Development of Data Augmentation and Display Tools for 360-Degree Fire Videos in WebVR

Frank Willard[1], Sandy Ressler[2], and Matthew Hoehler[3]

[1]Poolesville High School, Poolesville, MD [2]High Performance Computing and Visualization Group, Applied and Computational Mathematics Division, Information Technology Laboratory, National Institute of Standards and Technology [3]National Fire Research Laboratory Group, Fire Research Division, Engineering Laboratory, National Institute of Standards and Technology Gaithersburg, MD

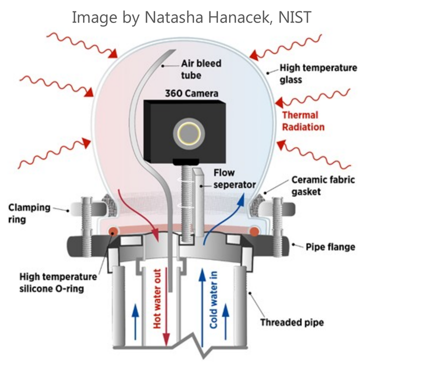
An INTRODUCTION

In 2018, the NIST Fire Research Division designed and built the Burn Observation Bubble, an apparatus comprised of a 360-degree camera placed in a heat-resistant glass sphere filled with water. This elaborate setup protects the camera from the intense heat and infrared radiation of a fire, enabling it to capture high quality videos from within a fire. Scientists and firefighters can utilize qualitative data from the newfound, interior fire perspective alongside concurrent spatial and temporal data to better understand fire's behavior.

Virtual reality (VR) consists of a 3D, computer-generated environment which can be used to simulate conditions through its user interactivity and immersion. With the development of VR headsets and expansion of WebVR, the benefits of VR have become increasingly available to the general public.

My project looks to integrate sensor data and add interactivity to a 360-degree fire video robustly in order to retain immersion while displaying data.

Image by Natasha Hanacek, NIST



Burn Observation Bubble

Image from Getty Images

High-quality image of a fire

MOTIVATIONS and METHODS

In creating a WebVR application, the application's breadth is not limited to any hardware or software but rather extended to reach any of the 4.4 billion people who use the Internet. WebVR enables cross-platform compatibility, allowing users of different headsets or no headset the ability to navigate the 360 degree scene. In addition, being on the web means that it falls under the World Wide Web Consortium (W3C), which develops protocols and standards for the World Wide Web.

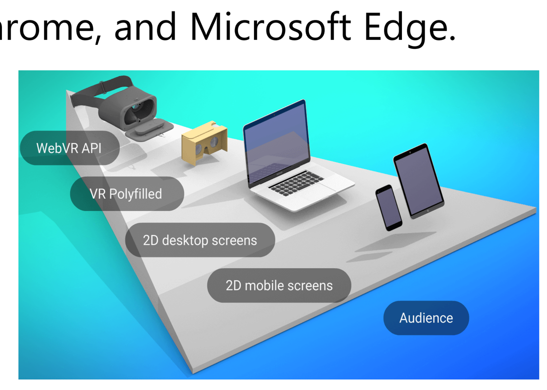
Hence, the application was developed for WebVR to increase its distribution and compatibility.

METHODS

- The Hypertext Markup Language (HTML) and JavaScript were used for the layout of the application
- A-Frame, an WebVR framework based on HTML and built upon WebGL and THREE.js, was used as the framework. We used it to display entities within the scene including sensors, video controls, and data.
- D3.js, a JavaScript library for producing data visualizations, and Cascading Style Sheets (CSS), a styling language, were utilized in developing the dynamic, live-time graphs for sensor temperatures.
- The application was tested on various VR headsets including the HTC Vive, Oculus Rift, and Windows Mixed Reality, as well as web browser such as Mozilla Firefox, Safari, Google Chrome, and Microsoft Edge.

