

360-Degree Video in Fire Research

Updated: 06/19/2019



Credit: M. Hoehler/NIST

NIST
Fire Research Division

360-Degree Video in Fire Research

Historically, visual data from fires has been limited to 2D, often with a narrow field of view and for limited periods of time; e.g., if the camera is destroyed



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Investigator: D. Madrzykowski

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High-resolution omni-directional cameras are rapidly getting smaller, better and cheaper



120 mm³
2.7K res
\$4000

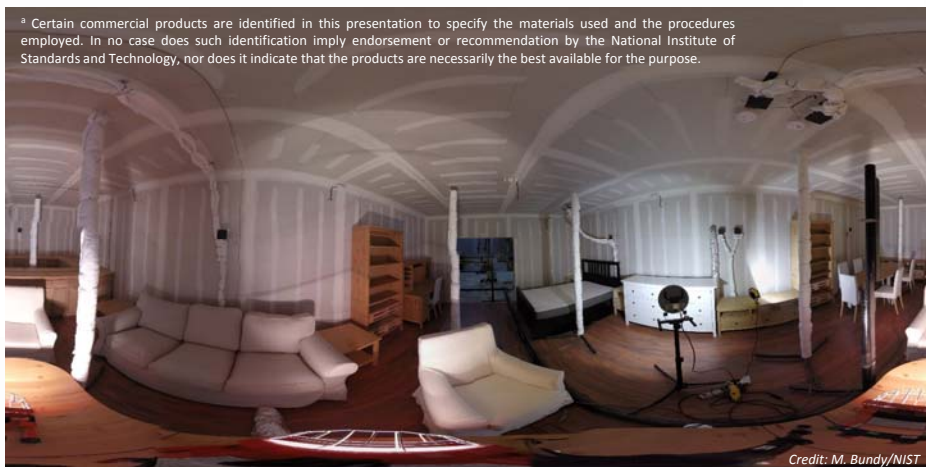
GoPro OMNI (launched 2016)^a



75 mm tall
5.2K res
< \$600

GoPro Fusion (launched 2017)

^a Certain commercial products are identified in this presentation to specify the materials used and the procedures employed. In no case does such identification imply endorsement or recommendation by the National Institute of Standards and Technology, nor does it indicate that the products are necessarily the best available for the purpose.



Credit: M. Bundy/NIST

360-degree image of cross-laminated timber compartment taken using GoPro OMNI Sync Cube at the National Fire Research Laboratory in 2017

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For video in fire, the challenge is twofold: **keep the camera cool** and **filter the intense thermal radiation**

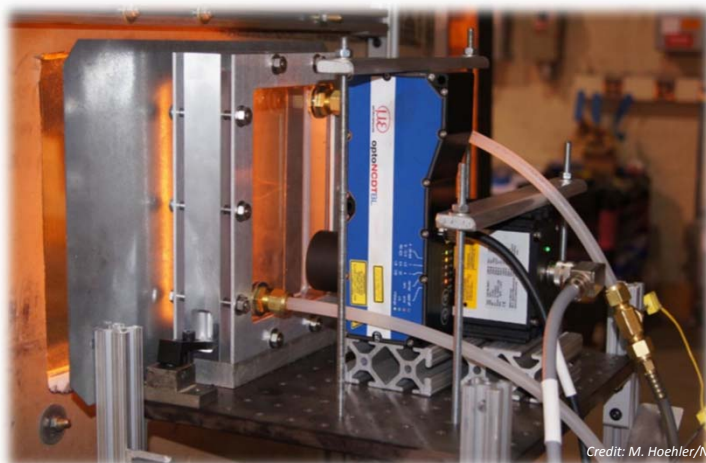
Hoehler, M; Su, J; Bundy, M; *Dataset from Fire Safety Challenges of Tall Wood Buildings - Phase 2: Task 3 - Cross Laminated Timber Compartment Fire Tests* <https://doi.org/10.18434/T4/1422512>



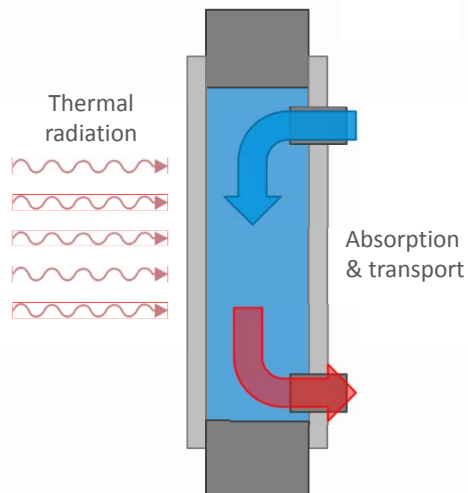
- Gas temperatures to 1400 °C
- Thermal radiation > 100 kW/m²

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Water is extremely good at absorbing thermal radiation...



