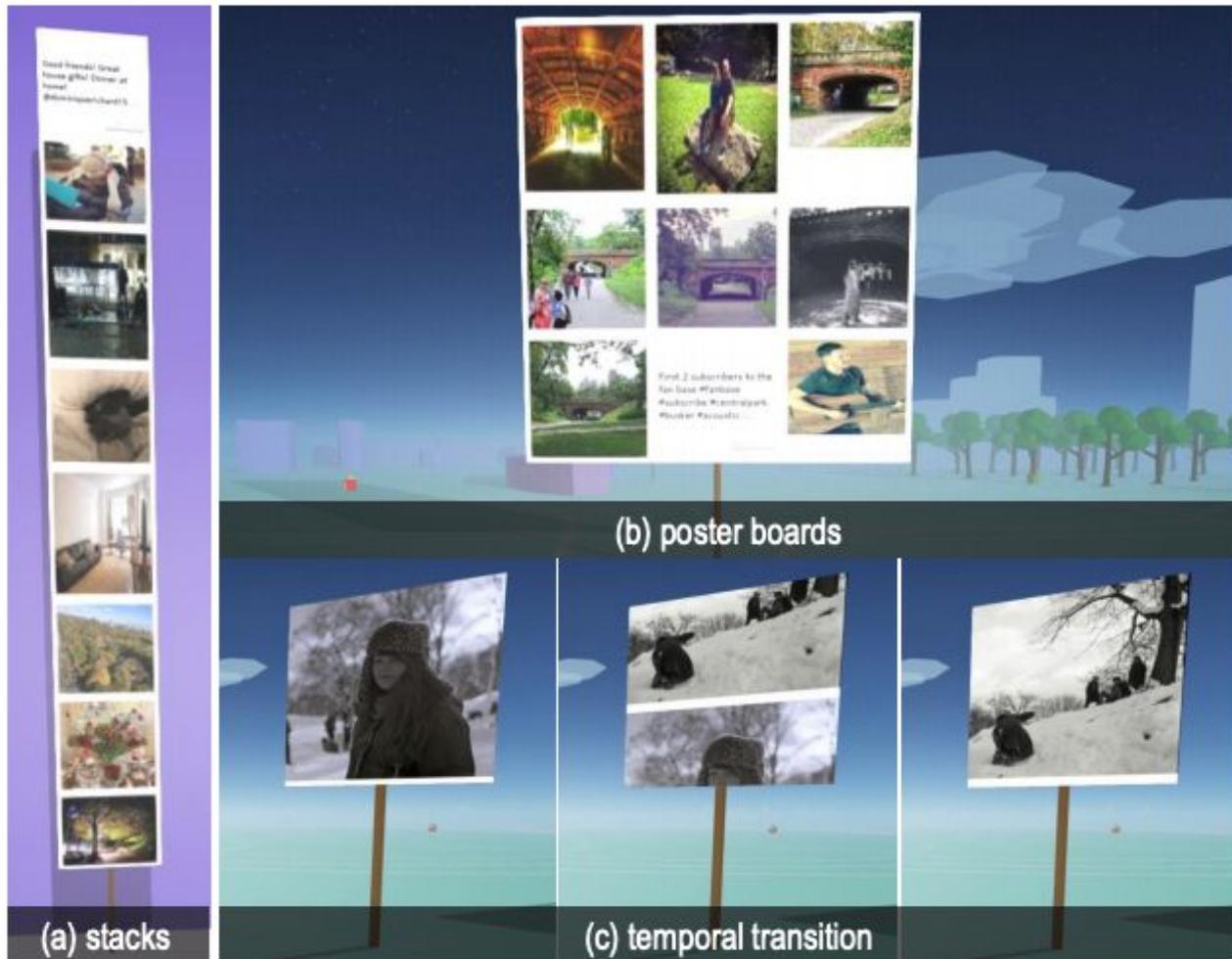
System Overview

Geollery Workflow



System Overview

Geollery Workflow



Design Space

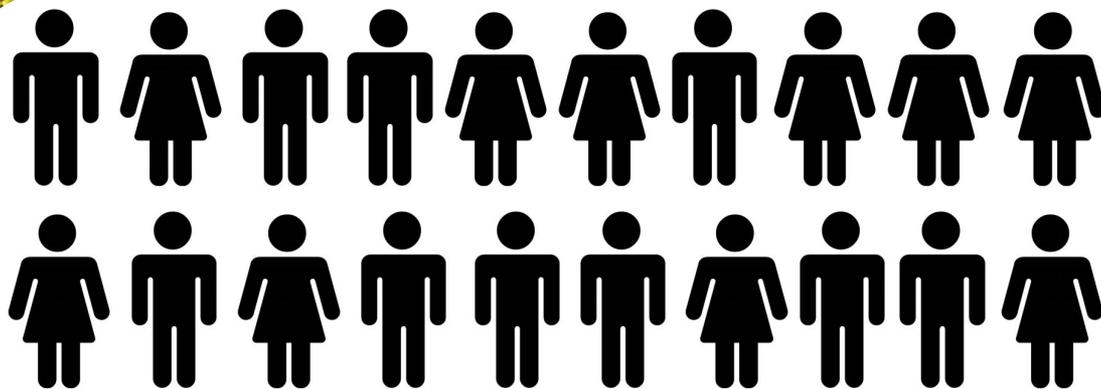
Geollery vs. Social Street View

Variable	Geollery	Social Street View
Mesh	Ground, 3D Buildings, trees, and clouds	Sphere
Textures	Geollery v1: No texture Geollery v2: With 360° street views	Textured by 360° street views
Availability	Almost always available	Only available for the locations with 360° street view data
Motion	6 DoF	3 DoF + Teleport
Virtual Avatar	Available	Not applicable
Collaboration	Available	Not applicable
Social Media Location Accuracy	Almost the exact location in the world	Estimated by distance and orientation
Virtual Representation	Billboards / Balloons / Framed photos / Doodles / Gifts	Billboards (v2: added balloons and gifts)
Aggregation	Based on spatial relationship	Based on direction and distance

User Study

Introduction

20 participants (10 females; age range: 21 - 30, with an average of 25.75 and standard deviation of 3.02) via campus email lists and flyers



User Study

Introduction



User Study

Four Stages, 45-60 minutes

A background interview

An exploration of Geollery and Social Street View

A quantitative evaluation

A discussion session about the future of 3D social media platforms

User Study

Background Interview (5 min)



Geollery & Social Street View Study

Semi-structured Interview and In-person User Study

[Introduction]

[Start timing!] Hello, my name is _____. I'm _____ in _____ at the _____. First, I would like to thank you for your participation. Today, you will be a participant in a user study with a semi-structured interview. Our goal is to explore your experience using *Geollery* and *Social Street View*, the **challenges** and **limitations** of the interfaces, as well as the types of **decisions** it could influence and potential **impacts** it might have. Then, we will **compare** and **rate** the advantages and disadvantages of both systems in different aspects.