WebVR software used for application

Image from https://lensreality.com/how-to-get-started-with-webvr/



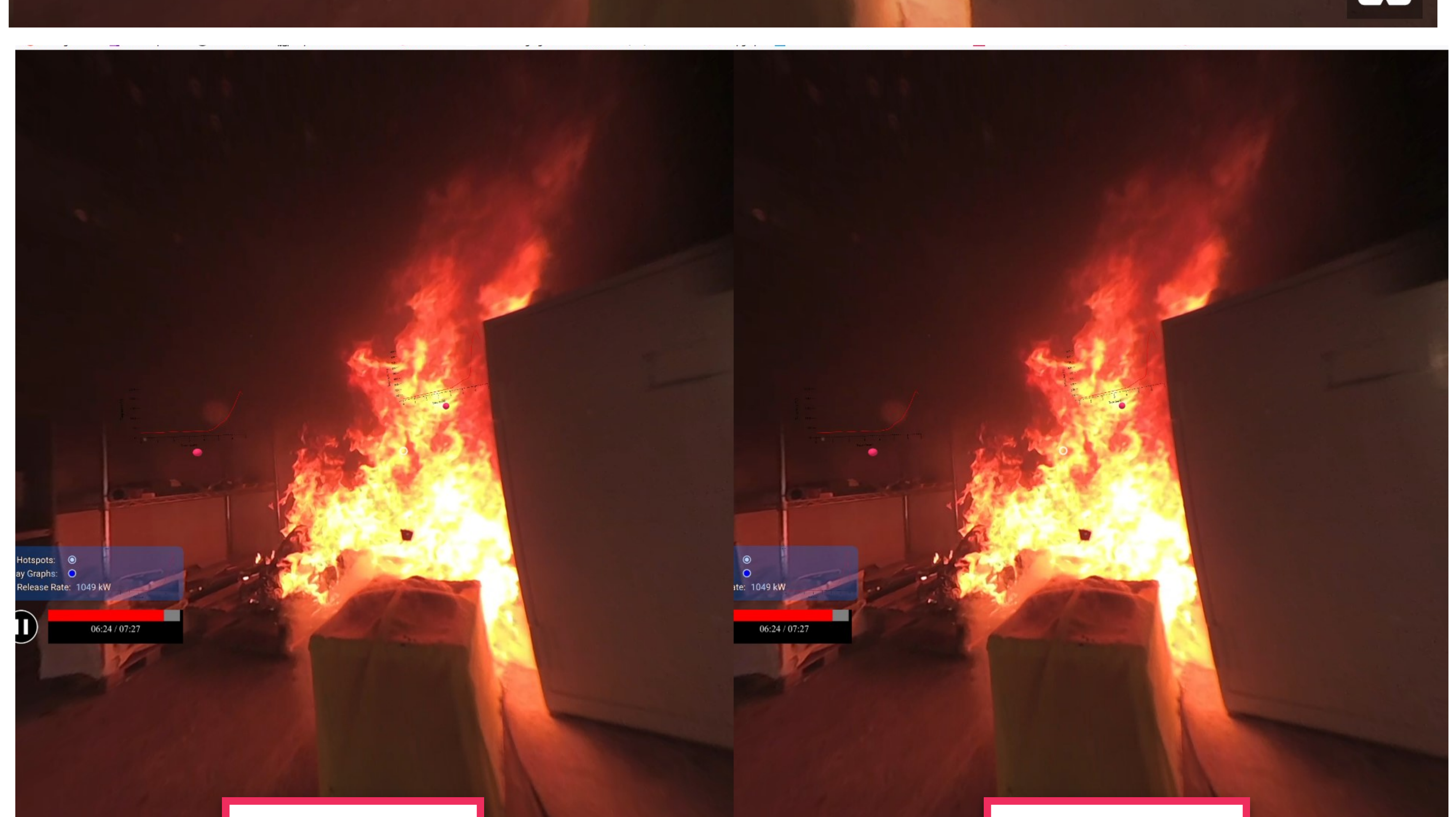
WebVR API Cross-Platform Compatibility

Image from https://anssiko.github.io/ac2017-webvr/?full#8

RESULTS

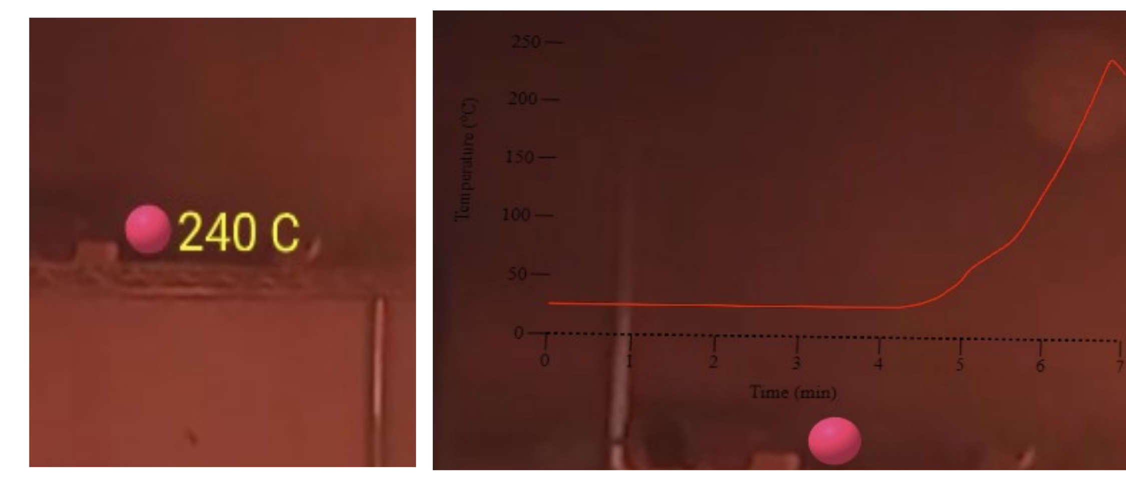
LEFT EYE RIGHT EYE

Graphical Display



LEFT EYE RIGHT EYE

Data Augmentation



The user has the ability to display the live temperature of any sensor within the scene as either a graph or text. This feature was enabled by executing a modified binary search to find the current time and then displaying its associated temperature. The ability to show data within the video allows the user to visualize the fluctuations in the scope and magnitude of the fire.

Heads-Up Display (HUD)

As the user navigates the scene, the Heads-Up Display Panel remains with them, serving as the primary graphical user interface (GUI) for the application. The HUD panel consists of a video slider and hotspot and graphical display buttons to allow customization of the video's display. Furthermore, the HUD contains the heat release rate data in both numerical and graphical format, indicating the intensity of the fire.

CONCLUSIONS

We were successful in integrating various video controls as well as numerical and graphical data for the sensors in the 360 degree video of the fire. These features are not only functional, but also robustly augmented into the video to retain the, immersive experience desired for the user.