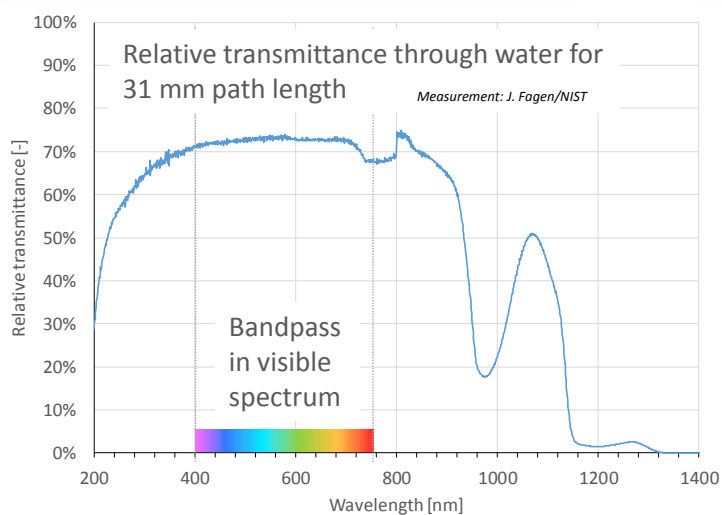
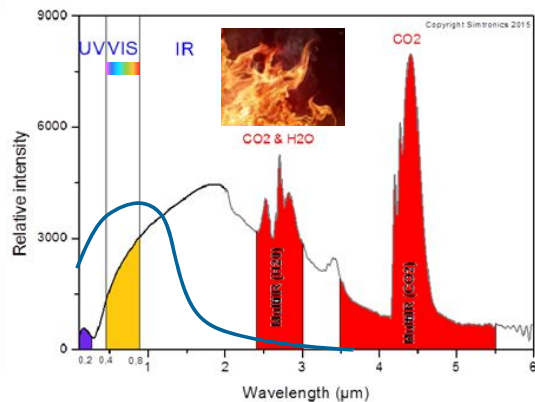
Credit: M. Hoehler/NIST



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...while transmitting energy in the visible spectrum.

Energy intensity spectrum for a hydrocarbon fire



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NIST has exploited this fact to get 2D video cameras closer to fires



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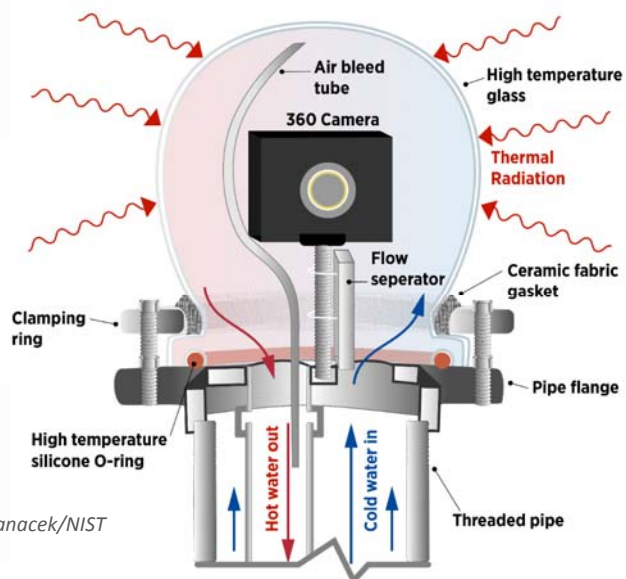


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Concept sketch of
application to
360-degree
cameras



Credit: N. Hanacek/NIST

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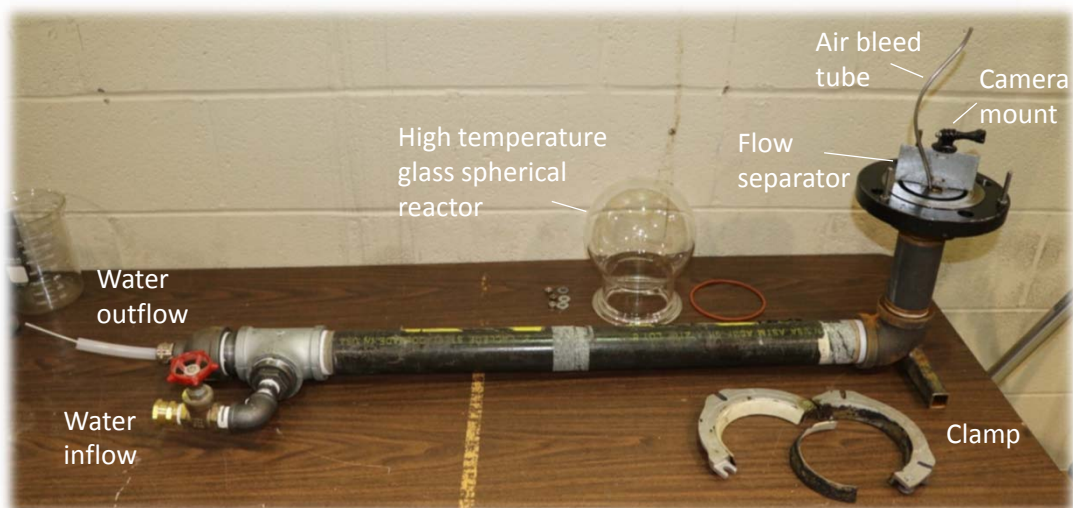
Burn Observation Bubble (BOB) functional prototype version 1.0



