Demo: An Immersive Visualization of Micro-climatic Data using USC AiR

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ABSTRACT

The air pollution level is increasing globally at an alarming rate. In the last two decades, many cities have adopted policies to control the emission of pollutants to the atmosphere as well as to promote sustainable urban developments. However, many of these initiatives have concluded that a long term success would require investing in the environmental literacy of the general population. In this demonstration paper, we present USC AiR, a mobile application that translates the air quality sensor feeds from the CCITI smart campus testbed into augmented reality visualizations for the USC community. USC AiR also allows users to report alarming air quality conditions and recommend environmental interventions such as planting trees. We believe that the integration of augmented reality for air quality monitoring enables the citizens to become more engaged with the air quality data while encouraging them to contribute to the reduction of anthropogenic air pollutants.

CCS CONCEPTS

• **Human-centered computing → Information visualization**.

KEYWORDS

Augmented Reality; Mixed Reality; Air Quality; Smart Campus; Smart City; IoT

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1 INTRODUCTION

The World Health Organization reported that in 2019, 91% of the world's population lived in places where pollution levels exceed the standard, resulting in the annual eight million deaths. This alarming number is approximately one in nine of the total global deaths which categorizes air pollution as the world's most significant environmental health risk. Thus, making people aware of urban air quality variation is one of the critical steps in minimizing anthropogenic air pollution and its contributing factors [1]. The U.S. Environmental Protection Agency (EPA) recognizes the week starting on the 29th of April, 2019 as the Air Quality Awareness Week and focuses on encouraging people to check Air Quality Index (AQI) to find out the best time of the day to be active outdoors[1].

History of modern urbanism is entangled with conversations around air quality monitoring. However, the complexity of its acquisition and visualization has removed the general public from understanding its nuances. Environmental data has been generally visualized as tabular data or two-dimensional plots that have traditionally only interested environmental scientists and meteorologists. With the growth of DIY culture, along with the accessibility of IoT hardware platforms and sensors, a new generation of scientists, policymakers, and active citizens, have begun exploring alternative methods of environmental data acquisition and analysis [2]. For example, exploring the idea of data marketplaces in the context of smart cities has enabled the city administrations to acquire data from community members [3].

In the past decade, numerous applications and frameworks have been developed to gather air quality information. However, such efforts have not focus on creating educational platforms which

[1] https://www3.epa.gov/airnow/airaware/index.html

Figure 1: USC AiR Application.

engage the citizens while raising awareness. In this demonstration paper, we present USC AiR to enable an immersive visualization of microclimatic data. USC AiR is an Augmented Reality (AR) data visualization mobile application which communicates with the CCITI testbed to acquire air quality data. CCITI is an outdoor smart campus internet of things (IoT) testbed which has been developed by the researchers at the University of Southern California (USC) Center for Cyber-Physical Systems and the Internet of Things (CCI). USC AiR captures and displays the air quality data of the USC campus in real-time through an interactive mobile AR application. Our interdisciplinary research efforts focus on extending the existing mobile AR capabilities to work with real-time air quality data in order to educate the public about air quality and its negative impacts.

2 USC AIR

USC AiR application augments the data from CCITI testbed sensors on to a 3D model of the USC campus as shown in Figure 1. This application has two modes:

- The **Aerial Mode**, is activated by scanning any USC student card and allows one to see the location and data of all the CCITI testbed sensors throughout the campus.
- The **First-person Mode**, is set up to guide the user to the nearest CCITI sensor based on their geolocation. This mode accesses the user's camera view and creates a color gradient, ranging from clear to saturated red based on nearest sensor readings. Once within a close range, the user can access an immersive visualization of the sensor data, as well as information about the sensing unit. In this mode, the user can snap a photo of the setup and upload to their Twitter account with suggested hashtags. The user also can plant virtual trees near each sensor, in order to trigger further action from the campus community and planning committee. These virtual trees are stored in the application's database and will appear next time when another user visits the location.

USC AiR allows the user to switch between these modes at any time, enhancing their understanding of the data and its immediate context. Designing these actions allow us to develop an engaging and context-aware air quality sensing and visualization workflow. The goal is to raise awareness about the urgency of ubiquitous environmental sensing and motivate the formulation of locally informed urban policies.

The USC AiR is developed using Unity framework, and it currently runs on Android devices. To access the sensor data from CCITI testbed, we used MQTT, a publish-subscribe messaging broker. Our future work includes extending the application to support "news-friendly" or "social-media-friendly" outputs to share the data with the members of the community.

3 CONCLUSION

In this demonstration paper, we have presented USC AiR, an immersive visualization application which engages with users to monitor air quality data using USC's CCITI testbed architecture. We allow the users to explore the pollution levels of the campus and plant virtual trees next to locations with sub-optimal air quality. We believe that the immersive visualization of air quality data will assist the university, city, and government officials in engaging in conversations with the citizens about the future health of our cities.

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