Before we begin the interview, we need to complete a consent form. After this, we will begin. Your data will be kept anonymous. Additionally, as a researcher I have no position on this topic and ask that you be **as open, honest, and detailed** in your answers as possible. Do you have any questions before we begin?

[Begin Interview Study]

- The interview is broken down into three components:
 - ↳ Your background in using social media platforms.
 - ↳ User study of the Geollery and Social Street View platforms
 - ↳ Survey about future of 3D social media platforms.

[Background]

Main goals:

- (1) Get people comfortable with answering questions and creating a rapport.
- (2) Assessing how they are accessing social media in real life, and gain an understanding of their experience.

1. What are your views on social media platforms like Twitter and Facebook, how important are they to you?
2. Can you talk about your social media experience? How often do you use social media platforms? And how often do you post on social media websites?
3. What do you usually use social media platforms for?
4. Have you ever viewed social media in a map?

User Study

Background Interview (5 min)

User Study

Background Interview (5 min)

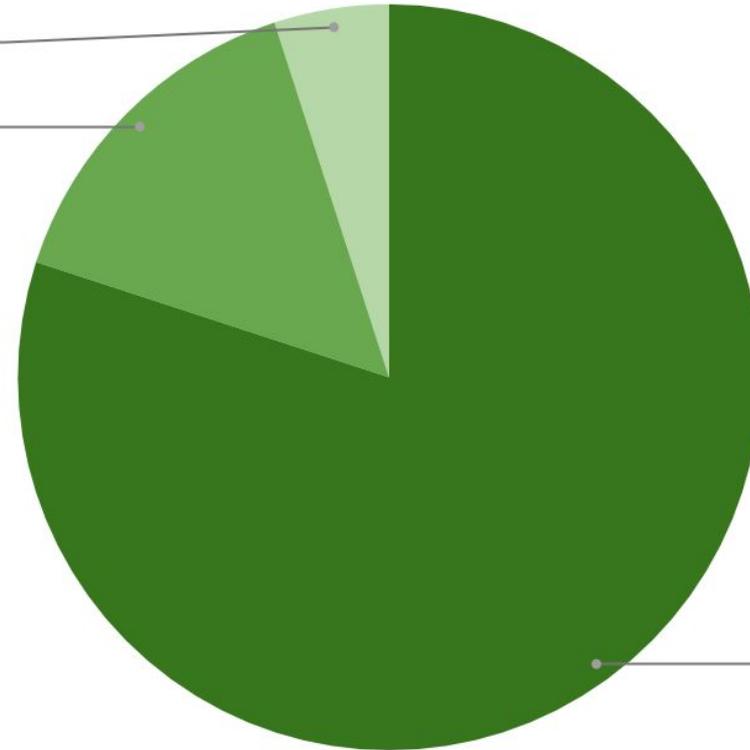
Social Media Usage

Once or twice per week

5.0%

Several times per week

15.0%

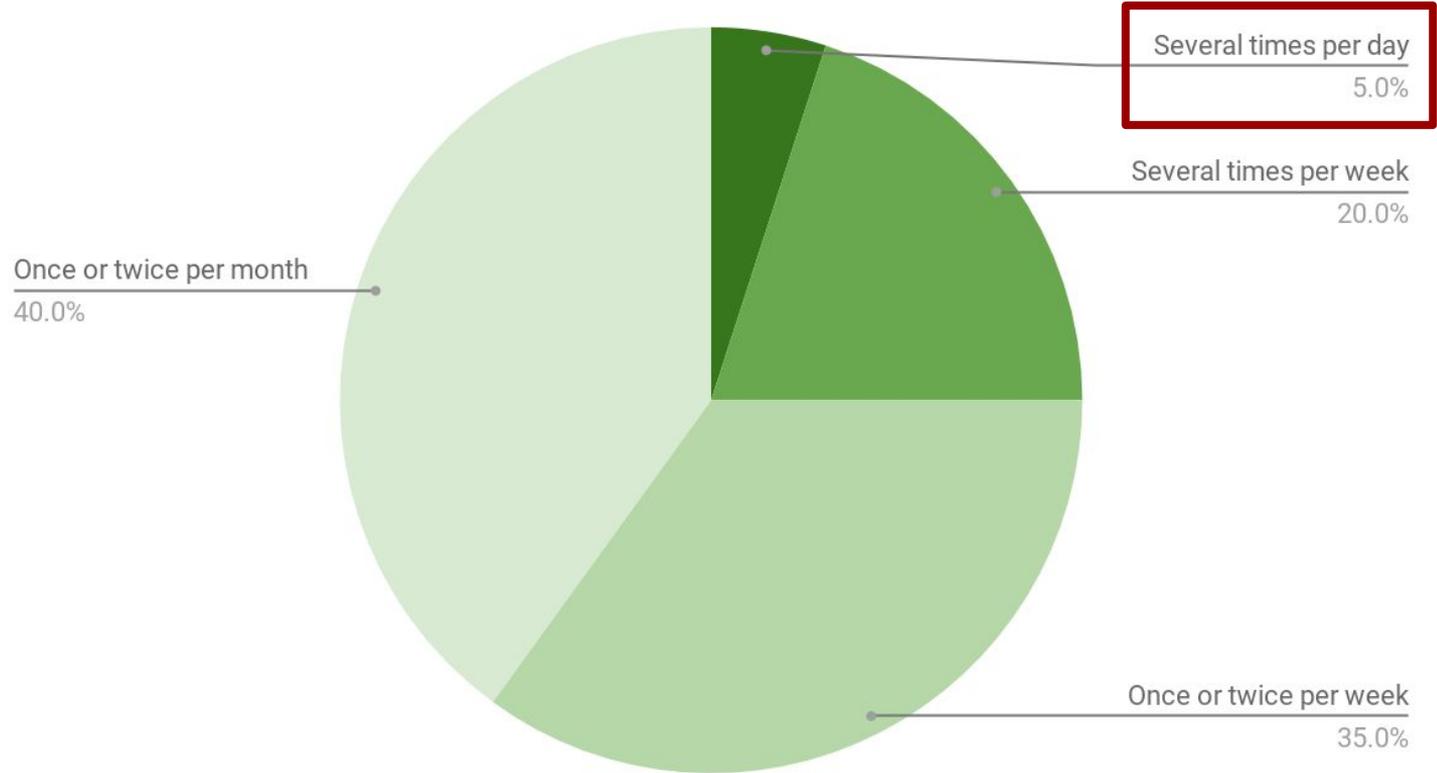


Several times per day
80.0%

User Study

Background Interview (5 min)

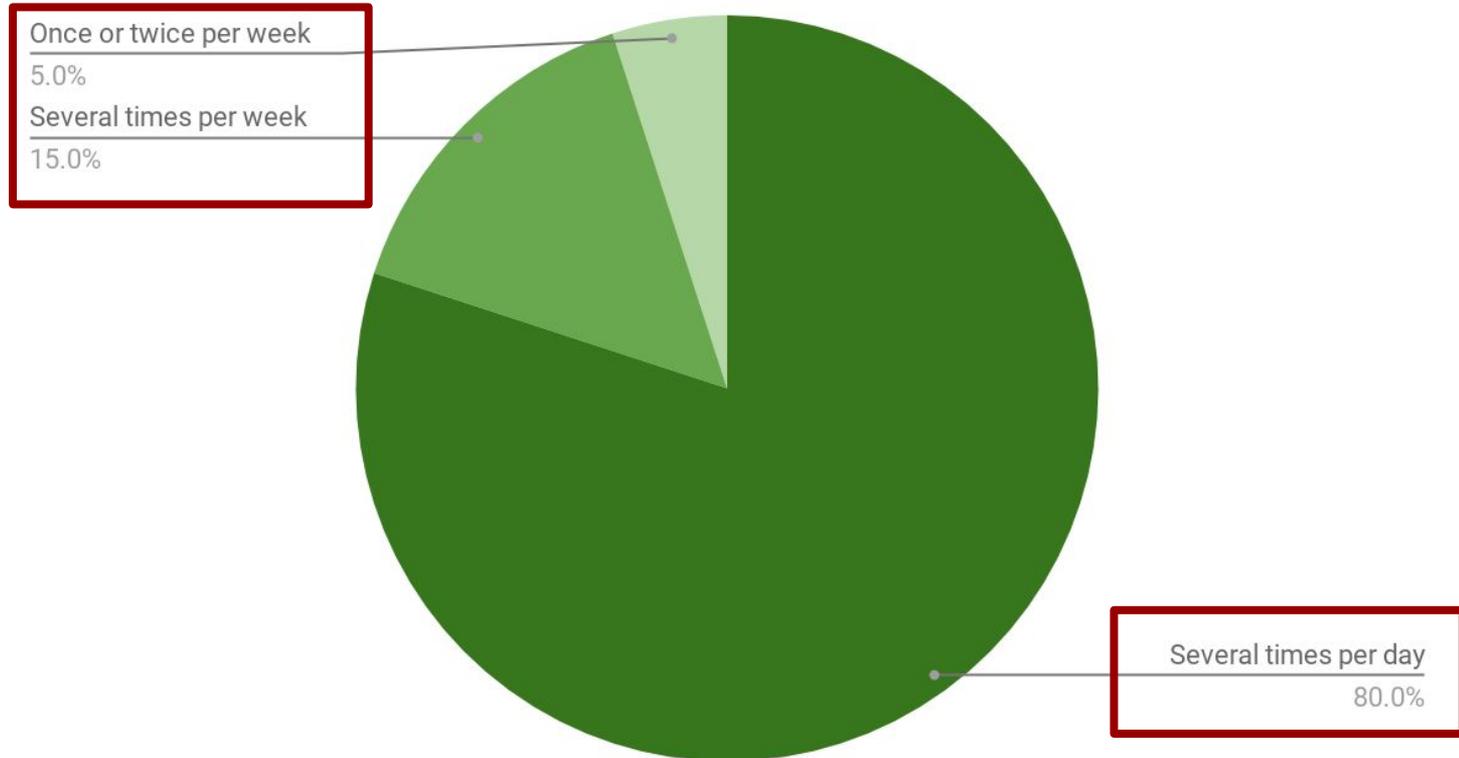
Frequency Posting Social Media



User Study

Background Interview (5 min)

