A Large-Scale Analysis of YouTube Videos Depicting Everyday Thermal Camera Use

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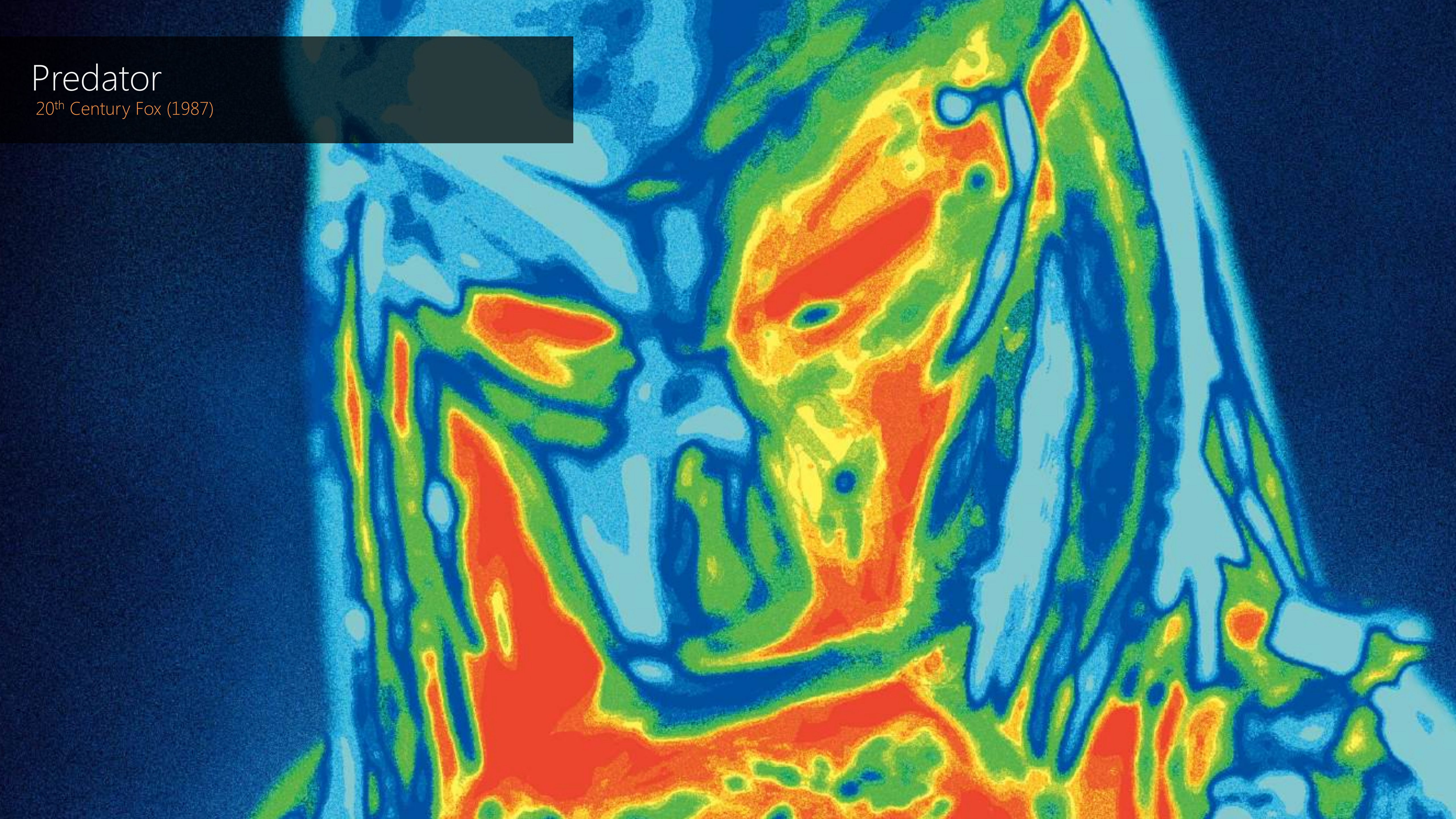
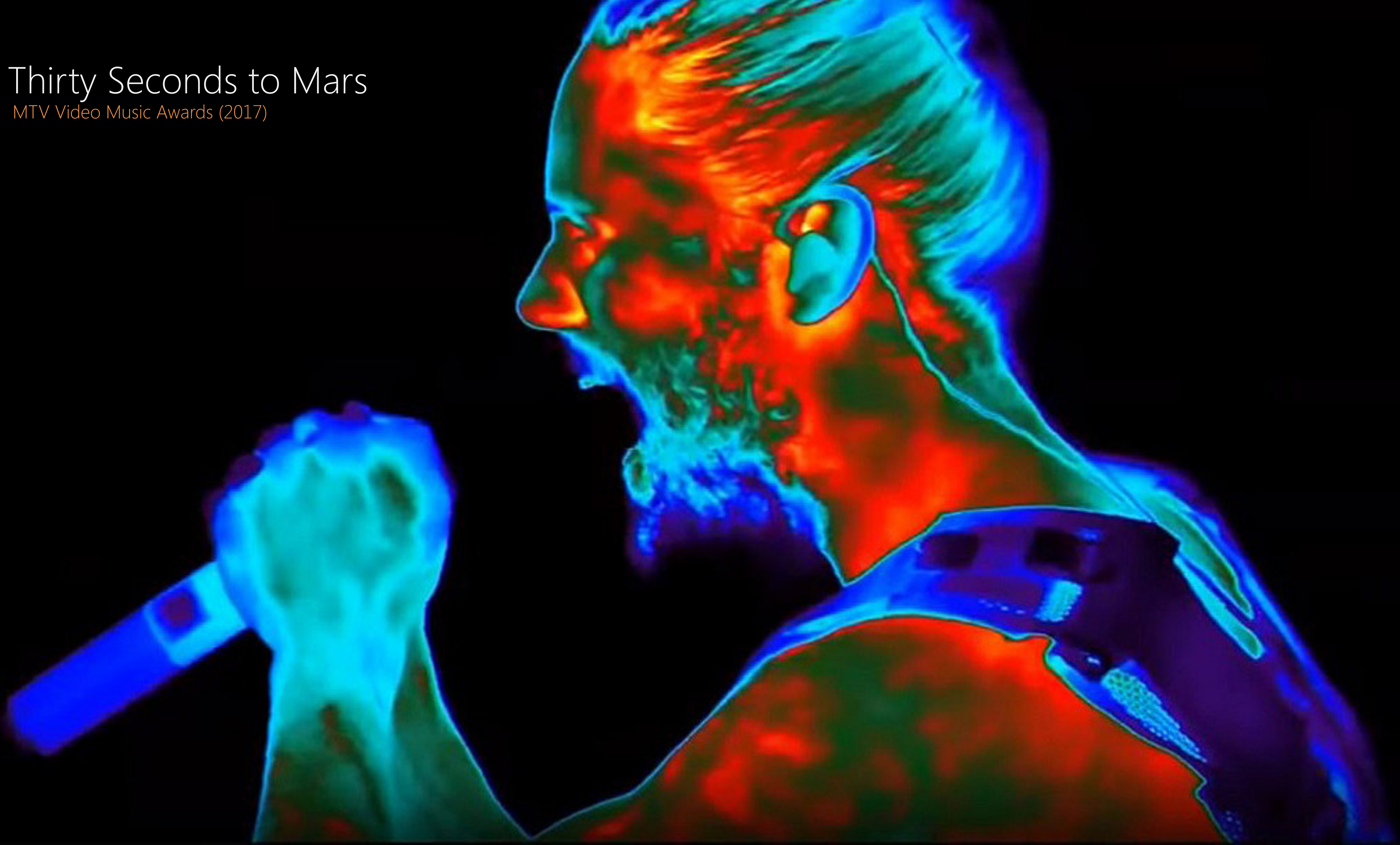
Predator

20th Century Fox (1987)



