Experiencing a Mirrored World with Geotagged Social Media in Geollery

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*.

Ruofei Du, David Li, Amitabh Varshney
Augmentarium, UMIACS, and Computer Science Department
University of Maryland, College Park, MD, USA
Contact:me@duruofei.com,varshney@cs.umd.edu

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.

Figure 2: Comparison amongst mixed reality systems or designs for visualizing geotagged social media. (a) shows *Social Street View* [7], a real-time system which depicts social media as billboards via maximal Poisson-disk sampling [10], **(b)** shows Bulbul and Dahyot's offline system [1] which leverages virtual lighting to visualize popularity and sentiments of social media, **(c)** shows the conceptual design by Kukka *et al.* [11], which explores presentation manner, visibility, organization, and privacy during co-design activities, and **(d)** shows our results in *Geollery*, which fuses 3D textured buildings, geotagged social media, and virtual avatars in *real time*.

[1]A mirrored world is defined as "a representation of the real world in digital form [which] attempts to map real-world structures in a geographically accurate way" [12].

INTRODUCTION

Despite the rapid innovation in virtual and augmented reality recently (VR and AR), existing social media platforms typically use a linear narrative (*Twitter*, *Facebook*) or a grid layout (*Pinterest*). While these traditional layouts are efficient for quickly browsing through social media posts, they lack the spatial context associated with social media posts in immersive environments.

Recently, Social Street View [7, 8] and its successors [1, 11] (Figure 2) have emerged for visualizing social media in *mirrored worlds*[1][9]. Nevertheless, user interaction is limited to street-level panoramas thereby limiting the system to areas covered by street views. In addition, designing an interactive social platform with immersive geographical environments remains a challenge due to the *real-time* constraints of rendering 3D buildings. In addition, the design space of visualizing and interacting with social media in mixed reality settings is not yet fully explored.

In this demo paper, we present Geollery, a social mixed reality platform for creating, sharing, and exploring geotagged social media in a highly scalable, cloud-based infrastructure (Amazon Web Services). In addition to the design choices introduced in [5], we introduce the latest implementation of Geollery and demonstrate new visualization inspired by renovated algorithms.
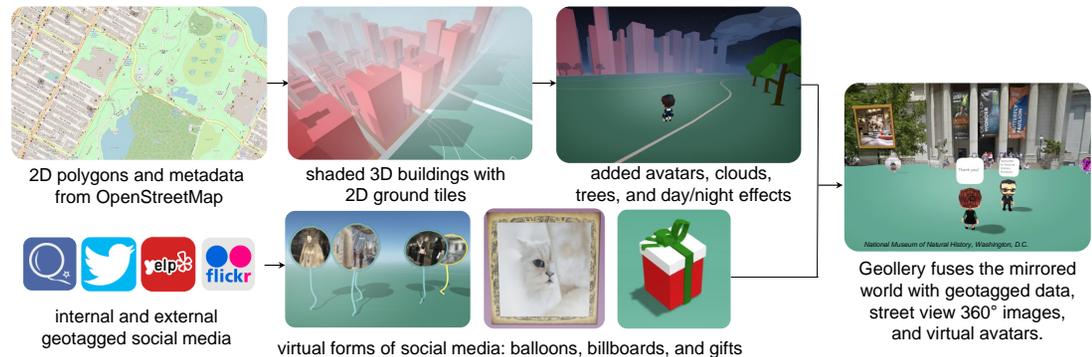

Figure 3: The workflow of *Geollery*. Based on users' geospatial requests, *Geollery* loads the nearby 2D map tiles, extrudes 3D geometries, and renders social media in real time. We take advantage of WebGL to enable users to access *Geollery* via modern browsers on a desktop, a mobile phone, or a head-mounted display.

(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
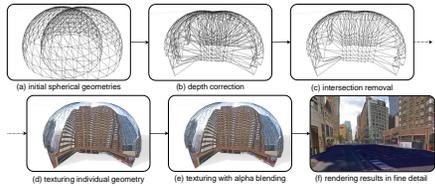
Figure 4: Our rendering pipeline for fusing 360° images in fine detail. (a) We start by generating spherical geometries to represent the 360° images. The segments of the sphere are greatly reduced for visualizing the geometries clearly. (b) In the vertex shader, we correct the depth value for each vertex by sampling the depth maps with its spherical coordinates. (c) In the fragment shader, we discard the pixels in the intersection of the adjacent geometries. (d) Texturing individual spheres with the corresponding 360 images may leave a visible seam. (e) Texturing the spheres with a weighted average according to the position to the camera yields a smoother result. (f) Finally, we interactively texture the ground plane with the corresponding satellite images, apply Gaussian filters in occluded regions, and allow the users to freely walk along the street while streaming the next street views on the go.

[2]Three.js: http://www.threejs.org.

IMPLEMENTATION

In its current form, Geollery is a web-based application, which is available on desktop, mobile phones, and virtual reality headsets. The architecture of Geollery consists of a 3D world generator, a social media scraper, a distributed SQL database, a web-server powered by Apache and PHP, and optional modules such as a temporal filter, a geospatial filter, and a computer-vision-based face filter.

We present the workflow of *Geollery* in Figure 3. *Geollery* consists of a data engine which streams 2D polygons and labels from OpenStreetMap, and social media data from our internal database and external sources such as *Twitter*, *Yelp*, and *Flickr*. Our rendering system is powered by Three.js[2] with custom shaders. *Geollery* further allows users to explore social media nearby or at a custom location.

coarse detail   fine detail

building polygons   360° images   depth maps

Figure 5: Results and overview of our interactive reconstruction pipeline at two levels of detail.

Unlike the prior art which aims to reconstruct the entire city, *Geollery* leverages a progressive approach to partially build the mirrored world at two levels of detail, as introduced in Figure 5. Given a pair of latitude and longitude coordinates, our pipeline streams and caches depth maps, street view panoramas, and building polygons from Google Maps and OpenStreetMap APIs. At a fine level of detail for close-up views, we render textured meshes using adjacent local street views and depth maps. The details are illustrated in Figure 4 and [6]. When viewed from afar, we apply projection mappings to 3D geometries extruded from building polygons for a coarse level of detail. Users could scroll in desktop or pinch to zoom on mobile devices. In contrast to teleportation, our system allows users to virtually walk through the mirrored world at the street level on various platforms.

In dense urban areas, undesirable cars and pedestrians often appear in street view images and get projected to the ground. To eliminate distorted cars and pedestrians, we choose to overlay Google Maps' satellite images instead. As shown in Figure 6, texturing the ground plane with satellite images results in a better visual appearance for our system.

(a) texturing with street view images

(b) texturing adding satellite images

Figure 6: Results before and after texturing with satellite images for the ground plane. Note that the satellite textures eliminate the distorted vehicles and pedestrians projected onto the road.

CONCLUSION AND FUTURE VISION

We have presented Geollery, a mixed reality social media platform. Geollery offers an opportunity to overcome one of the biggest challenges of social media today: lack of social interactions in a natural real-world setting that we are all familiar and comfortable with. Imagine: part social meetups, part social storytelling, part social city guide, part social gift exchange, all in a 3D world setting. Geollery is a web-based application that helps you discover nearby social media, keep up with your friends while using social psychology and gamification techniques to encourage and reward users for experiencing social interactions in a 3D setting. To users, Geollery is a tool for interacting with friends in a geographical context and rewarding oneself for discovering restaurants and navigating cities. To brands and advertisers, such a system may encourage and reward customers for participating in experiences that take place in the real world. In the future, we envision a real-time system that fuses street views, social media, and multiview videos [3, 4] to create a vivid mirrored world [2].

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