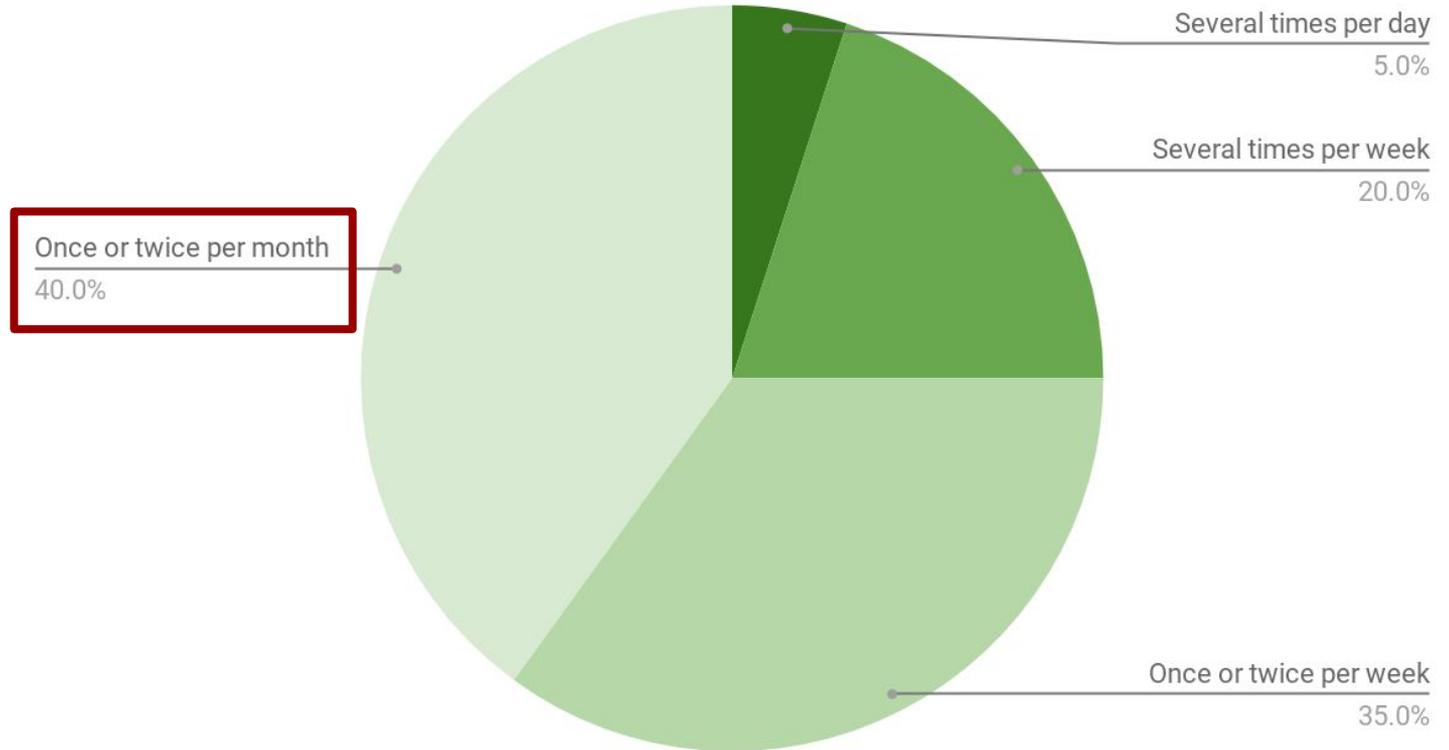
Social Media Usage



User Study

Background Interview (5 min)

Frequency Posting Social Media



“

I post **news** about sports and
games every day.

”

“

I majorly use **Instagram**, I post from my own portfolio.

”

User Study

Exploration (30-40 min)



User Study

Social Street View vs. Geollery



User Study

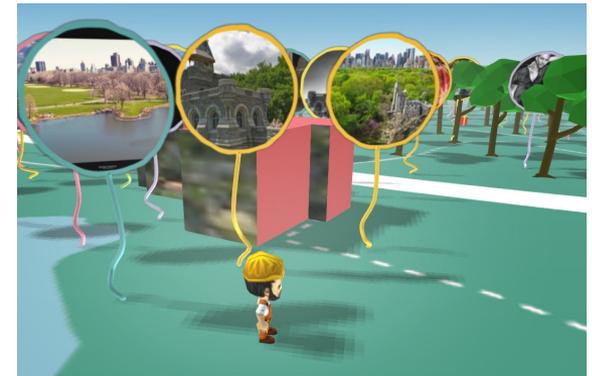
Latin Square Design



University Campus



New York City



Washington D.C.

Female

Male

Other

User Study

Login Screen



What's Next?

Research Question 3/3

What's your first impression?

First Impression

Geollery



“

I think it's a very good start, it's very good experience to walk around.

”

“

I believe I am in a museum.

”

“

I like that the buildings are
forming while I am walking.

”

“

It's cool to see posts by people
in *real time*, along with the
establishment they're in.

”

“

It's like you don't have to be
there.

”

User Study

Quantitative Evaluation

Please compare the two systems and indicate the degree to which you agree with the following description. For example, for the first question, 4 is most immersive, -4 is most unengaging, 0 is neutral.

