Demo: CityAtmosphere: VR Image to Glimpse Wishes in the Air

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ABSTRACT

This paper presents a novel virtual reality demonstration program that provides people immersive urban experience, i.e. helps people understand characteristics of the city atmosphere from big data analysis on GPS location logs and search query logs. In contrast to the other demonstration systems that show the characteristics of areas of interests by using tag cloud, or VR systems using 3D computer graphics, our system synthesizes both the functionalities by showing 3D point clouds, where each particle shows search queries made by people staying at the area of interests. This synthesis invokes people feel the atmosphere of the city while traditional VR systems could not offer it. To make demonstration system effective, a new feature extraction process on search query logs is proposed by focusing on the users who visit the area of interests. In the demonstration at the conference, visitors could enjoy immersive urban experience with VR headset. Furthermore, the paper also shows the empirical evaluation on our new feature representation from search query logs.

CCS CONCEPTS

• **Applied computing → Fine arts**.

KEYWORDS

Virtual Reality, Big Data, GPS Location History, Search History, Urban Planning

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1 INTRODUCTION AND MOTIVATION

Thanks to the commonality in web services in the last two decades, building personalized recommendation systems based on search querying histories and e-commerce logs in web services have been actively developed [1, 2]. With the development of these big data analytics, the visualization techniques such as tag clouds with topic analysis, are also actively developed to enhance interpretation of the large scale data. With these developments, socio-scale media such as twitters, and new media information could help us obtain knowledge base efficiently; however, the knowledge base obtained from the online media is quite separated from the nature of real world. Specifically, technology behind natural language processing could not provide immersive urban experience for human, meanwhile the query words related to the place could bring the knowledge on the areas. In this context, urban experience represents feeling and impression of human as if they visit some areas of interests. As a concrete example, assume we would like to visit Times Square in New York, then check the information about Times Square from guidebook, web queries or Google street view. Although these media would help us to understand the characteristics

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of Times Square, these media could not provide information on what kind of visitors come and stay. From the perspective of urban planner, the demand analysis of the visitors or analysis of visitors interests are quite important to improve the quality of the city. However, current techniques based on guidebooks, web queries, and street view could not offer this functionalities.

In this paper, we focus on location histories of massive users as well as search queries to invoke urban experience what we call city atmosphere. This is because massive size of GPS location histories data are stored continually with widespread use of ubiquitous devices. It is natural to understand the land-use patterns of Point-of-Interests (POI) from GPS location data[4, 5]. However, with location histories only, it is not straightforward to capture the visitors actual requirements. The land use analysis from the GPS traces could not provide us the immersive urban experience.

By compensation of web based analysis on search query logs with urban computing with GPS logs, we present a new scheme to provide city atmosphere by combining the natural language processing and GPS traces of millions of users. Our main contribution of this demonstration is to confirm the feasibility of providing urban experience via VR systems at the conference. During the system development, we also propose a new feature representation on search query logs to extract implicit demand or feeling of the visitors of the area of interests. *What kind of demand is important for people who visit Shibuya in Japan?* could be analyzed by our approach. As one of the realization of this concept, we present 3D virtual reality system with 3D point clouds where each particle represents key words related to implicit demand by visitors. Throughout the experience of this demonstration systems, user could enjoy the experience as if one walk through the city as well as confirming what are implicit demands and preferences by the visitors.Therefore, this demonstration shows cityscape and point clouds based on search query words iteratively (see Figure 1).