Thirty Seconds to Mars

MTV Video Music Awards (2017)



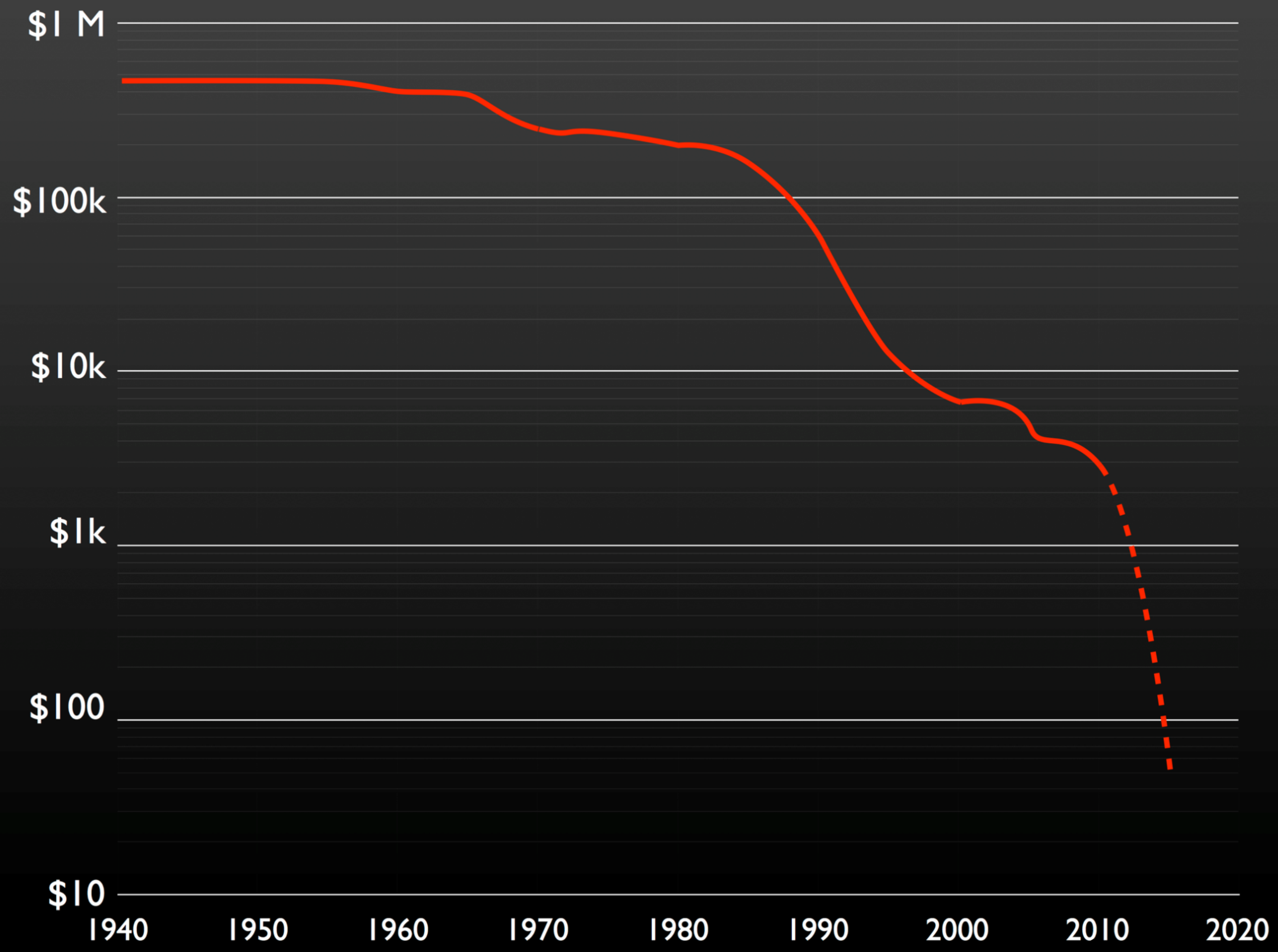
Thermal Cameras

- Thermal cameras (or infrared cameras) detect electromagnetic radiation with lower frequencies than visible light (*i.e.*, infrared frequencies)
- All objects above absolute zero emit infrared radiation, so thermal cameras can ‘see’ in the dark without external illumination.
- The amount of radiation emitted by an object increases with temperature, so thermal cameras can also measure heat.

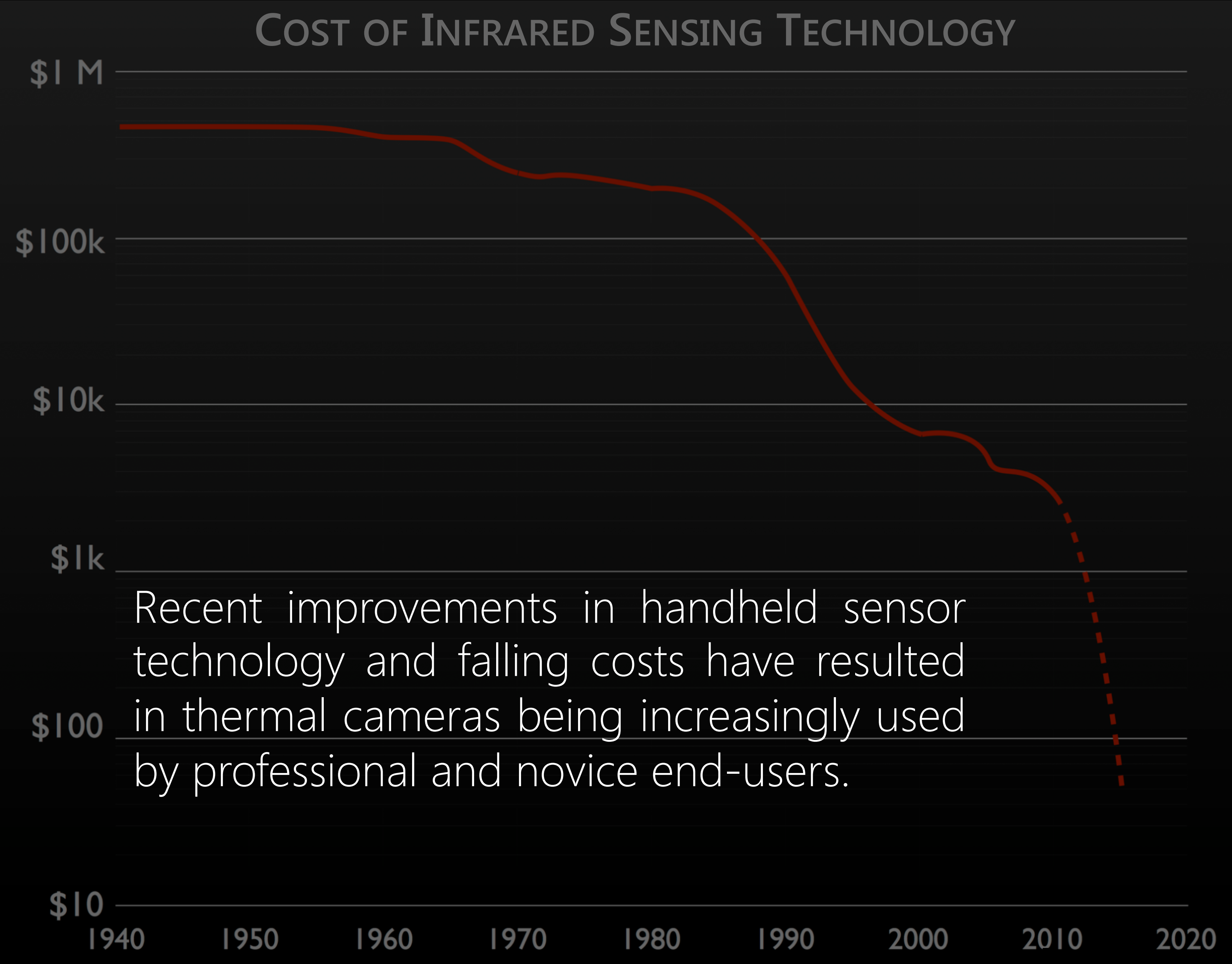
Commercial Cameras

FLIR (1960)

Cost of Infrared Sensing Technology



Source: Larson *et al.*, CHI2011, http://www.slideshare.net/ericcooperlarson/heatwave-chi2011



Recent improvements in handheld sensor technology and falling costs have resulted in thermal cameras being increasingly used by professional and novice end-users.

