360-Degree Video in Fire Research

Updated: 06/19/2019

Credit: M. Hoehler/NIST

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

Investigator: D. Madrzykowski

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

120 mm^3
2.7K res
$4000

GoPro OMNI (launched 2016)[a]

75 mm tall
5.2K res
< $600

GoPro Fusion (lunched 2017)

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**

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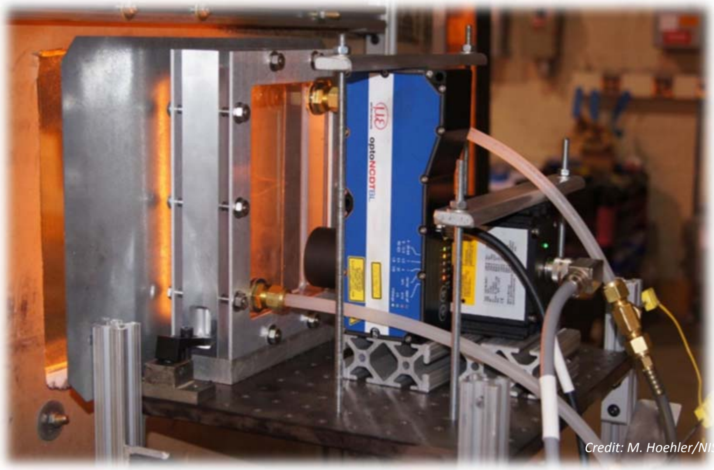
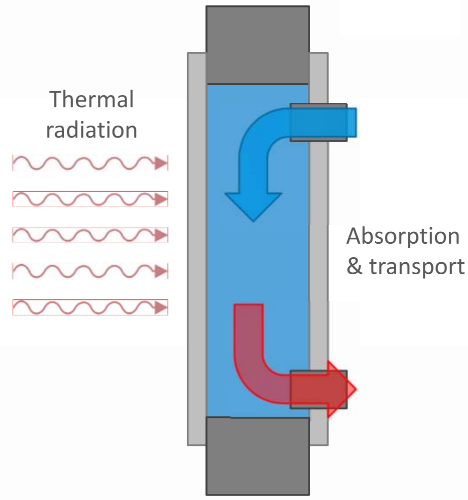
Water is extremely good at absorbing thermal radiation…





Hoehler, M. S.; Smith, C. M.: "Application of Blue Laser Triangulation Sensors for Displacement Measurement Through Fire." Measurement Science and Technology, 27(11) 2016, doi: 10.1088/0957-0233/27/11/115201.

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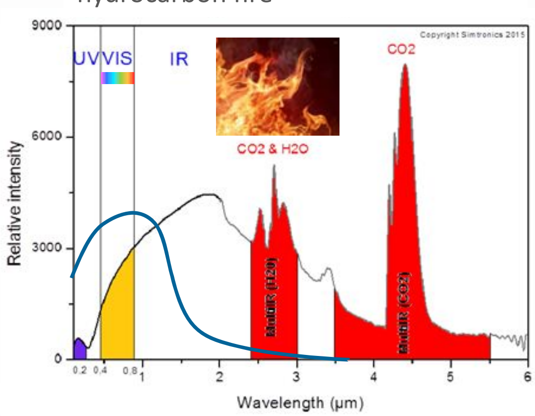
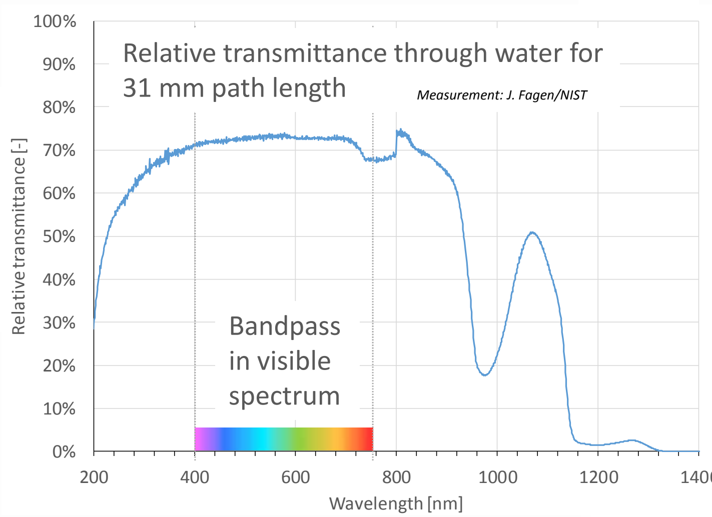
…while transmitting energy in the visible spectrum.