Geollery

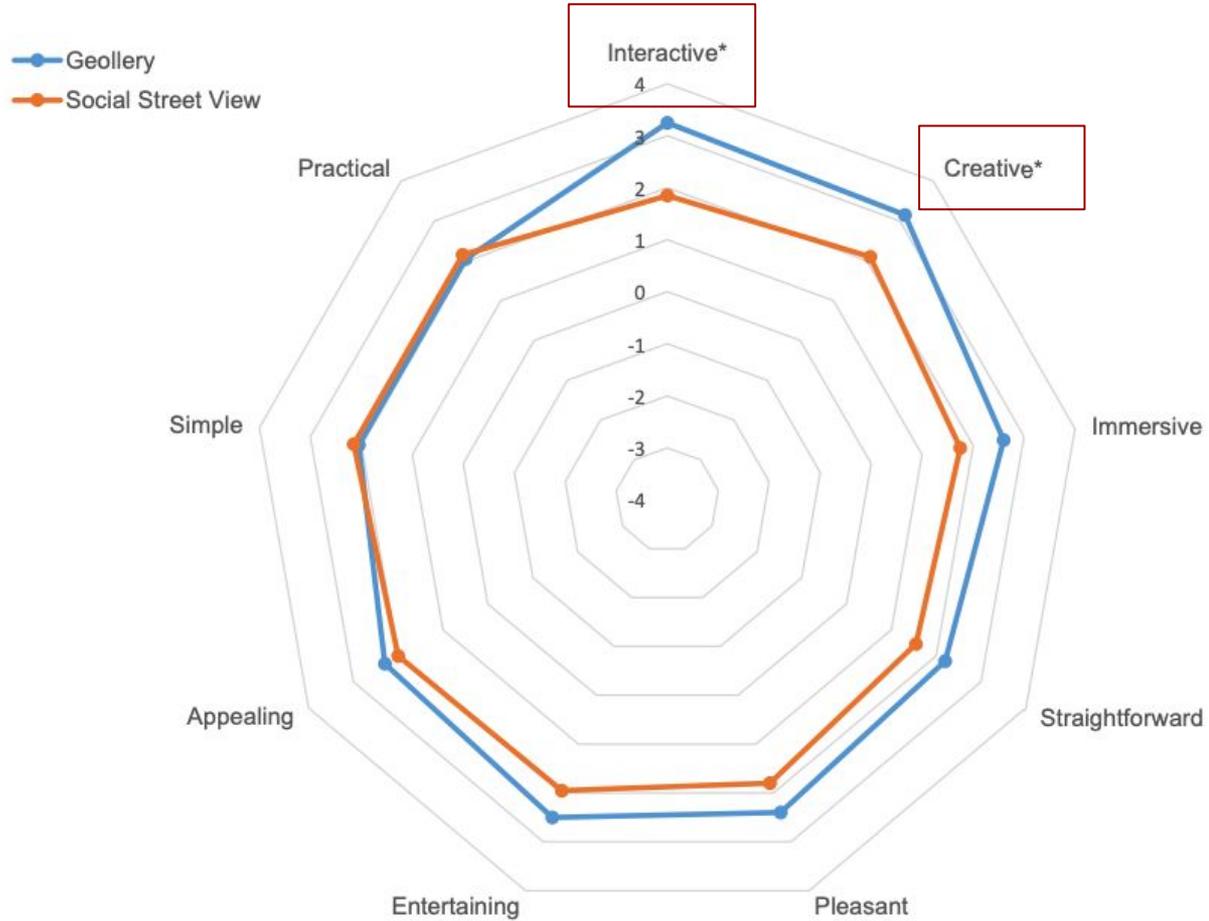
Unengaging	-4	-3	-2	-1	0	1	2	3	4	Immersive
Cumbersome	-4	-3	-2	-1	0	1	2	3	4	Straightforward
Unimaginative	-4	-3	-2	-1	0	1	2	3	4	Creative
Unpleasant	-4	-3	-2	-1	0	1	2	3	4	Pleasant
Impractical	-4	-3	-2	-1	0	1	2	3	4	Practical
Complicated	-4	-3	-2	-1	0	1	2	3	4	Simple
										Appealing

Social Street View

Unengaging	-4	-3	-2	-1	0	1	2	3	4	Immersive
Cumbersome	-4	-3	-2	-1	0	1	2	3	4	Straightforward
Unimaginative	-4	-3	-2	-1	0	1	2	3	4	Creative
Unpleasant	-4	-3	-2	-1	0	1	2	3	4	Pleasant
Impractical	-4	-3	-2	-1	0	1	2	3	4	Practical
Unappealing	-4	-3	-2	-1	0	1	2	3	4	Simple
	-3	-2	-1	0	1	2	3	4	Appealing	

User Study

Quantitative Evaluation



User Study

Post-interview



Post Interview

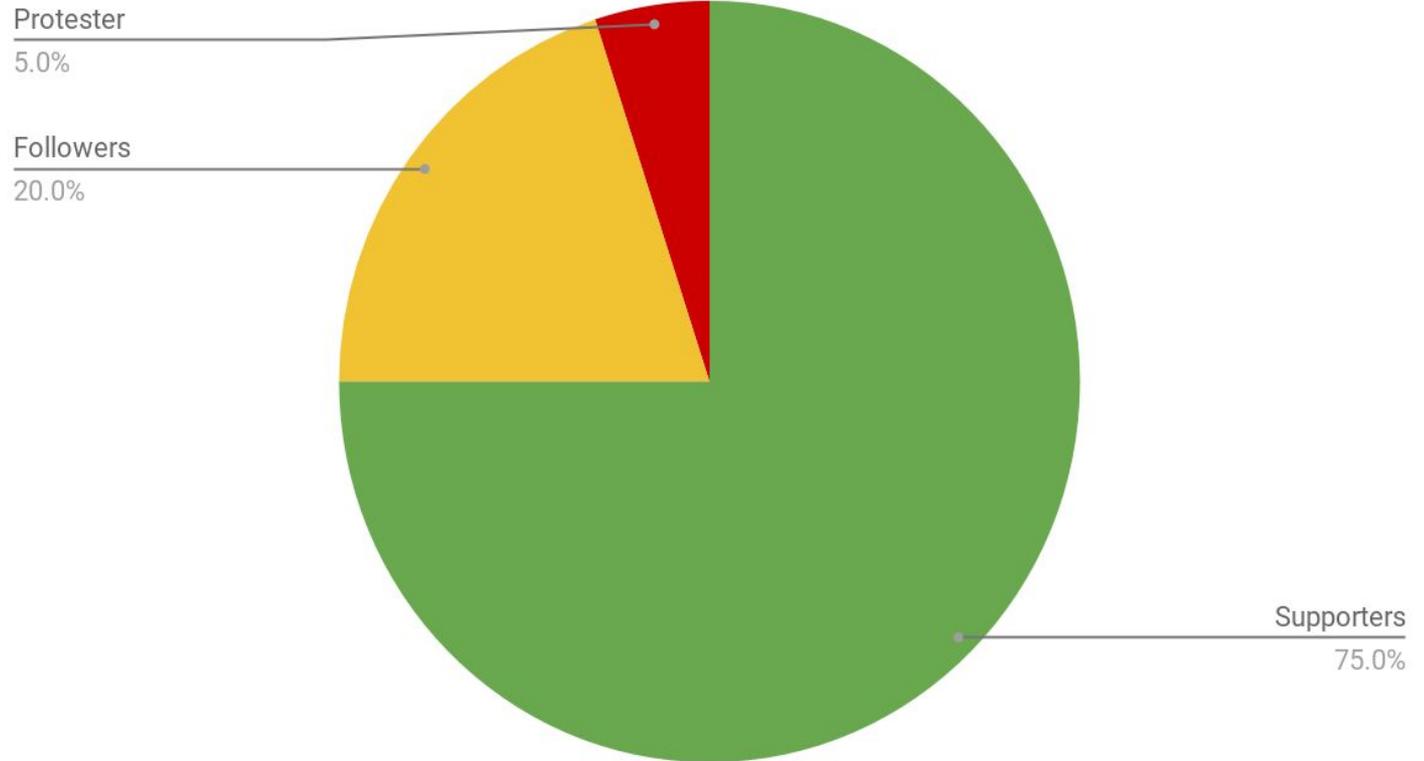
Question 1/3

Suppose that we have a polished 3D social media platform like Geollery or Social Street View, would you like to use it? If so, how much time would you like to spend on it?

