Project Geollery.com: Reconstructing a Live Mirrored World With Geotagged Social Media

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Introduction
Social Media
Motivation

Social Media + XR
Motivation

Social Media + XR

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

2D layout

Image courtesy: pinterest.com
Motivation
Pros and cons of the classic
Motivation

Pros and cons of the classic
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. Applications include examples of every photo and every place in practice. In particular, we introduce PhotoStand, an interactive 3D
setup which allows users to visualize places with photos and focus on
their interest. The map presents the photos as a 3D model of the
Earth. The photos are displayed on the Earth's surface, and the
user can interact with them by selecting a photo and clicking on
it to display information about the photo. The setup allows users to
see the photos from different angles and zoom in on specific areas.

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
organize huge quantities of images for a few
intuitive retrieval, additional textual tags attached
to the images are considered. In this paper, we present a
set of solutions for an effective management of
geolocalized images, i.e., pictures equipped with tags
identifying the geographical coordinates of acquisition,
thus bringing an extensive content visualization
and management of large geo-referenced image
databases.

Keywords

Geolocalization, digital images, search

ACM Classification Keywords

H.5.1. Information interfaces and presentation (e.g., HCI):
- Hypertext navigation; I.3.7. Content Analysis and
- Information Storage and Retrieval

Introduction

The recent growth of social networking platforms, those sites that
are based on the social networking concept, has made it
possible to share personal photos and personal information
with the world. However, the problem of organizing and
managing these photos has become a major challenge.

In this paper, we present a new approach to solving
this problem. We propose a method to organize and
display photos based on the geographical coordinates
of their acquisition. This approach allows users to
quickly browse and search for photos from different
locations, making it easier to find specific content.

2. RELATED WORK

Many of the works presented in this paper are based on
the successful efforts made by researchers in the
field of multimedia and web technologies. For
example, the use of geographical coordinates to
organize and display photos has been studied by
several researchers. More recently, researchers have
focused on using social networks to facilitate
photo sharing and organization.

The proposed method has been shown to be effective
in organizing and displaying photos based on their
geographical coordinates. It allows users to easily
search for and view photos from different locations,
making it a valuable tool for those interested in
organizing and managing their personal photos.
Related Work

2D Geospatial Visualization
Social Snapshot: A System for Telling Social Photographs

Robert Patro, Cheuk Yiu, Sajal Das, and Alex Simpson

Abstract

Social snapshots actively acquire and reconstruct temporally dynamic data. The system enables spatial-temporal 3D photography using commodity devices, augmented by auxiliary sensors and networked functionality. It equips users making them passive participants in data acquisition.

Social snapshots actively acquire and reconstruct temporally dynamic data. The system enables spatial-temporal 3D photography using commodity devices, augmented by auxiliary sensors and networked functionality. It equips users making them passive participants in data acquisition.

3D Wikipedia: Using online text to automatically label and navigate reconstructed geometry

Bryan C. Rommel

Figure 1: A snapshot of a Wikipedia article generated using Deep3D.
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

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

Virtual Oulu, Kukka et al.
CSCW 2017
Related Work

3D Visual Popularity
*Bulbul and Dahyot, 2017*
Related Work

Immersive Trip Reports
Brejcha et al. UIST 2018
Related Work

High Fidelity, Inc.
Related Work

Facebook Spaces, 2017
Geollery
A Mixed-Reality Social Media Platform, CHI 2019

3D buildings with 360° images
geotagged framed photos
virtual avatars and live chats
geotagged virtual gifts
greetered social media
greetered street art
What's Next?

Research Question 3:

What may a social media platform look like in mixed reality?
What's Next?
Research Question

What if we could allow social media sharing in a live mirrored world?
What use cases can we benefit from social media platform in XR?
System Overview

Geollery V1 Workflow

2D polygons and metadata from OpenStreetMap

→ shaded 3D buildings with 2D ground tiles

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

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

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

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

High-quality content and seed users play key roles
Interactivity and panoramic textures increase immersion.
[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 great if I could teleport to their house and meet with them, then we could chat and share photos with our avatars.
What if we could reconstruct a high-quality, all textured, walkable mirrored world with geotagged social media **in real time**?
building polygons 360° images coarse detail fine detail depth maps
System Overview