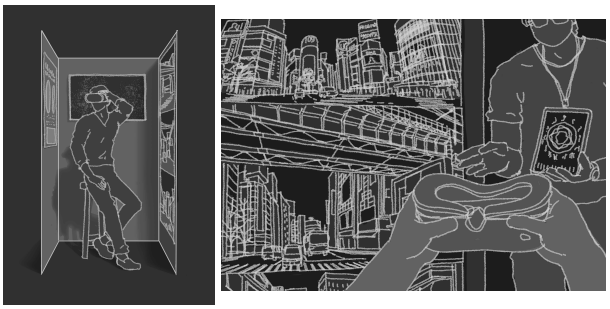

Figure 1: The layout image of our demo

2 DEMONSTRATION SYSTEM AT THE CONFERENCE

During the conference, we will provide three scenes selected from the famous sightseeing areas in Japan; Akihabara, Shibuya, and Shinjuku. The city-scape images are made by applying 3D mapping process to camera photos (Figure 2), and are shown with particles based on search queries related to the location of interests. The search queries are shown and hidden repeatedly to zooming out and in Figure 3. The sounds are also synchronized from its scene. When the scene consists of 3D particles with buildings, the sounds are mainly based on the noise captured at scene. When the point clouds are spread over the scene like clouds, the sound mainly consists of speaking query word; i.e. it represents the brain inside of visitors. With this iterative process, the system could offer the functionalities of traditional virtual reality systems and word cloud like representation simultaneously.

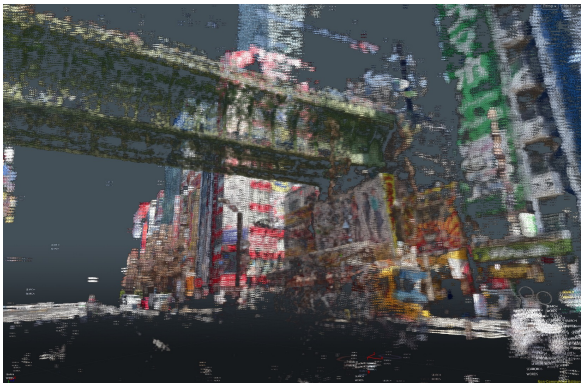

Figure 2: VR cityscape of Akihabara

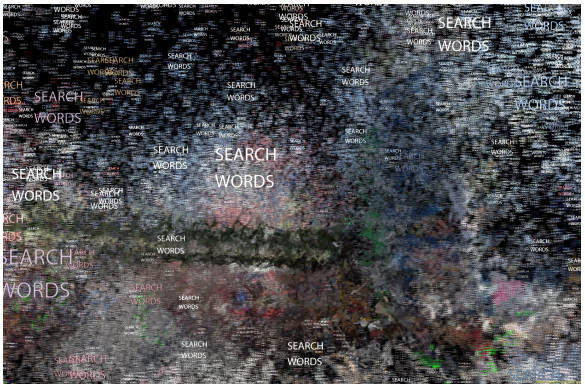

Figure 3: Cityscape drawn by 3D word cloud

3 DESIRE ANALYSIS

In this paper, we also provide a new feature representation that characterize areas of interests. It should be noted that

our demonstration systems is designed for showing the feasibility of integrating GPS logs and search query logs in big data analytics. In other words, we think this demonstration system is a kind of media art. Therefore, it is not so realistic to use the system for practical use case. To compare the characteristics of multiple areas of interest, we need to build a new representation that characterize the areas of interest. As a first step towards practical applications, we pursue how to characterize the cities and how to represent the atmosphere in the location by analyzing the combination of location histories and search histories. To achieve the goal, we employ a new categorization scheme for search histories. Specifically, we focus on "demand" to design a new characteristics. By combining analysis of visit history and search history, cities from the viewpoint of people demand can be characterized. Furthermore, implicit demand by visitors can be also displayed. We believe that city characteristics would help us urban planning, advertising strategies and other versatile applications.

Methodology

This section describes the flow of proposed extraction analysis.

As the first step of designing categories, we focus on desire analysis and have selected twelve desires (Table 1). We assume each area can be represented by the characteristics of POI as *desire feature* $\boldsymbol{f} \in \mathbb{R}^{12}$.

Table 1: Query categories of desires

Desire	Categories
trend	popular idol, fashion model
curiosity	TV, news
life	job offer, job, administrative organization
greed	money, currency, investment, finance
shopper	product name, shop name, fashion
docile	place name, facility name
entertainment	culture, sports, theme park
knowledge	school, education
sexual	sexual services, porn
existence	sick, injury, childbirth, child care
slack	transportation
hungry	recipe, food, restaurant

The extraction flow of desire feature is divided as follows.