Post Interview

Question 1/3

High-level Attitude Towards 3D Social Media Platform



“

I would like to use it every day
when I go to work, or travel
during weekends.

”

“

If it's not distracting like Facebook and Instagram, I would use it every day on a couple of things.

”

“

I am a follower on most social media sites. I would only join a 3D social media platform once my friends are there.

”

“

If my friends are all on this, I
can see myself spend a couple
of hours every week.

”

“

I don't think I will use this. I prefer to use Yelp to see comments [of nearby restaurants]

”

Post Interview

Question 2/3

Can you imagine your use cases for Geollery and Social Street View? What would you like to use 3D social media platforms for?

“

I would like to use it for the food in different restaurants. I am always hesitating of different restaurants. It will be very easy to *see all restaurants with street views*. In Yelp, I can only see one restaurant at a time.

”

“

[I will use it for] exploring *new places*. If I am going on vacation somewhere, I could *immerse myself* into the location. If there are avatars around that area, I could *ask questions*.

”

“

I think it (Geollery) will be useful for **families**. I just taught my grandpa how to use Facetime last week and it would be great if I could teleport to their house and meet with them, then we could chat and share photos with our avatars.

”

“

... for communicating with my families, maybe, and distant friends, [so] they can see New York. And, getting to know more people, connecting with people based on similar interests.

”

Post Interview

Question 3/3

If you were a designer or product manager for Geollery or Social Street View, what features would you like to add to the systems?

“

A mapping of the texture,
high-resolution texture, will be
great.

”

“

if there is a way to unify the interaction between them, there will be **more realistic buildings** [and] you could have more roof structures. **Terrains** will be interesting to add on.

”

“

I would like to see **kitties** and **puppies** running around, and birds flying in the air

”

“

I could also add a **bike**, add a **vehicle**, a **motorcycle** in Geollery, this will add some fun.

”

Insights

What we learned

High-quality content and seed users play key roles



Insights

What we learned

Winter Garden Theatre
The Winter Garden Theatre is a Broadway theatre located at 1634 Broadway between 50th and 51st Streets in midtown Manhattan.

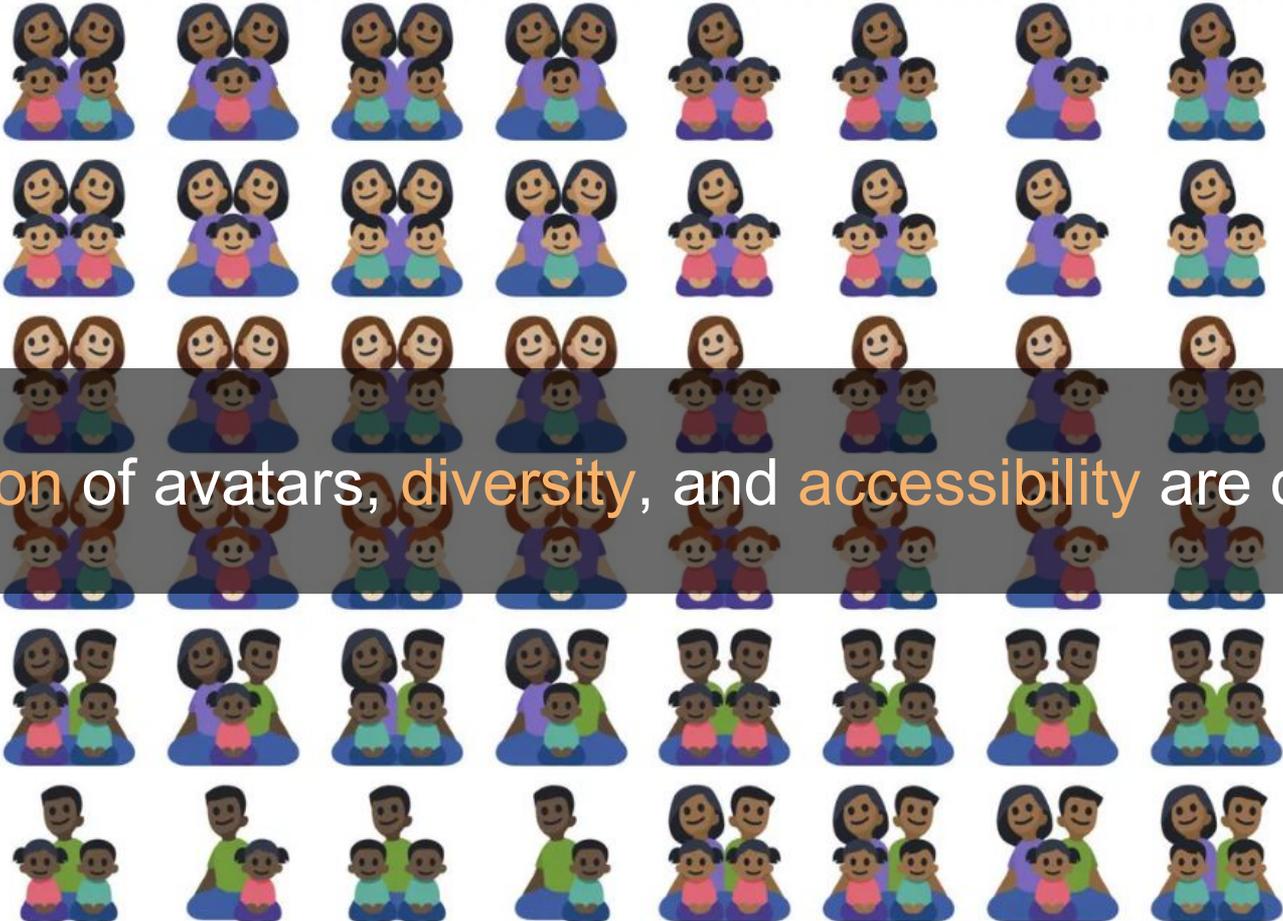


Interactivity and panoramic textures matter.



