Demo Abstract: The Immersive Reality of Building Data

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ABSTRACT

Since the first automated buildings, sensor data was used to monitor and visualize building operations. The first automated buildings had only a few meters and sensors on the main equipment and were operated by dedicated computers in special control rooms. Modern buildings tend to have thousands of sensors down to individual desk level. The systems can now be managed remotely and mobile smart devices are on the advent of becoming primary interfaces for operation. But, the sheer amount of data that needs to be visualized adds a new layer of complexity. The tools and workflows that were designed to operate a few systems are not efficient for large buildings with thousands of sensors neither are modern apps developed to control small smart homes. The demo explores ways to visualize real-time building data on smart devices using virtual and augmented reality without specialized software requirements on devices.

Categories and Subject Descriptors

H.5.1 [**Information Systems**]: Information Interfaces And Presentation—*Artificial, augmented, and virtual realities*

Keywords

Virtual Reality; Augmented Reality; Smart Buildings

1. INTRODUCTION

Virtual Reality (VR) and Augmented Reality (AR) had an early hype already in the beginning of the century. Several papers explored their applicability in architecture [2] and system design [4]. Particularly during design, VR helps designers to explore their concepts [1]. However, these technologies never established in practice as the delivered quality was not appealing and the technical requirements were large and relied on simulated data and pre-rendering [3, 4].

Google Cardboard demonstrates that now every smart phone can be easily turned into a VR device. WebGL and Javascript frameworks make it possible to utilize the devices web browser instead of requiring dedicated software suites. The demo explores how this can be leveraged to create an immersive visualization of real-time data for modern buildings. It is demonstrated in different aspects of building operation for the IBM Research Living Laboratory building in Dublin with more than 2.000 datapoints.

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2. OPERATORS 3D VIEW

Operators have to constantly monitor the performance of the building. But, the new data richness makes it actually harder for them to navigate and investigate the data relevant for their task. The operators view aggregates sensor data into a simple 3D visualization. It utilizes the Autodesks View and Data API[1], which converts and displays most common 3D formats. The API uses internally the WebGL framework 'three.js'[2]. This allows to easily modify and render the model with Javascript in the mobile browser.

Figure 1: Operators view of the estimated occupancy.

The operators view in Fig. 1 visualizes multiple sensor values. The operator can select on the top different environmental sensors (temperature, illumination, etc.) or virtual sensors for thermal comfort[5] or occupancy based on PIR, CO_2, and temperature. The selected sensors are dynamically added to the model. They are visible as boxes hovering over the model in Fig. 1. Real-time data from the sensors is used to compute a heatmap of the sensor value distribution. For example, the red and blue heatmap in Fig. 1 highlights zones of high and low occupancy density. The heatmap is projected on the 3D model as texture. The timeline at the bottom is used to present and navigate the historic data. It reveals the typical daily usage profile of the total space.

[1] `https://developer.autodesk.com/api/`
[2] `http://threejs.org/`

3. OPERATORS VR VIEW

The 3D model can also be visualized with Virtual Reality devices such as Google Cardboard. Therefore we duplicate the view and shift the camera to create a stereo effect. The 3D image benefits the exploration of complex situations such as the interaction of sensors in zones where depth information is relevant. For example, Fig. 2 shows a workplace that is monitored by three wireless temperature sensors as well as a desk temperature sensor. Each sensor is represented as a box with the current sensor reading above them. The increase in temperature with the mounting height of the sensors reveals the stratification effect. In contrast, the temperature under the desk is lower as it is not exposed to sunlight. Such effects could not be easily visualized in 2D.

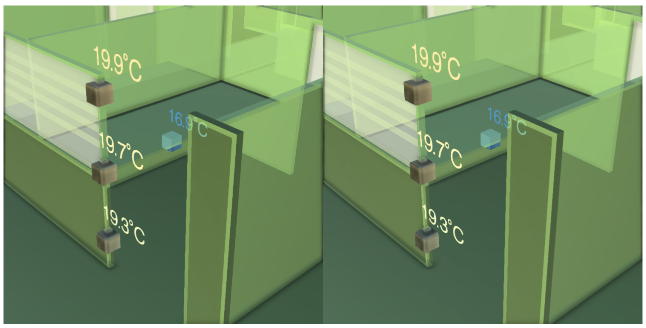

Figure 2: Stereo VR view of multiple temperature sensors.

4. SENSOR AR VIEW

A common use case for operators and occupants is to check the current sensor readings. The marker-based AR sensor overlay shown in Fig. 3 makes it simple. We labeled the sensors with black-white markers encoding a unique ID. Pointing a smart device on it will reveal the current and historical readings. We utilize the 'webar' extension[3] of Three.js to compute a pose matrix that correctly places a HTML5 overlay with the sensor data.

Figure 3: Sensor AR view showing the values of a wireless sensor.

5. SYSTEMS AR VIEW

We can also project more complex 3D elements in AR. We labeled some vents on the ceiling with markers. Using the same AR and 3D libraries we can visualize the Fan Coil Units (FCU) in the ceiling as well as the assigned variables as seen in Fig. 4. We therefore project a simplified 3D model of the FCU and relate the real time data to it. This enables maintenance people to easily access real-time data of physical objects in the field.

[3] `https://github.com/jeromeetienne/threex.webar`

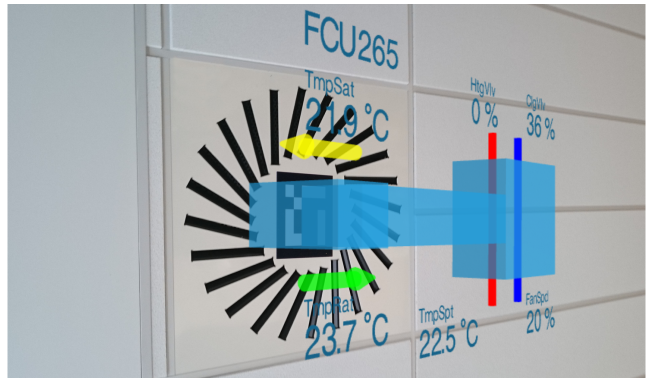

Figure 4: Systems AR View showing a FCU in the ceiling.

6. CONCLUSION

The paper demonstrates various visualizations for building data that realize Virtual and Augmented Reality in the web browsers of smart devices. Different VR and AR visualization of real-time data create an immersive interaction and understanding of building systems. It removes the overhead in identifying and visualizing relevant datapoints as data can be accessed by pointing a device while walking the building. Large sensor amounts are visualized together by heatmaps and aggregated distributions. Previous works in the field required simulated data and dedicated heavyweight systems. The demo shows what you can do out of real-time data using the web browser on a smart phone. It can be replicated with the links provided in the text. Future work addresses replacing markers by location based services using indoor localization, iBeacons, and object recognition.

7. ACKNOWLEDGMENT

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