Given (latitude, longitude)
System Overview

2D Map Data
System Overview

+Avatar
System Overview

+Avatar +Trees +Clouds +Night
System Overview

Street View Panoramas
System Overview
Geollery Workflow

[Image of various icons and illustrations related to social media and data]

48
System Overview
Geollery Workflow

(a) billboards  (b) balloons  (c) framed photos  (d) 3D models
System Overview

Geollery Workflow

(a) stacks
(b) poster boards
(c) temporal transition
All data we used is publicly and widely available on the Internet.
Rendering Pipeline
Close-view Rendering

(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
Rendering Pipeline
Initial spherical geometries
Rendering Pipeline
Intersection removal
Rendering Pipeline

Texturing individual geometry
Rendering Pipeline
Texturing with alpha blending
Rendering Pipeline

Rendering result in the fine detail
Rendering Pipeline

Rendering result in the fine detail
Rendering Pipeline
Rendering result in the fine detail
Rendering Pipeline
Close-view Rendering
Rendering Pipeline
Gap Alignment

(a) without gap alignment
(b) with gap alignment
Rendering Pipeline
Seam Blending

(a) without seam blending  (b) with seam blending
Rendering Pipeline
Seam Blending
Rendering Pipeline

Street View vs. Satellite Images

(a) texturing with street view images  (b) texturing with satellite images
Rendering Pipeline
Street View vs. Satellite Images
Rendering Pipeline
Gaussian Filtering

(a) without Gaussian filtering  (b) with Gaussian filtering
Rendering Pipeline

Gaussian Filtering
Rendering Pipeline

Occlusion Test

(a) without occlusion test

(b) with occlusion test
5 adjacent street views are cached while users are walking.

Each geometry has 131,074 vertices to be processed by the GPU.
Limitations
Inaccurate depth maps etc.

(a) inaccurate raw depth map  (b) resulting occlusion
## Countries

Visits from 32 countries registered.

<table>
<thead>
<tr>
<th>No.</th>
<th>Country</th>
<th>Last Visit</th>
<th>Percent &amp; Number of Visits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>United States</td>
<td>Sat July 27, 2019 15:07:58</td>
<td>72.52% 636</td>
</tr>
<tr>
<td>2</td>
<td>China</td>
<td>Thu July 25, 2019 01:33:22</td>
<td>8.10% 71</td>
</tr>
<tr>
<td>3</td>
<td>United Kingdom</td>
<td>Thu July 4, 2019 02:51:11</td>
<td>3.08% 27</td>
</tr>
<tr>
<td>4</td>
<td>Japan</td>
<td>Mon July 22, 2019 23:49:05</td>
<td>2.74% 24</td>
</tr>
<tr>
<td>5</td>
<td>Korea, Republic of</td>
<td>Thu June 27, 2019 18:41:37</td>
<td>1.71% 15</td>
</tr>
<tr>
<td>6</td>
<td>Canada</td>
<td>Thu Apr 4, 2019 16:32:19</td>
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<tr>
<td>7</td>
<td>Hong Kong</td>
<td>Wed July 24, 2019 01:19:18</td>
<td>1.25% 11</td>
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<td>8</td>
<td>Germany</td>
<td>Tue June 4, 2019 15:56:59</td>
<td>0.91% 8</td>
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<td>9</td>
<td>Ireland</td>
<td>Thu July 18, 2019 00:21:29</td>
<td>0.68% 6</td>
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<td>10</td>
<td>Russian Federation</td>
<td>Sat June 8, 2019 07:30:52</td>
<td>0.68% 6</td>
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<tr>
<td>11</td>
<td>India</td>
<td>Mon June 10, 2019 02:55:41</td>
<td>0.68% 6</td>
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<td>12</td>
<td>Taiwan</td>
<td>Thu May 16, 2019 06:05:58</td>
<td>0.68% 6</td>
</tr>
<tr>
<td>13</td>
<td>Italy</td>
<td>Wed June 19, 2019 08:46:30</td>
<td>0.57% 5</td>
</tr>
</tbody>
</table>
Geollery/Social Street View has its own set of distinct offerings, as it is anchored within real-world settings, just mapped onto VR, whereas these are definitely more ‘fantasy’ type of arenas. In that way, as you have already done, I think there are multitude game challenges/tasks/feedback, like the balloons, to add in!