Insights

What we learned



Customization of avatars, diversity, and accessibility are crucial.

image courtesy:
Facebook
Messenger

Discussion

Use Case: Audio Tour



(Museum of Modern Art, New York, USA)

...

Discussion

Taking the Feedback:
Geollery v2, Web3D & VR 2019

Geollery: A Mixed Reality Social Media Platform



Figure 1: Geollery creates an interactive mirrored world where users are immersed with 3D buildings, live chats, and geotagged social media. The social media are visualized as balloons, billboards, framed photos, and gift boxes, all in real time.

ABSTRACT
We present Geollery, an interactive mixed reality social media platform for creating, sharing, and exploring geotagged information. Geollery introduces a real-time pipeline to progressively render an interactive mirrored world with three-dimensional (3D) buildings, internal user-generated content, and external geotagged social media. This mirrored world allows users to see, chat, and collaborate in an immersive virtual environment. We describe the system architecture of Geollery, its key interactions, and its user interface. We discuss responses, we discuss system and derive key insights from our study revealing travel planning.

CCS CONCEPTS
• Human-centered computing
• Virtual reality

KEYWORDS
virtual reality, 3D view, visualization

ACM Reference Format:
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<https://doi.org/10.1145/3296667.3313273>



Figure 1: Geollery creates an interactive mirrored world in real time in which users are immersed with 3D buildings, live chats, and geotagged social media. The social media are visualized as balloons, billboards, framed photos, and gift boxes, all in real time.

Interactive Fusion of 360° Images for a Mirrored World

Ruofei Du*, David Li†, and Amitabh Varshney†
Fellow, IEEE
Augmentarium, Department of Computer Science, and University of Maryland Institute for Advanced Computer Studies
University of Maryland, College Park



The system is available at <https://geollery.com>.

Experiencing a Mirrored World with Geotagged Social Media in Geollery

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ABSTRACT
We demonstrate the online deployment of Geollery [5], a mixed reality social media platform. We introduce an interactive pipeline to reconstruct a mirrored world at two levels of detail: the street level and the bird's-eye view. Instead of using offline 3D reconstruction approaches, our system streams and renders a mirrored world in real time, while depicting geotagged social media as billboards, balloons, framed photos, and virtual gifts. Geollery allows multiple users to see, chat, and collaboratively sketch with the spatial context in this mirrored world. We demonstrate a wide range of use cases including crowdsourced tourism, interactive audio guides with immersive spatial context, and meeting remote friends in mixed reality. We envision Geollery will be inspiring and useful as a standalone social media platform for those looking to explore new areas or looking to share their experiences. Please refer to <https://geollery.com> for the paper and live demos.

ACM Reference Format:
Ruofei Du, David Li, Amitabh Varshney. 2019. Experiencing a Mirrored World with Geotagged Social Media in Geollery. In *CHI Conference on Human Factors in Computing Systems Extended Abstracts (CHI'19 Extended Abstracts)*. May 4–9, 2019, Glasgow, Scotland UK. ACM, New York, NY, USA, 4 pages. <https://doi.org/10.1145/3296667.3313273>

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from the satellite imagery. On the other hand, classic high-resolution methods for modeling the 3D world have concentrated on MIP pipelines [15, 16]. Despite the effectiveness of these methods, their data requirements and processing requirements are unsuitable for mobile and web applications with limited bandwidth constraints. We propose an interactive pipeline of fusing 360° images for a mirrored world at two levels of detail (Fig. 1). At a fine level of detail, we incorporate multiple Google Street View images and depth data to reconstruct textured meshes on the GPU. At a coarse level of detail when viewed from a distance, we extrude boxes with the building metadata from web-based architecture to stream, cache, reconstruct, and render the mirrored world in real time. Our system, Geollery [8], is available at <https://geollery.com>.

2. ALGORITHMS

2.1. COARSE DETAIL
For detail for close-up views, we reconstruct an appropriate ways of seamlessly aligning the adjacent images. As illustrated in Fig. 2, this approach takes high resolution of the street view images while low resolution depth maps to generate an approximate mirrored world. We use the OpenStreetMap (OSM) data to obtain 2D building polygons. We find that in urban areas such as New York City, the height in meters of the number of floors for each building is not available, we extrude the height of 16 meters to represent a 4-story building. This requires any server-side preprocessing that can be done in background threads for

[https://opensstreetmap.org/api/overpass_API](https://opensstreetmap.org/api/overpass)