Credits: M. Hoehler/NIST

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Burn Observation Bubble (BOB) functional prototype version 1.0



Credit: M. Hoehler/NIST

360-Degree Video in Fire Research

Case Study 1: Influence of Fire on the Lateral Resistance of Cold-Formed Steel Shear Walls – Kitchen Fire



Camera located in front of the doorway

Hoehler, M; Andres, B; Bundy, M; *Influence of Fire on the Lateral Resistance of Cold-Formed Steel Shear Walls – Phase 2: Oriented Strand Board, Strap Braced, and Gypsum-Sheet Steel Composite, Technical Note (NIST TN) – 2038* (<https://doi.org/10.6028/NIST.TN.2038>)



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Case Study 1: Influence of Fire on the Lateral Resistance of Cold-Formed Steel Shear Walls – Kitchen Fire



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Case Study 1: Influence of Fire on the Lateral Resistance of Cold-Formed Steel Shear Walls – Kitchen Fire



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Case Study 1: Influence of Fire on the Lateral Resistance of Cold-Formed Steel Shear Walls – Kitchen Fire



Learnings:

- Combustible seal failed
- Bolts stretched too much
- Water flow rate too low
- Camera exposure saturated
- Need audio

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Case Study 2: Smithsonian Institution – Preparedness and Response in Collections Emergency (PRICE) Workshop



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Stereo sound was added using two external microphones



Camera

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Inexpensive capsule mics were installed in the compartment wall with thermal protection



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Case Study 3: Prescribed forest management fires in the New Jersey Pine Barrens



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Case Study 3: Prescribed forest management fires in the New Jersey Pine Barrens



$$A = 4 \cdot \pi \cdot r^2 \quad r = 80 \text{ mm}$$

$$c_{H_2O} = 4.186 \text{ joule/gram } C^\circ$$

$$\Delta T = 20 \text{ } C^\circ \quad \text{Allowable temperature rise of camera}$$

Assumed duration and intensity of max heat flux

$$t = 10 \text{ min} \quad \dot{q} = 100 \text{ kW/m}^2$$

$$mass_{H_2O} = \frac{Q}{c_{H_2O} \cdot \Delta T} = 57 \text{ kg } (\approx 15 \text{ gal water})$$

$$\text{Where, } Q = \dot{q} \cdot A \cdot t$$



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Case Study 3: Prescribed forest management fires in the New Jersey Pine Barrens



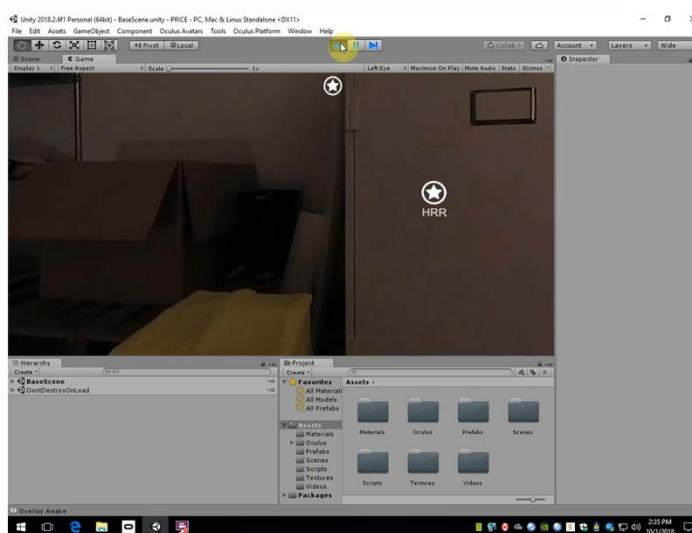
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A first step from 360-degree video to Augmented Reality (AR) was achieved using a commercially-available game engine

Once the video is transcoded into the game engine, one can add interactive elements to augment the user experience:

- data overlays
- explanatory information
- ...



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360 fire video was successfully displayed in various immersive viewing environments



Credit: L. Gerskovic/NIST



Credit: F. Kuester/UCSD

360-Degree Video in Fire Research



Matthew Bundy



Matthew Hoehler



Artur Chernovsky

Audio & Video
support



Andrew Mundy



Jose Garcia

Sandy
Ressler



XR guys...



Tom Roth & DJ Anand

Special thanks to Arron Kirchoff & Jeffrey Anderson (Master Glassblowers), Falko Kuester (UCSD/Calit2 Professor for Visualization and Virtual Reality), NIST Shops, William (Tre) Harrison, David Stewart, Norris Ng