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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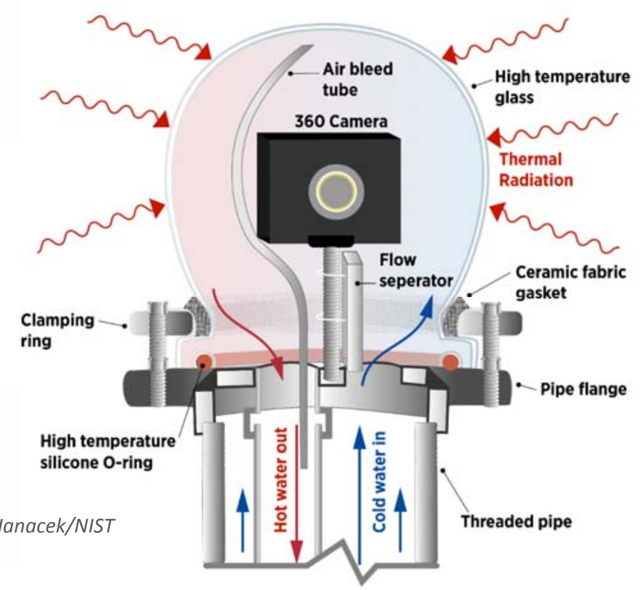
Concept sketch of application to 360-degree cameras



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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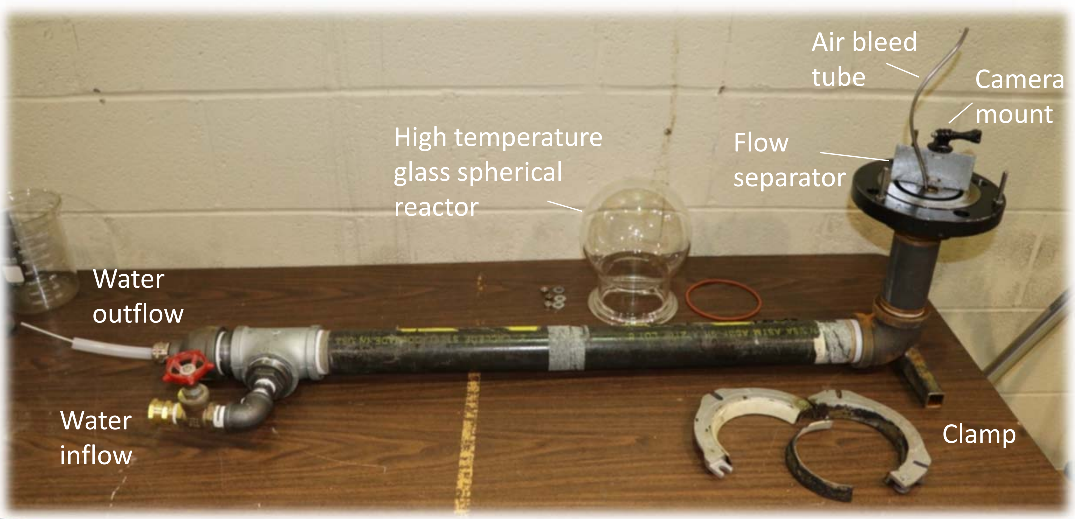
360-Degree Video in Fire Research

Burn Observation Bubble (BOB) functional prototype version 1.0



Credit: M. Hoehler/NIST

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360-Degree Video in Fire Research

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

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)

