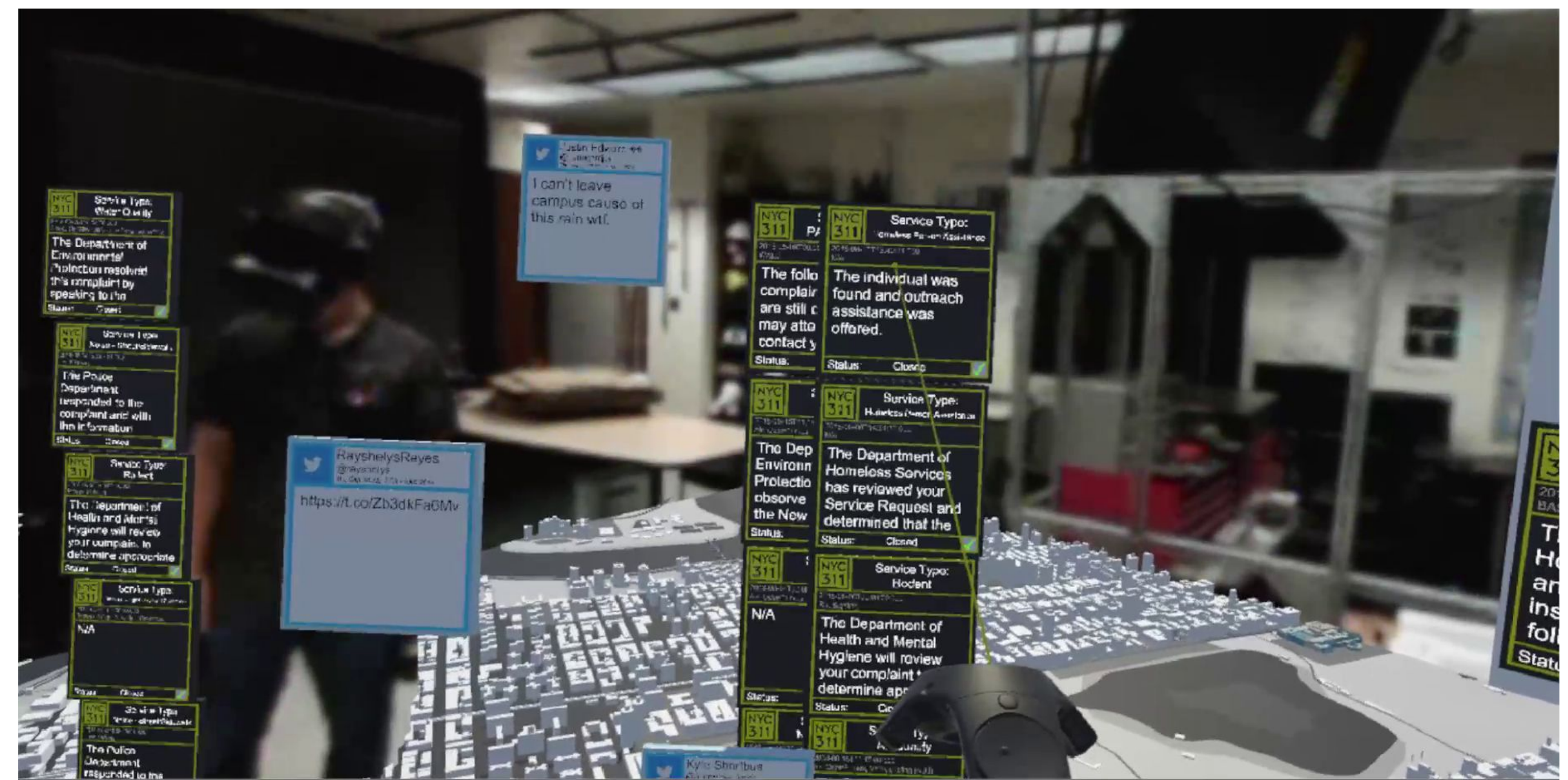


Collaborative Exploration of Urban Data in AR and VR

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311 call records from NYC Open Data and Twitter tweets viewed by a user wearing a VR headset



User wearing an AR headset grabs a 311 call record with their controller to inspect it, while another AR user is seen in the background

Introduction

- Multiple users in AR and VR collaboratively explore live geotagged urban data in context of an immersive scale model of New York City

Problems

- Users must be aware of each other's actions
- Urban data must be synchronized between users
- Multiple users should be able to collect and organize data simultaneously
- Need to standardize relationships between users/input/data to simplify state/spatial data/content propagation

Data

- Data sources are captured live:
 - NYC Open Data 311 call records
 - Tweets
 - Yelp reviews
- Data records include:
 - Content
 - Location
 - Nonspatial metadata
- Data Synchronization
 - Any user can request data
 - Propagates to selected/all users

Data Request Flow

- AR/VR controller sends trigger press event
- System:
 - Raycasts into environment
 - Extracts Latitude & Longitude
 - Gets associated data sources
 - Generates data visualizations

Implementation

- Display and Tracking
 - Oculus Rift with Touch controllers
 - Vive Pro with stereo camera pair for video see-through AR
- Software
 - Unity 2017
 - Mercury Messaging framework
 - SteamVR
 - Vive SRWorks SDK
 - Oculus SDK
 - WRLD 3D Mapping API
 - Socrata Open Data API (SODA)
- Networking
 - Server/Client Architecture
 - Server spawns data visualizations on behalf of clients
 - User avatars controlled by each client
 - Data bulletin boards are synchronized between users

Mercury Messaging Framework

- Propagates messages between scene-graph elements in Unity
- Decouples event instantiation from event handling
- Transmits messages across devices
 - With no additional network programming!
- Facilitates standardization of data transmission protocol
- Allows for bidirectional communication between users (avatars and data)

Conclusions

- Our collaborative urban exploration system allows users to explore geotagged data sources in situ
 - Interaction standardized across data sources
- Users interact in AR and VR

Future Work

- Support additional approaches to collaboration
- Include nontextual data sources:
 - Traffic
 - Weather
 - Imagery
 - 3D models
- Run user studies

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- Created with Unity 2017 and our open-source Mercury Messaging framework, github.com/ColumbiaCGUI/MercuryMessaging