The user maintains the ability to zoom, rotate, play, pause, skip ahead or backward, and select sensors or buttons to access the live temperature data in either numerical or graphical formats. In interacting with the video and viewing the coinciding data, scientists and firefighters can observe changes in the intensity and breadth of the fire.

Furthermore, it functions in both browsers and head-mounted displays, expanding its availability and usability, thus magnifying its potential impact.

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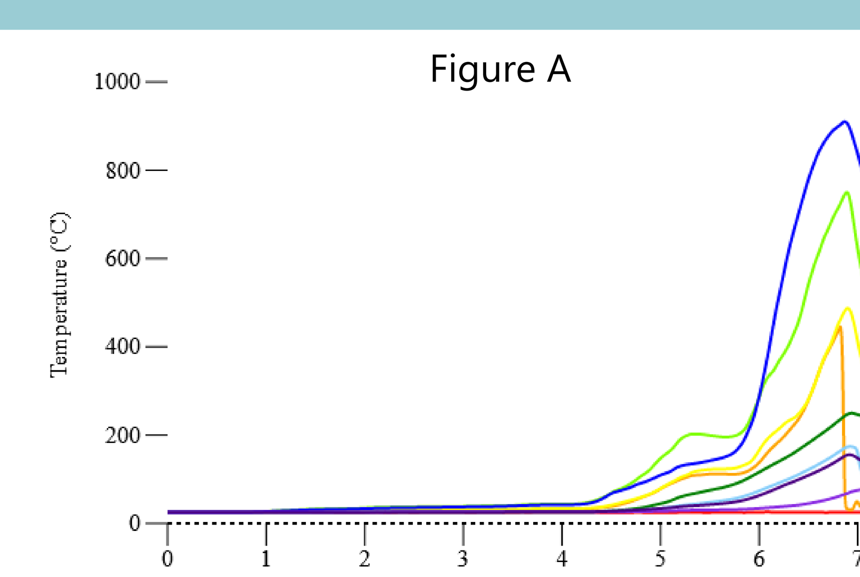
Finally, I would like to thank Justin Slud and Adam Lenker for accompanying me in my work on the project.

FUTURE WORK

This project will be further developed with new features and will serve as the first of many 360-degree fire videos to use VR. More browser-based features will be implemented for VR headsets including the ability to zoom and click. Additionally, we will add comparative plotting between graph entities (Figure A). For future programs, we plan to construct an algorithm that will calculate the location distortion from physical space to the video sphere and automate sensor location. Finally, we will use a stereoscopic video with surround sound to increase immersion and quality.

Figure A



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