Source: Larson *et al.*, CHI2011, http://www.slideshare.net/ericcooperlarson/heatwave-chi2011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FLIR Approved Applications

In addition to the official FLIR apps, we've built a showcase of the best of breed apps written for the FLIR ONE. When your app achieves FLIR Approved App status, it will automatically be added to the gallery.

Featured App

Boat Beacon for FLIR ONE

by PocketMariner

Boat Beacon uses AIS to show the positions of ships around you when at sea including bearing and distance and closest point of approach (CPA). It also has a Marker button (MOB) which you can use to mark a spot and track its location. Boat Beacon's Augmented Reality view shows the ship positions, a thermal view, and MOB overlaid on the live Camera View. *Available Now!*

The Apps listed on this page have been reviewed and approved by FLIR and have been given the "FLIR Approved" status, which is verification that the App conforms to FLIR's corporate guidelines and policies for appropriate content and user experience. FLIR does not review the App for compliance with Intellectual Property rights, safety, or other potential factors that may result in liability to the Developer; thus FLIR disclaims any and all liability that may arise through a third party's use of the App or whether the App will meet any quality standard or level of merchantability.

FLIR ONE App

Provides a simple user interface with a variety of functions for operating your new FLIR ONE device.

Download on the App Store

FLIR Approved Apps

What does FLIR Approved app mean and what's the process for getting an app approved? Find out here ▸

FLIR Certified Developer Program

FLIR Certified Developers are trained by FLIR on thermal imaging and FLIR ONE developer tools. Want to become one of the elite certified developers? Learn more on the process ▸

iPhone Apps | iPad Apps | Android Apps

Apps for Android

Baby Monitor for FLIR ONE
by Mobile Toys & Tools
This application monitors your baby during sleep and raises alarm if he/she is out of rectangular Region of Interest defined by you.

CompassEye with FLIR
by Electric Pocket
A Professional Bearing Compass designed to help navigate at sea and used much like a pair of Compass Binoculars. When held vertically it shows the real-time camera view with a compass, bearings and artificial horizon overlaid, when flat it shows a real time map centred on where you are with the bearings and compass overlaid.

NovaVision
by NovaCoast
NovaVision utilizes the thermal image processing from the FLIR One to create thermal goggles for the user. The screen is divided in half and each half contains an image view, where the content comes directly from the FLIR One.

Remote Thermal Cam f. FLIR ONE
by Sven Killig
Remote Thermal Cam is a useful Android app that lets you use Your FLIR ONE as a Webcam for Your PC by sending an MJPEG stream to a SmartCam server via WiFi.

Thermal Camera for FLIR ONE
by Georg Friedrich
Thermal Camera uses the Flir One v2 to display a live infrared image. To achieve this task it uses its own render mechanism, that uses the 14bit raw data from the Flir SDK. Due to the nature of this implementation it can add new features, which are Flir independent.

Thermori-on
by maffydub
Thermori-on is a thermal musical instrument, inspired by the "Tenori-on", and using your FLIR thermal imaging camera.

ThermoVisual Motion Detector
by Mobile Toys & Tools
ThermoVisual Motion Detector (TVMD) is an intelligent, easy to use application that detects thermal and/or visual motion or changes automatically by using FLIR ONE infrared camera.

Thermal Paint for FLIR ONE
by Whale Tale Games
With Thermal Paint you can draw areas of the thermal image on top of the aligned visible-light image from the FLIR One. Highlight important areas of an image, or get creative and create unique works of art.

Related Work: Previous Studies of Thermal Camera End-Users

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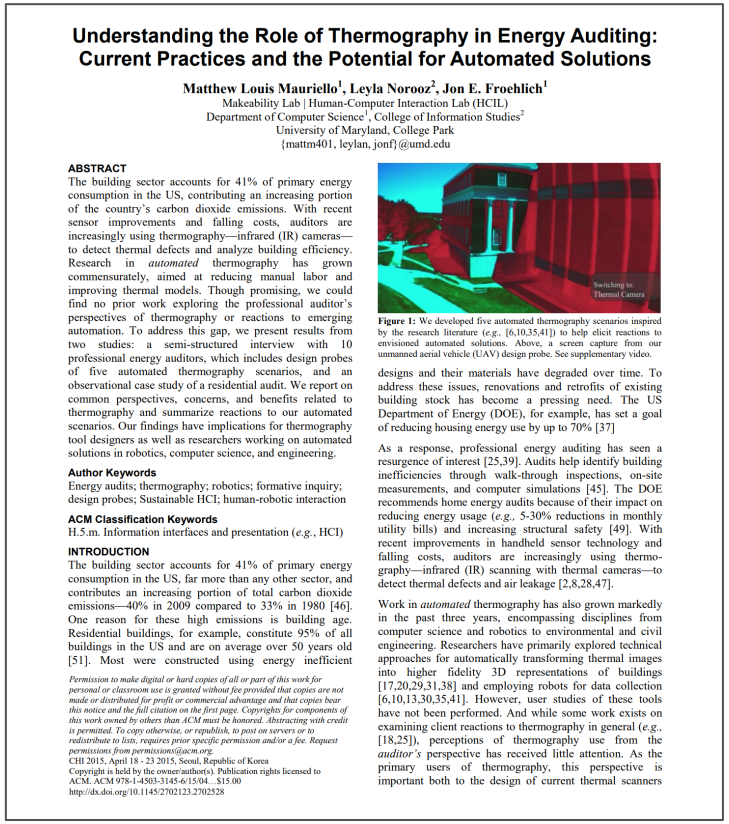

Understanding the Role of Thermography in Energy Auditing: Current Practices and the Potential for Automated Solutions

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Figure 1: We developed five automated thermography scenarios inspired by the research literature (*e.g.,* [6,10,35,41]) to help elicit reactions to envisioned automated solutions. Above, a screen capture from our unmanned aerial vehicle (UAV) design probe. See supplementary video.

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As a response, professional energy auditing has seen a resurgence of interest [25,39]. Audits help identify building inefficiencies through walk-through inspections, on-site measurements, and computer simulations [45]. The DOE recommends home energy audits because of their impact on reducing energy usage (*e.g.,* 5-30% reductions in monthly utility bills) and increasing structural safety [49]. With recent improvements in handheld sensor technology and falling costs, auditors are increasingly using thermography—infrared (IR) scanning with thermal cameras—to detect thermal defects and air leakage [2,8,28,47].

