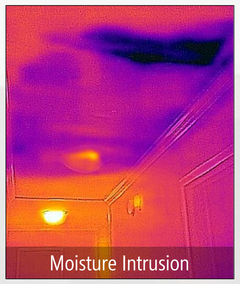
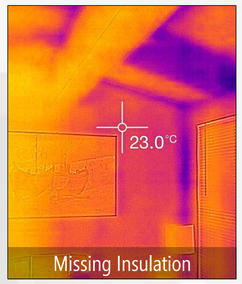
How Might We **Collect** and **Analyze Temporal Thermography Data** to Support **Energy Audits**

Energy Auditing and Thermography

Buildings consume 41% of the energy produced in the US and make up an increasing portion of CO2 emissions. To combat this issue, there has been a resurgence of interest in energy auditing—studying the operating conditions of buildings to evaluate renovations and retrofits that can improve energy efficiency. **Thermography is an increasingly common technique** used by energy auditors of varying skill to detect:


Moisture Intrusion

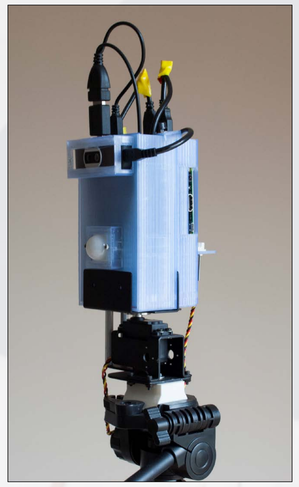


Missing Insulation

Air Leakage

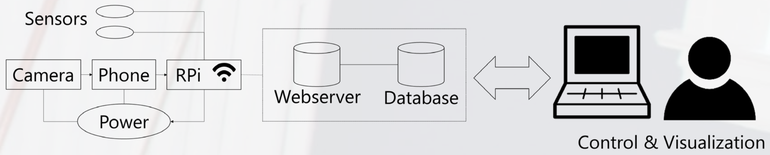
Still, interpreting thermal images is **often subjective** requiring both **training and experience**. One promising solution to this problem is the use of **temporal thermography**, which may provide additional information that can mitigate these issues. However, current **consumer thermography tools do not support this use case well**.

A Sensor Kit for Temporal Data Collection

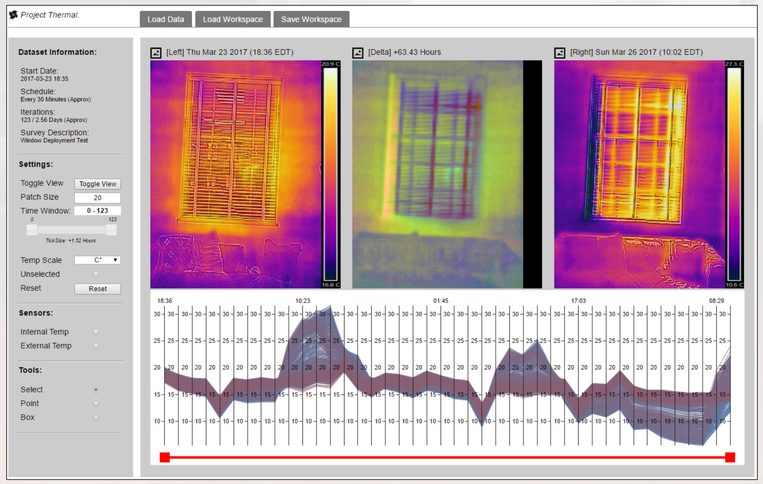


Our sensor kit consists of a **FLIR One thermal camera** connected to a smartphone, which communicates via Bluetooth to a Raspberry Pi. The system has onboard sensors for humidity, local air temperature, and motion detection.

The sensor kit is designed to deploy in a single location and **collect data over several days or weeks** on a user-specified schedule. Scheduling data collection and accessing the data is done via a web application. Detailed analysis of the collected images and sensor data is provided to users via our data analysis tool.



A Web Application for Temporal Analysis



Our temporal analysis tool is centered around a Parallel Coordinate Plot of the temperature changes between the collected images; this **plot visualizes the trend of the temperatures** at each pixel location as images are spatially aligned. We also overlay sensor data on this plot and allow the user to scan through the images to make point-in-time comparisons and derive insights.

Supporting Energy Auditing

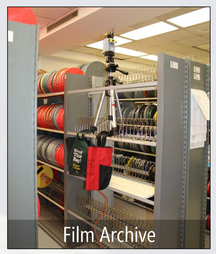
Post usability and internal testing, we conducted a recent deployment to augment an energy audit being conducted at the University of Maryland.

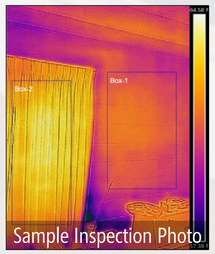
Goals. The goals were to investigate recent changes to HVAC settings, ensuring proper regulation of a room housing archival materials, and to check for adverse effects caused by solar loading or structural degradation.

Setup. We collected data in three-day intervals on two separate occasions, first during winter weather conditions and again during the spring.

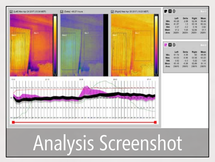
Results. All data indicated a stable environment that seemed to be invariant of external weather. There was some evidence of solar loading, but this was not significant.

"The data supports the conclusions I made based on my models and makes me more confident in the recommendations that I'll make going forward" (P5).


Film Archive



Sample Inspection Photo


Analysis Screenshot

For more information about the "Scalable Thermography" project, visit our website: http://makeabilitylab.io/project/thermography/

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