(1) Extract list of search queries linked to area of interests from visitor's search histories. For each area, we list the users who have visited. We defined all of the search history of the visitors as search queries linked to POIs.
(2) Weight the search queries to find distinctive queries in POIs by similar to TF-IDF[3] method.
(3) Assign the desires to search queries. We assign the categories to search queries with private API. And we conducted large questionnaire to assign desires to categories.
(4) Calculate desire feature of area of interest with weights of queries and contribution of queries to desires. Table 2 is an example of calculated result.

Table 2: Score of desires of "Shibuya lunch"

trendy	curiosity	life	greed
0.043	0.039	0.006	0.000
shopper	**docile**	**entertainment**	**knowledge**
0.002	0.100	0.003	0.313
sexual	**existence**	**slack**	**appetite**
0.001	0.002	0.001	0.492

(5) Aggregate the scores for each POIs. As a result, we can define the desire feature of POI. We observe the feature by drawing as a radar chart like Figure 4.

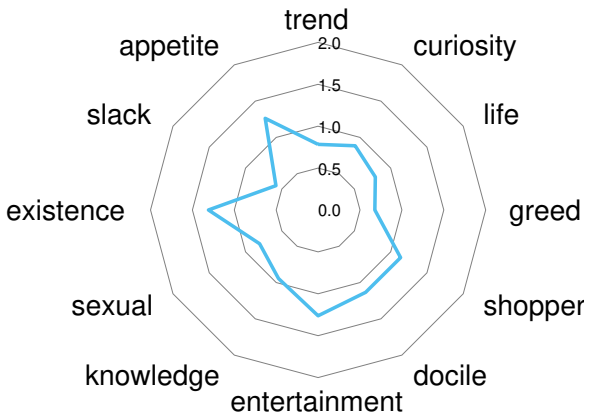

Figure 4: Desire feature plot as a radar chart

Experiment

In order to verify the feasibility of the new feature representation based on demand, we conduct a simple experiment. Specifically, we use K-means algorithm to run the clustering algorithms where demand feature is used and confirm the clustering result qualitatively.

We divide Tokyo area into over 6,000 meshes and we extract desire feature of each meshes. This clustered result in Figure 5 ($k = 3$) seems to be similar to the actual land use pattern of Tokyo. In this figure, the red area includes business area and major railway lines, the blue area contains suburb railways and residential area around stations, and green area indicates residential area in suburb areas.

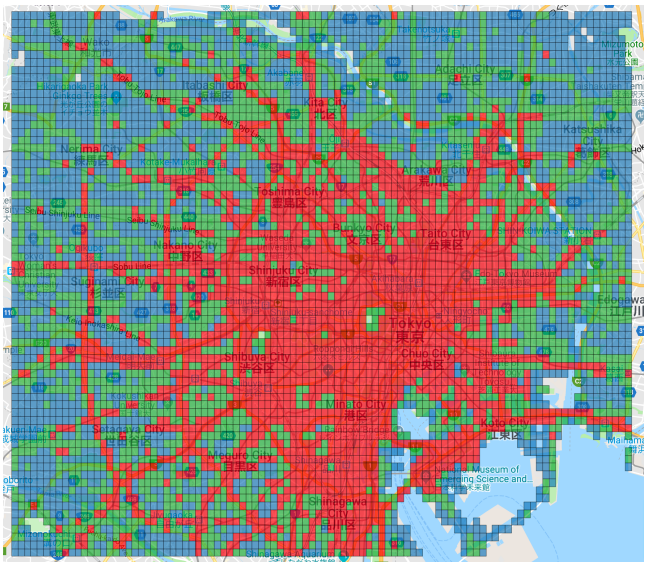

Figure 5: K-means clustering result of Tokyo area with desire feature

4 CONCLUSION

This paper has presented a newly UX virtual reality demonstration program that provides people immersive urban experience. The system integrates functions of traditional 3D VR systems and document representation by using tag clouds. i.e. shows 3D point clouds, where each particle shows search queries made by people staying at the area of interests. This synthesis provides people the atmosphere of the city, while traditional VR systems could not offer it. In the demonstration at the conference, visitors could enjoy immersive urban experience with VR headset.

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