Work in *automated* thermography has also grown markedly in the past three years, encompassing disciplines from computer science and robotics to environmental and civil engineering. Researchers have primarily explored technical approaches for automatically transforming thermal images into higher fidelity 3D representations of buildings [17,20,29,31,38] and employing robots for data collection [6,10,13,30,35,41]. However, user studies of these tools have not been performed. And while some work exists on examining client reactions to thermography in general (*e.g.,* [18,25]), perceptions of thermography use from the *auditor's* perspective has received little attention. As the primary users of thermography, this perspective is important both to the design of current thermal scanners

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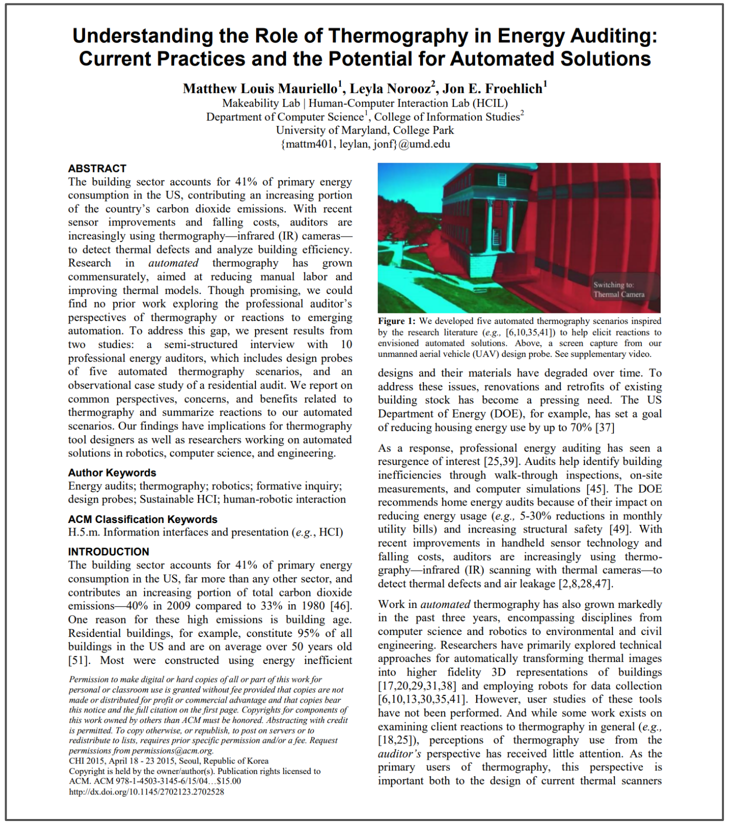

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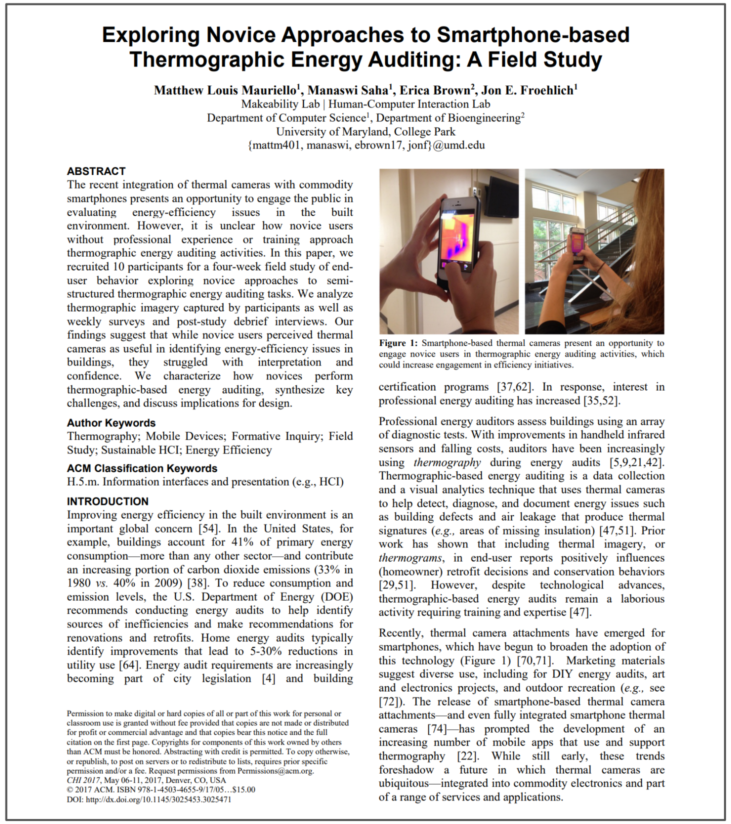

Exploring Novice Approaches to Smartphone-based Thermographic Energy Auditing: A Field Study

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Figure 1: Smartphone-based thermal cameras present an opportunity to engage novice users in thermographic energy auditing activities, which could increase engagement in efficiency initiatives.

certification programs [37,62]. In response, interest in professional energy auditing has increased [35,52].

Professional energy auditors assess buildings using an array of diagnostic tests. With improvements in handheld infrared sensors and falling costs, auditors have been increasingly using *thermography* during energy audits [5,9,21,42]. Thermographic-based energy auditing is a data collection and a visual analytics technique that uses thermal cameras to help detect, diagnose, and document energy issues such as building defects and air leakage that produce thermal signatures (*e.g.,* areas of missing insulation) [47,51]. Prior work has shown that including thermal imagery, or *thermograms*, in end-user reports positively influences (homeowner) retrofit decisions and conservation behaviors [29,51]. However, despite technological advances, thermographic-based energy audits remain a laborious activity requiring training and expertise [47].

Recently, thermal camera attachments have emerged for smartphones, which have begun to broaden the adoption of this technology (Figure 1) [70,71]. Marketing materials suggest diverse use, including for DIY energy audits, art and electronics projects, and outdoor recreation (*e.g.,* see [72]). The release of smartphone-based thermal camera attachments—and even fully integrated smartphone thermal cameras [74]—has prompted the development of an increasing number of mobile apps that use and support thermography [22]. While still early, these trends foreshadow a future in which thermal cameras are ubiquitous—integrated into commodity electronics and part of a range of services and applications.

Novice Building Thermography
Mauriello *et al.* CHI2017

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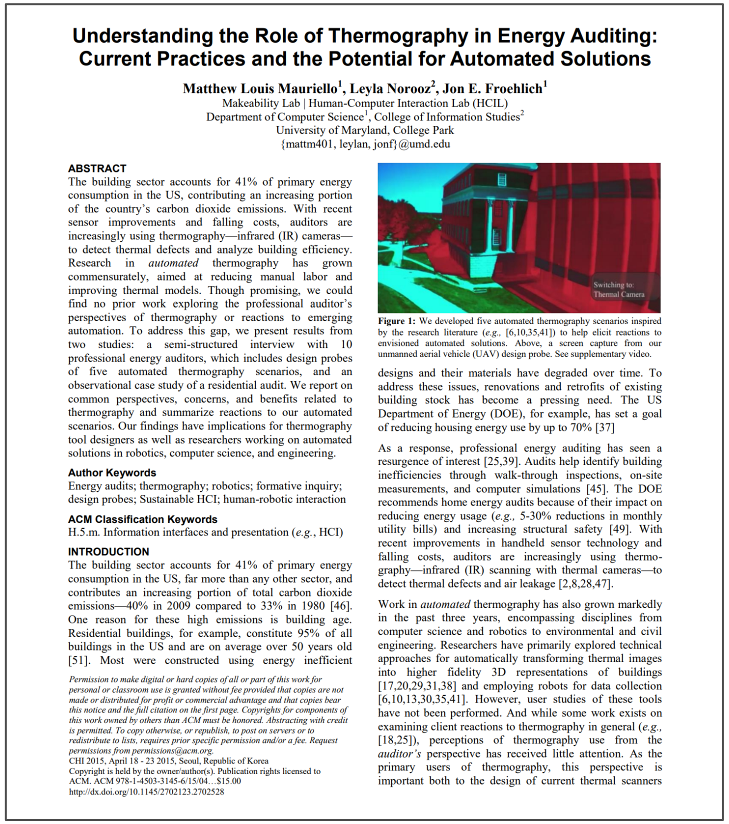

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Switching to: Thermal Camera