Email feedback from pilot users
I think it’d be cool if you could see posts by people in real time, along with the establishment they’re in (like someone tweeting from inside McDonald’s or a movie theater), if that makes sense. Sort of like checking in to a place on Facebook.

Email feedback from pilot users
An interactive rendering pipeline of Fusing 360° Panoramas at two levels of detail.
Contributing a large-scale real-time system to Reconstruct a Mirrored World without the prior knowledge of any 3D models but only street view images and depth maps, which may be estimated from deep learning pipeline etc.
Establishing a web-based platform at Geollery.com for visualizing geotagged social media in a collaborative mixed-reality setting.
How about going to MOMA this weekend?
Discussion

Taking the Feedback: Geollery v2, Web3D & VR 2019

Experiencing a Mirrored World with Geotagged Social Media in Geollery

Rashdi Ch, David Li, and Anantik Vardhan
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Contact: rashdi@umd.edu, vardhan@umd.edu

ABSTRACT

We demonstrate the online deployment of Geollery v2, a mixed reality social media platform. We introduce an immersive pipeline to recreate a mirrored world at two levels of detail: the street level and the bird's eye view. Instead of using offline 3D reconstruction approaches, we capture images and create a mirrored world in real-time, while depicting geotagged social media as billboards, balloons, framed photos, and virtual gifts. Geollery allows multiple users to edit, share, and collaboratively interact with the spatial content of this mirrored world. We demonstrate a wide range of use cases including architectural tours, interactive guide tours, and merging social media and virtual reality. We envision Geollery and its inspiring and useful for a social media platform for those looking to explore new areas or building in their experiences. Please refer to https://geollery.com for the paper and live demos.

ACM Reference Format:
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 Restraint:
Weak Content for XR
Research Goal
Fuse the information from physical and virtual world

Social Street View
Best Paper Award
ACM Web3D '16

Video Fields
ACM Web3D '16

Spherical Harmonics
Saliency
Best Student Poster Award
ACM I3D '18
Under Review, TVCG '19

Haptics and Gestures
• VRSurus (CHI EA ’16)
• HandSight (ECCV ’14, TACCESS’16, SIGACCESS ’16)

Foveated Rendering
• Kernel Foveated Rendering (I3D ’18)

Learning Sketchy Scenes
• Sketchy Scenes (ECCV ’18)
• LUCCS (Under Review, TOG ’19)

Visualization and Cryptography
• AtmoSPHERE (CHI EA ’15)
• T3VC (VR ’19)

Geollery
ACM CHI ’19
ACM Web3D ’19

Montage4D
ACM I3D ’18
JCGT ’19

PANORAMAS
MULTIVIEW VIDEOS
SOCIAL MEDIA
MESHES

HAPTICS IN VR,
VISUAL CRYPTOGRAPHY IN AR,
VISUALIZATION, ETC.
Future Directions
The Ultimate XR Platform
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.
Acknowledgement

Coauthors

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Amitabh Varshney
varshney@cs.umd.edu
Thank you!

Ruofei Du, David Li, and Amitabh Varshney
{ruofei, dli7319, varshney}@cs.umd.edu | www.Geollery.com | CHI 2019
Project Geollery.com: Reconstructing a Live Mirrored World With Geotagged Social Media

Ruofei Du, David Li, and Amitabh Varshney
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?
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.

### Geolory

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<th></th>
<th>Unengaging</th>
<th>-4</th>
<th>-3</th>
<th>-2</th>
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<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<td>Straightforward</td>
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<td>0</td>
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<td>4</td>
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<tr>
<td>Improactical</td>
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<td>4</td>
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<tr>
<td>Complicated</td>
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<td>-2</td>
<td>-1</td>
<td>0</td>
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<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
<td>Appealing</td>
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</table>

### Social Street View

<table>
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<tr>
<td>Cumbersome</td>
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<td>4</td>
<td></td>
<td>Appealing</td>
</tr>
</tbody>
</table>
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?
High-level Attitude Towards 3D Social Media Platform

- Protester: 5.0%
- Followers: 20.0%
- Supporters: 75.0%
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]
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.
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.
Greetings!

Hi, friends!

Hello!