Camera located in front of the doorway

Credits: M. Hoehler/NIST

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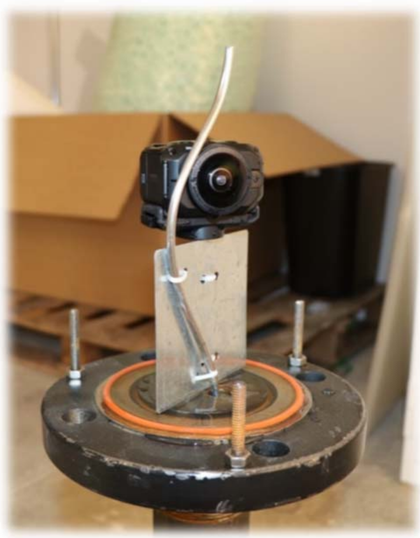
Case Study 1: Influence of Fire on the Lateral Resistance of Cold-Formed Steel Shear Walls – Kitchen Fire



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

Capsule mic

w/ thermal protection

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360-Degree Video in Fire Research

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

THE UNIVERSITY of EDINBURGH

360-Degree Video in Fire Research

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

$A = 4 \cdot \pi \cdot r^2$ $\qquad r = 80\ mm$

$c_{H20} = 4.186\ joule/gram\ C°$

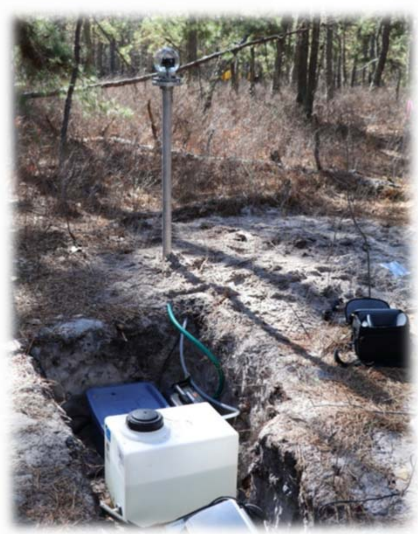
$\Delta T = 20\ C°$ Allowable temperature rise of camera

Assumed duration and intensity of max heat flux

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

$$mass_{H20} = \frac{Q}{c_{H20} \cdot \Delta T} = 57\ kg\ (\approx 15\ gal\ water)$$

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



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

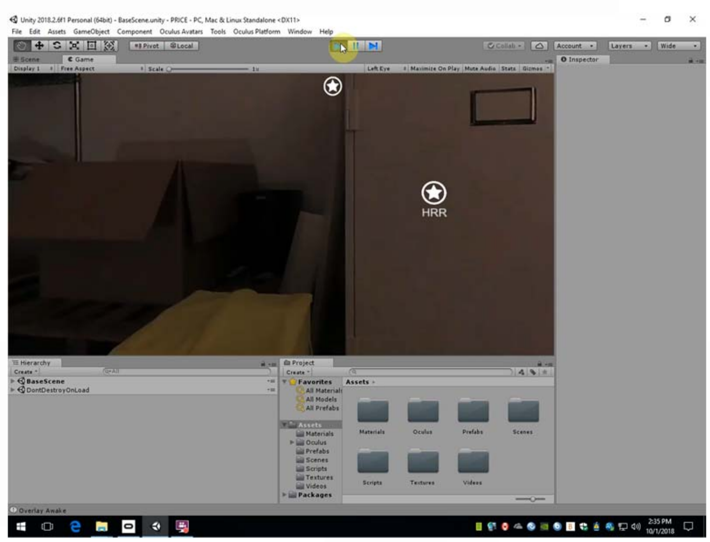
Credits: M. Hoehler/NIST

360-Degree Video in Fire Research

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

NIST's 3D visualization laboratory

Credit: L. Gerskovic/NIST

Viewing in the *SunCAVE*
at the UC San Diego Qualcomm Institute

Credit: F. Kuester/UCSD

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360-Degree Video in Fire Research

Matthew Bundy

Matthew Hoehler

Artur Chernovsky

Sandy Ressler

XR guys…

Tom Roth & DJ Anand

Audio & Video support

Andrew Mundy

Jose Garcia

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