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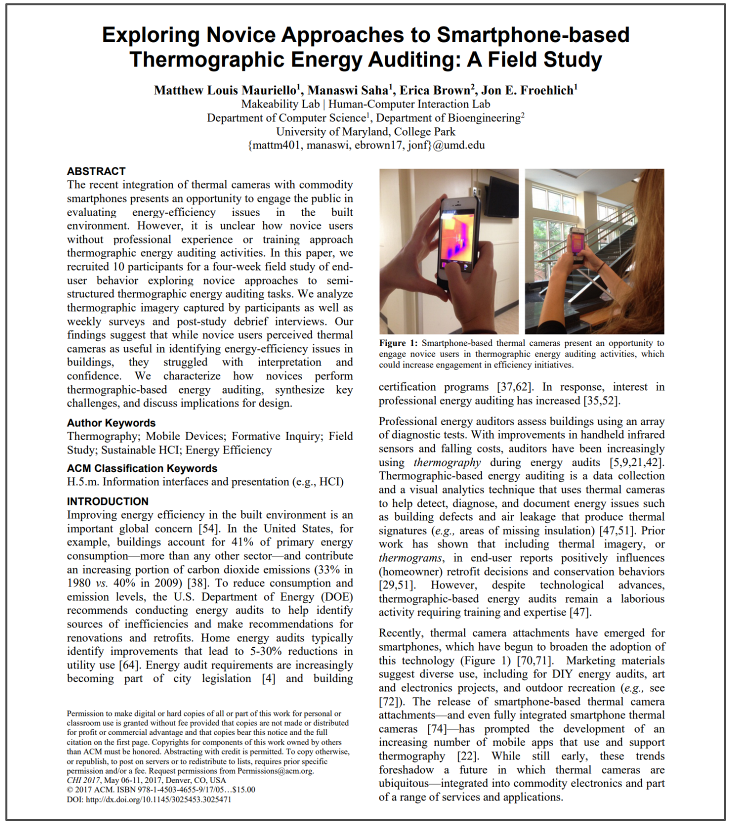
Concerns about undertrained practitioners and misconceptions about thermography



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Challenges interpreting data and being confident in results

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CHI'17: Reviewer 2

…Although the authors do highlight the **"mission" structure as a limitation**, this very specific structure heavily shapes their results…

CHI'17: Reviewer 2

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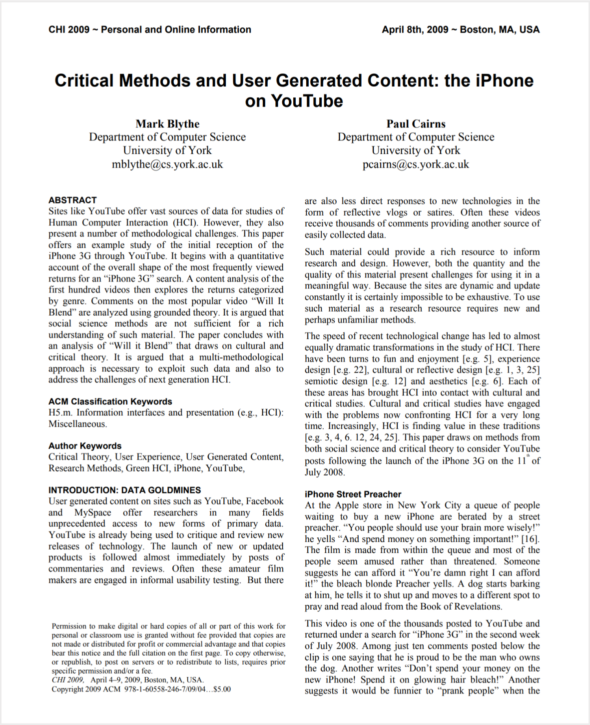
What valuable results might have been produced by allowing another group to **freely experiment with the FLIR camera** to see how much prompting is required for novices to make use of the technology and, more specifically, to see what contexts users are likely to explore?


10:48
6:54
3:13
THERMAL FARTS
1:56
14.9°C
FLIR
2:17
4:33
DAILY LIFE IN THERMAL
2:10
Federico Cerva
www.instagram.com/federicocerva
UNION REPAIR
6:51
PARANORMAL
EVIDEN
Short
3:38
2:41
6:57
$40,000 THERMAL CAMERA
FLIR C2 / C3
Seek RevealPRO
FLIR
76.8°F
3:00
FROZEN ENGINE THERMAL CAMERA
4:44
INFRARED BURNOUT
3:22
215-396-8452
water was hiding.
2:11
FLIR
My PlayHo se
18.4
22.0
13.7

YouTube Study: Research Questions

1. What activities do novice end-users of mobile and handheld thermal cameras engage in and why?
2. What level of understanding about the technology is demonstrated?
3. How might these observations inform the design of future thermographic technologies?

Related Work: Digital Ethnography via YouTube



CHI 2009 ~ Personal and Online Information April 8th, 2009 ~ Boston, MA, USA

Critical Methods and User Generated Content: the iPhone on YouTube

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ABSTRACT
Sites like YouTube offer vast sources of data for studies of Human Computer Interaction (HCI). However, they also present a number of methodological challenges. This paper offers an example study of the initial reception of the iPhone 3G through YouTube. It begins with a quantitative account of the overall shape of the most frequently viewed returns for an "iPhone 3G" search. A content analysis of the first hundred videos then explores the returns categorized by genre. Comments on the most popular video "Will It Blend" are analyzed using grounded theory. It is argued that social science methods are not sufficient for a rich understanding of such material. The paper concludes with an analysis of "Will it Blend" that draws on cultural and critical theory. It is argued that a multi-methodological approach is necessary to exploit such data and also to address the challenges of next generation HCI.

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Author Keywords
Critical Theory, User Experience, User Generated Content, Research Methods, Green HCI, iPhone, YouTube,

INTRODUCTION: DATA GOLDMINES
User generated content on sites such as YouTube, Facebook and MySpace offer researchers in many fields unprecedented access to new forms of primary data. YouTube is already being used to critique and review new releases of technology. The launch of new or updated products is followed almost immediately by posts of commentaries and reviews. Often these amateur film makers are engaged in informal usability testing. But there are also less direct responses to new technologies in the form of reflective vlogs or satires. Often these videos receive thousands of comments providing another source of easily collected data.

Such material could provide a rich resource to inform research and design. However, both the quantity and the quality of this material present challenges for using it in a meaningful way. Because the sites are dynamic and update constantly it is certainly impossible to be exhaustive. To use such material as a research resource requires new and perhaps unfamiliar methods.

The speed of recent technological change has led to almost equally dramatic transformations in the study of HCI. There have been turns to fun and enjoyment [e.g. 5], experience design [e.g. 22], cultural or reflective design [e.g. 1, 3, 25] semiotic design [e.g. 12] and aesthetics [e.g. 6]. Each of these areas has brought HCI into contact with cultural and critical studies. Cultural and critical studies have engaged with the problems now confronting HCI for a very long time. Increasingly, HCI is finding value in these traditions [e.g. 3, 4, 6. 12, 24, 25]. This paper draws on methods from both social science and critical theory to consider YouTube posts following the launch of the iPhone 3G on the 11th of July 2008.

iPhone Street Preacher
At the Apple store in New York City a queue of people waiting to buy a new iPhone are berated by a street preacher. "You people should use your brain more wisely!" he yells "And spend money on something important!" [16]. The film is made from within the queue and most of the people seem amused rather than threatened. Someone suggests he can afford it "You're damn right I can afford it!" the bleach blonde Preacher yells. A dog starts barking at him, he tells it to shut up and moves to a different spot to pray and read aloud from the Book of Revelations.