Discussion

Taking the Feedback



coarse detail



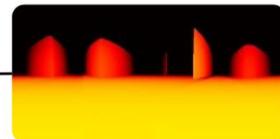
fine detail



building polygons



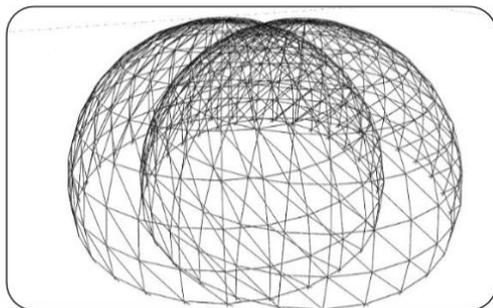
360° images



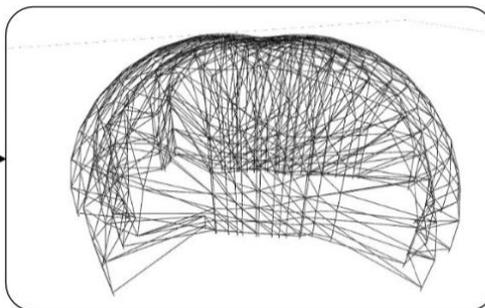
depth maps

Discussion

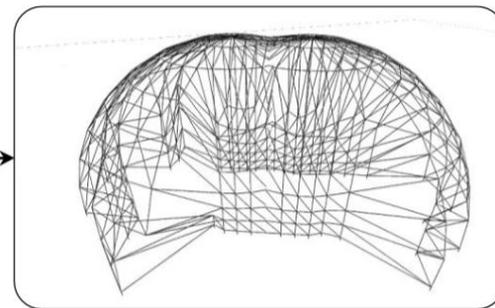
Taking the Feedback



(a) initial spherical geometries



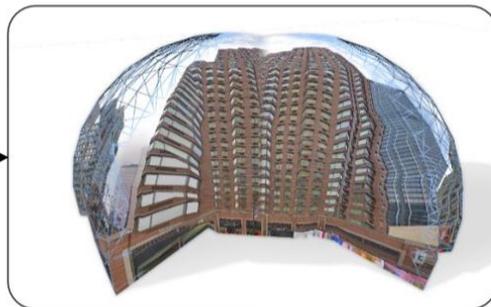
(b) depth correction



(c) intersection removal



(d) texturing individual geometry



(e) texturing with alpha blending



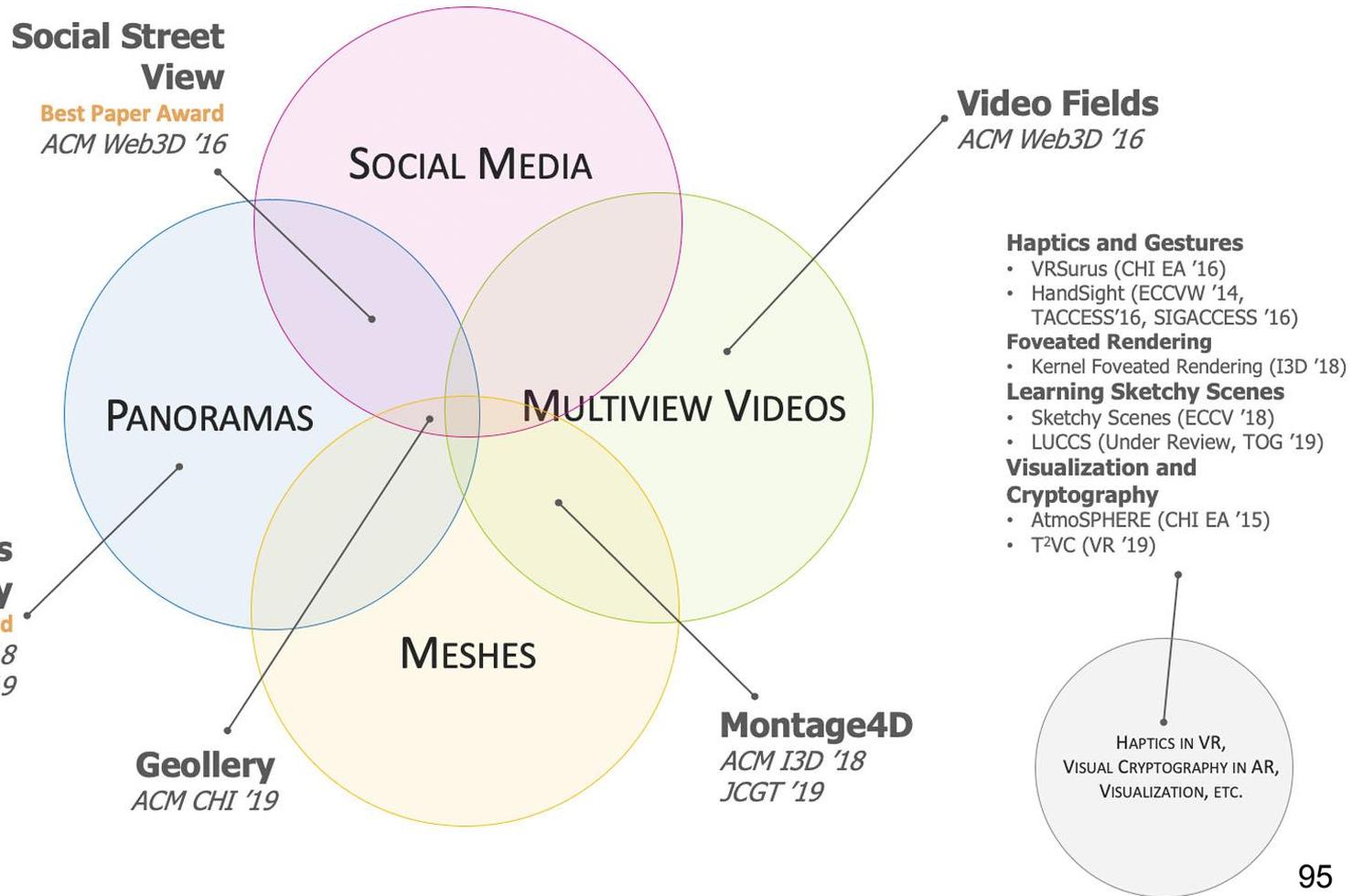
(f) rendering results in fine detail

Challenge

Global Market Constraints:
Weak Content for XR



Research Goal
Fuse the information from
physical and virtual world



Future Directions

The Ultimate XR Platform



Future Directions

Fuses Past Events



An aerial, high-angle photograph of a city street intersection at night. The scene is illuminated by streetlights and building lights, creating a warm, orange glow. A central building has a flat roof with a small, white, snow-like patch. To the right, a building features a prominent blue neon light strip along its edge. In the bottom right corner, a circular structure with a glass and metal framework is visible. The overall atmosphere is that of a bustling, modern urban environment.

Future Directions
With the present

Future Directions

And look into the future



Future Directions

Change the way we
communicate in 3D and
consume the information



Future Directions

Consume the information
throughout the world



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UMIACS
University of Maryland
Institute for Advanced
Computer Studies



Unsplash
Photos for everyone

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Thank you!



Greetings!



Hi, friends!



Hello!



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COMPUTER SCIENCE
UNIVERSITY OF MARYLAND, COLLEGE PARK

Geollery: A Mixed Reality Social Media Platform



Ruofei Du, David Li, and Amitabh Varshney

{ruofei, dli7319, varshney}@umiacs.umd.edu | www.Geollery.com | CHI 2019 | Demo at D-2 (INT-40)



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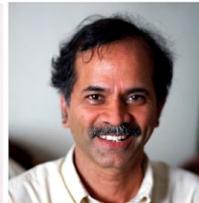
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Greetings!



Hi, friends!



Hello!



...we've built
...we've built
...we've built