This video is one of the thousands posted to YouTube and returned under a search for "iPhone 3G" in the second week of July 2008. Among just ten comments posted below the clip is one saying that he is proud to be the man who owns the dog. Another writes "Don't spend your money on the new iPhone! Spend it on glowing hair bleach!" Another suggests it would be funnier to "prank people" when the

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CHI 2009, April 4–9, 2009, Boston, MA, USA.
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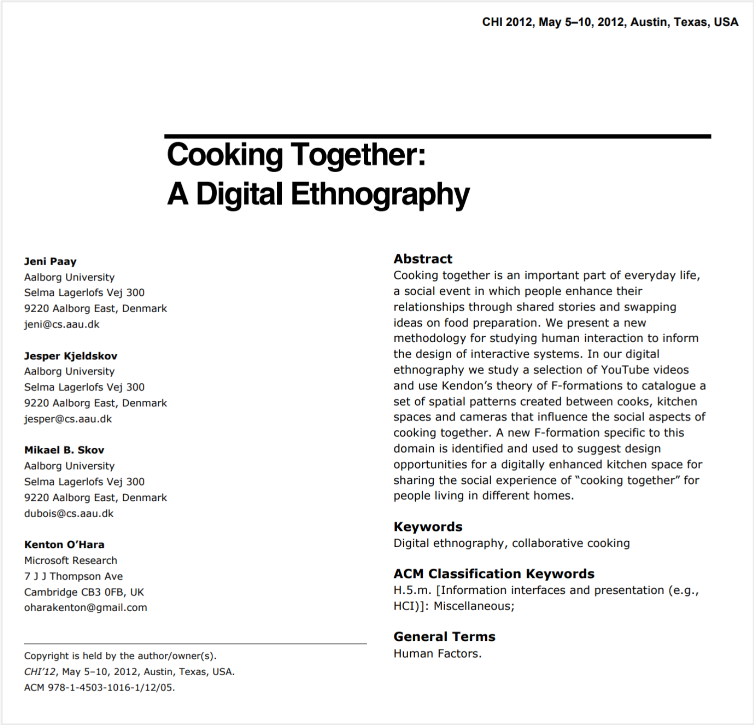
Specific Technology
Blythe & Cairns 2009



CHI 2012, May 5–10, 2012, Austin, Texas, USA

Cooking Together: A Digital Ethnography

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ACM 978-1-4503-1016-1/12/05.

Abstract
Cooking together is an important part of everyday life, a social event in which people enhance their relationships through shared stories and swapping ideas on food preparation. We present a new methodology for studying human interaction to inform the design of interactive systems. In our digital ethnography we study a selection of YouTube videos and use Kendon's theory of F-formations to catalogue a set of spatial patterns created between cooks, kitchen spaces and cameras that influence the social aspects of cooking together. A new F-formation specific to this domain is identified and used to suggest design opportunities for a digitally enhanced kitchen space for sharing the social experience of "cooking together" for people living in different homes.

Keywords
Digital ethnography, collaborative cooking

ACM Classification Keywords
H.5.m. [Information interfaces and presentation (e.g., HCI)]: Miscellaneous;

General Terms
Human Factors.

Specific Activities
Paay *et al.* 2012

Analyzing User-Generated YouTube Videos to Understand Touchscreen Use by People with Motor Impairments

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ABSTRACT
Most work on the usability of touchscreen interaction for people with motor impairments has focused on lab studies with relatively few participants and small cross-sections of the population. To develop a richer characterization of use, we turned to a previously untapped source of data: YouTube videos. We collected and analyzed 187 non-commercial videos uploaded to YouTube that depicted a person with a physical disability interacting with a mainstream mobile touchscreen device. We coded the videos along a range of dimensions to characterize the interaction, the challenges encountered, and the adaptations being adopted in daily use. To complement the video data, we also invited the video uploaders to complete a survey on their ongoing use of touchscreen technology. Our findings show that, while many people with motor impairments find these devices empowering, accessibility issues still exist. In addition to providing implications for more accessible touchscreen design, we reflect on the application of user-generated content to study user interface design.

Author Keywords
Touchscreen; motor impairments; physical disabilities; assistive technology; YouTube; iPad; iPhone.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (*e.g.*, HCI): Miscellaneous; K.4.2. Computers and society: Social issues – assistive technologies for persons with disabilities.

INTRODUCTION
Mainstream mobile devices are becoming an important means of daily technology interaction for many people with disabilities. Such devices are being used, for example, by users with visual impairments to navigate unfamiliar areas [24], by older adults with limited mobility as a communication channel to family and caregivers for greater independence [1], or by hearing-impaired users to communicate without expensive, specialized TTY (teletype) hardware [28]. Most newer mobile devices, however, offer touchscreen interaction that may be particularly problematic for people with physical disabilities. Research on touchscreen interface design for users with physical disabilities has been largely limited to lab studies with relatively few participants [3,6,10,16,31], or to small interview studies [20]. Moreover, even less attention has been paid to subpopulations such as children.

(a) (b)

Figure 1. Examples of unconventional touchscreen use being adopted by people with physical disabilities: (a) a user with a hand prosthesis demonstrates unlocking; (b) nose input with an iPhone.

To develop a richer characterization of how people with physical disabilities are adopting touchscreen devices, we turned to a previously untapped source of data: YouTube videos. We collected and analyzed 187 non-commercial videos uploaded to YouTube that depicted a person with a physical disability interacting with a mobile touchscreen device. In analyzing the videos, we asked questions such as: What are these touchscreen devices being used for on a daily basis? How well do they work out of the box, or how poorly? What adaptations are users making to improve accessibility? We coded the videos along a range of subjective and objective dimensions designed to characterize the interaction and to identify any challenges or adaptations we witnessed. To complement the videos themselves, we also invited the video uploaders to complete a survey on their opinions and use of touchscreen technology in their daily lives.

Our results show that, while many people with physical disabilities find touchscreen devices empowering, accessibility challenges still exist. We observed a range of interaction styles and use cases, from interaction with one's foot or nose or with a prosthesis (Figure 1) to interacting while lying down or, particularly with children, using arm or leg slings for support. Specific breakdowns were evident, such as challenges of multitouch interaction. We also observed a range of physical device adaptations, including

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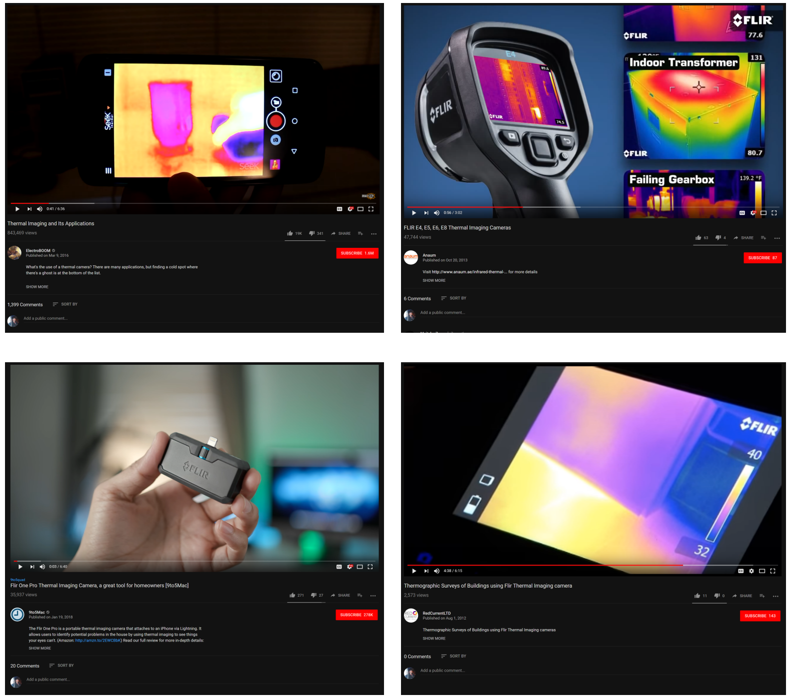
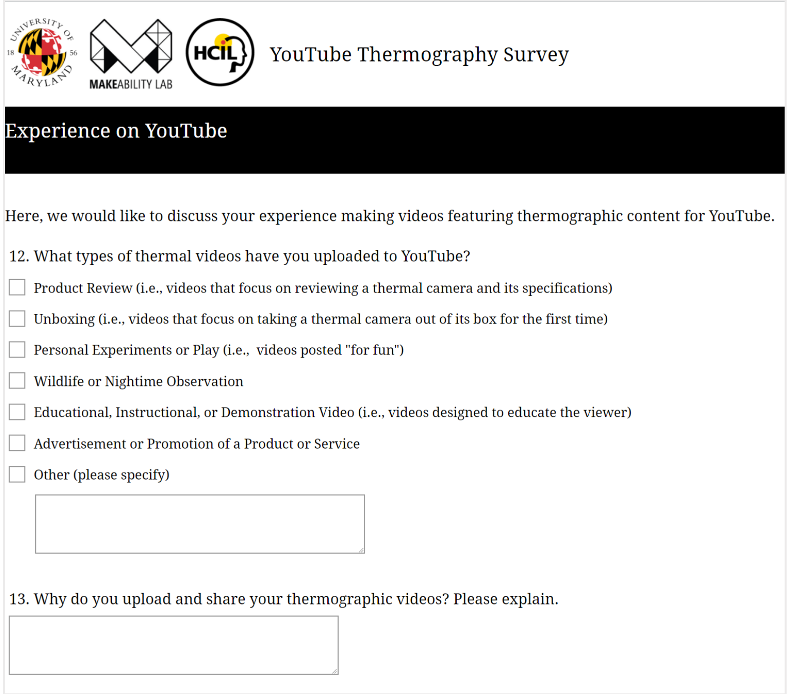
Specific Populations
Anthony *et al.* 2013

Study Method: Two-Part Study



Part One:
Dataset Generation & Qualitative Coding



YouTube Thermography Survey

Experience on YouTube

Here, we would like to discuss your experience making videos featuring thermographic content for YouTube.

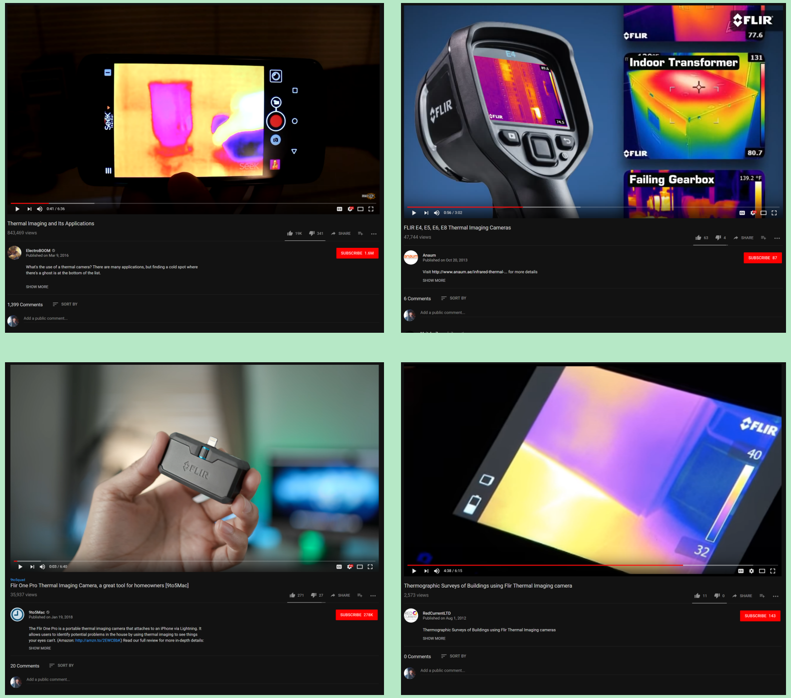
12. What types of thermal videos have you uploaded to YouTube?

- ☐ Product Review (i.e., videos that focus on reviewing a thermal camera and its specifications)
- ☐ Unboxing (i.e., videos that focus on taking a thermal camera out of its box for the first time)
- ☐ Personal Experiments or Play (i.e., videos posted "for fun")
- ☐ Wildlife or Nightime Observation
- ☐ Educational, Instructional, or Demonstration Video (i.e., videos designed to educate the viewer)
- ☐ Advertisement or Promotion of a Product or Service
- ☐ Other (please specify)

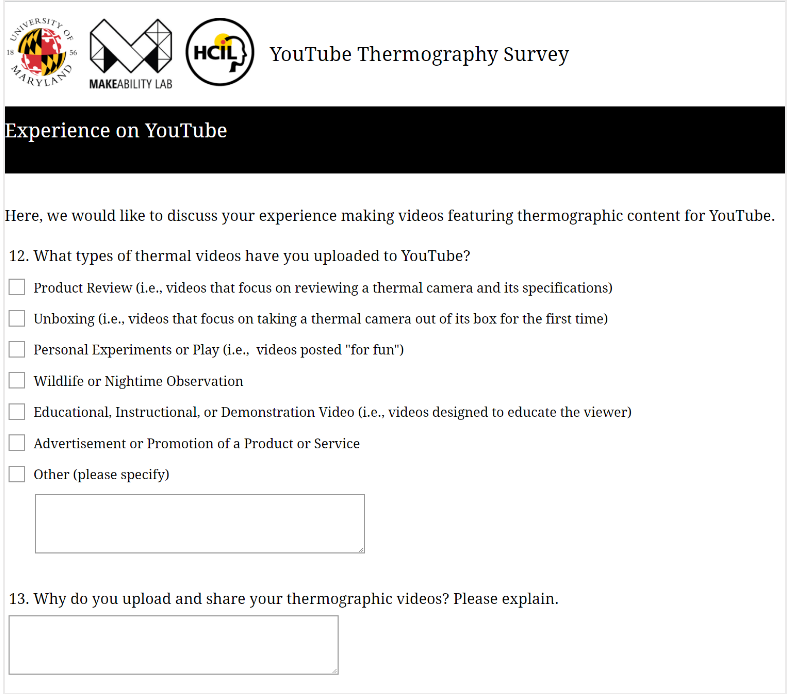
13. Why do you upload and share your thermographic videos? Please explain.

Part Two:
Online Survey of Content Creators

Study Method: Two-Part Study



Part One:
Dataset Generation & Qualitative Coding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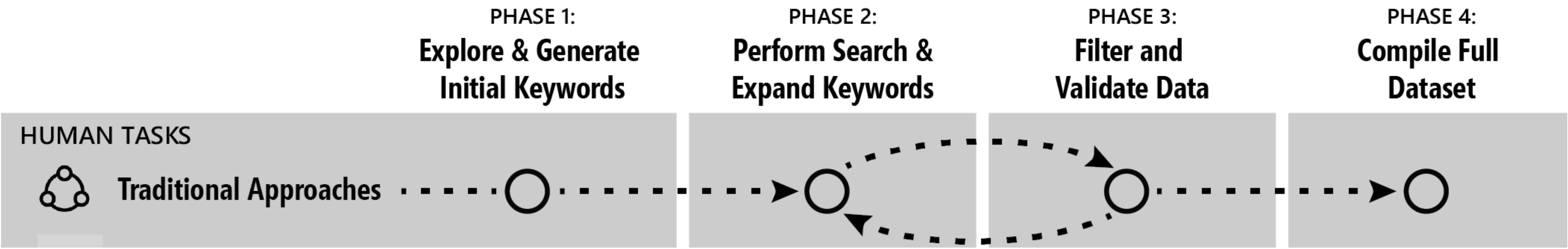
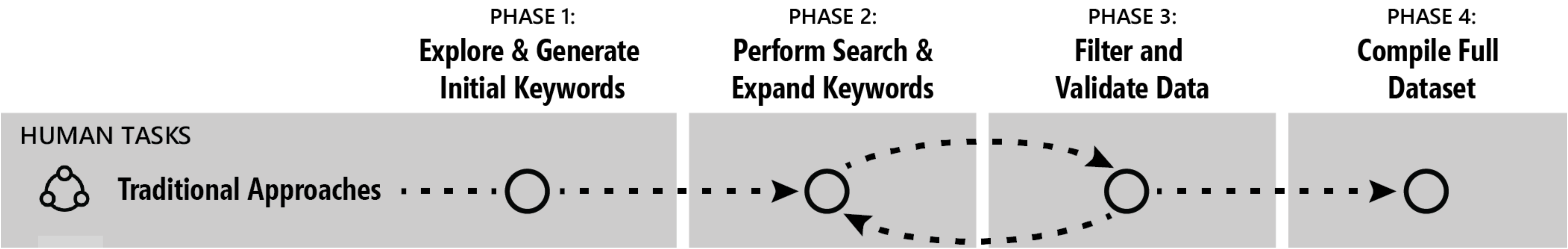
Part Two:
Online Survey of Content Creators

STUDY METHOD: DATASET GENERATION

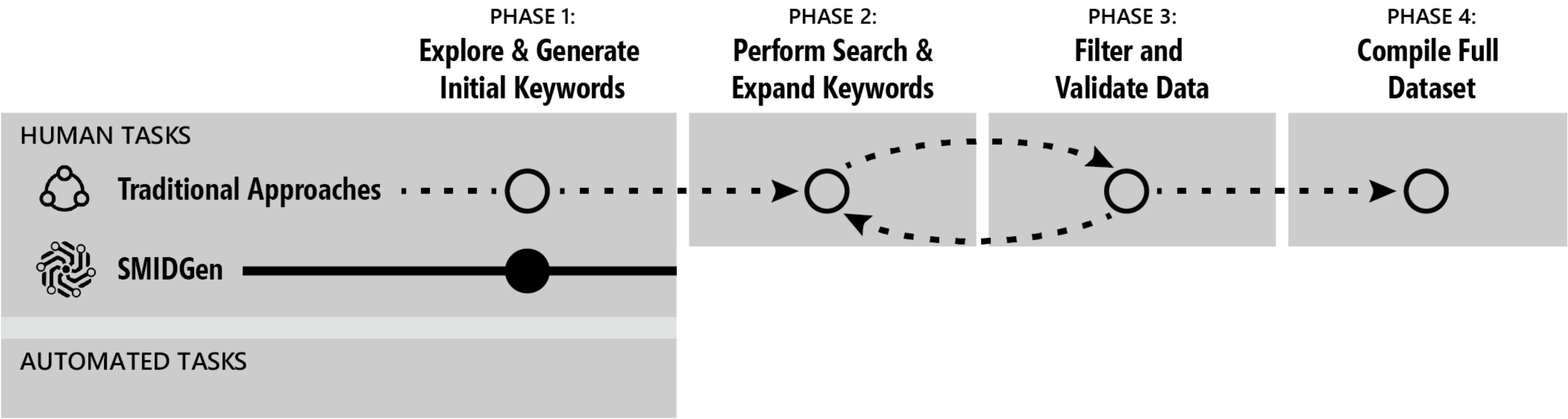


Study Method: Dataset Generation



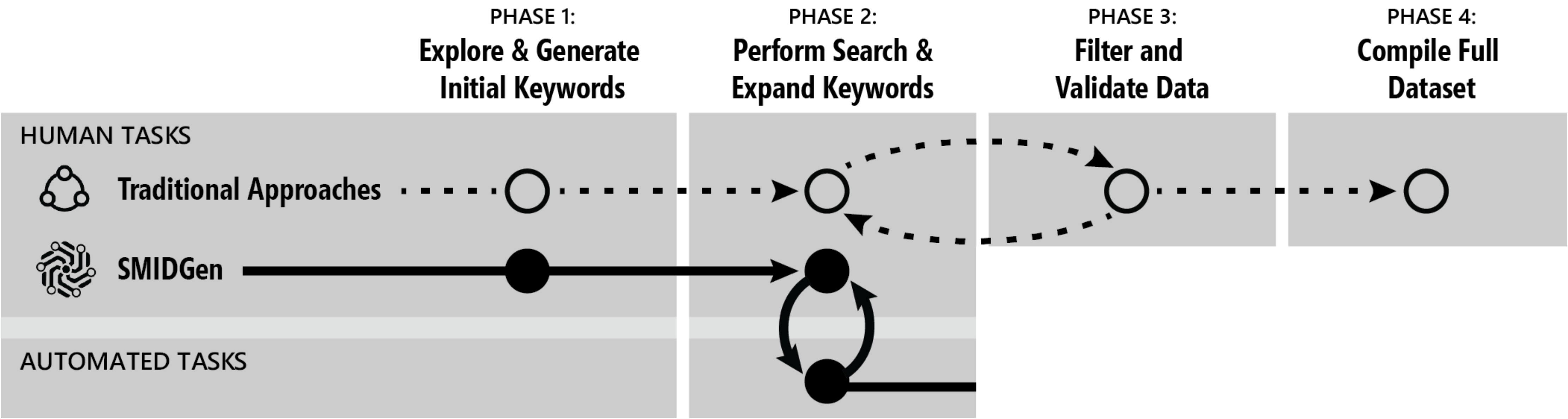
Problem:
A search for "Thermal Camera" in July of 2017 resulted in over 1 million videos since 2005 compared to the 169 videos that resulted from "Cooking Together" in November of 2010.

Study Method: Dataset Generation



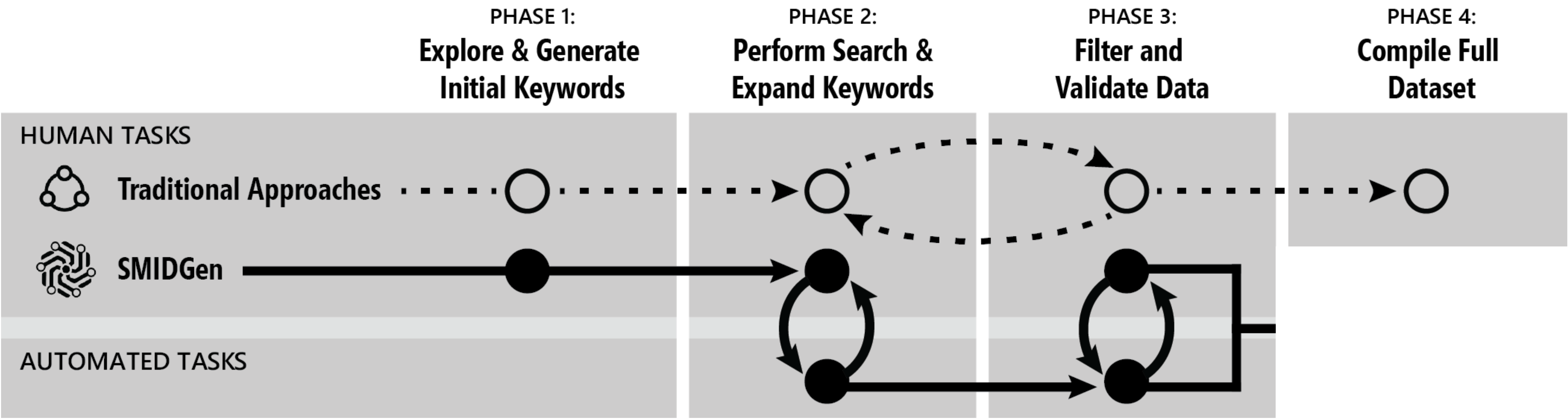
Phase 1: Explore videos on YouTube and generate initial keyword list.

STUDY METHOD: DATASET GENERATION



Phase 2: Perform searches. Then, apply Kullback-Leibler Divergence (KLD) and Word Co-Occurrence query expansion methods to generate new terms. Perform more searches.

Study Method: Dataset Generation



Phase 3: Label a subset of data to train machine learning classifiers for filtering, then infer document labels on unseen videos.

Study Method: Dataset Generation

Step	Terms
Step 1: Initial Keywords	infrared, lepton, thermal, thermal camera, thermal image, thermal imaging, thermography
Step 2: Expanded Keywords	breast thermography, flir lepton, flir one, flir thermal, imaging camera, infrared camera, infrared thermography, night vision, seek thermal, thermal imager
Step 3: Iterated Codebook	everyday use, product review, news coverage, unboxing, professional demo, advertisement, off topic

Average IRR across codes in Step 3 was 0.69 (SD=0.09)

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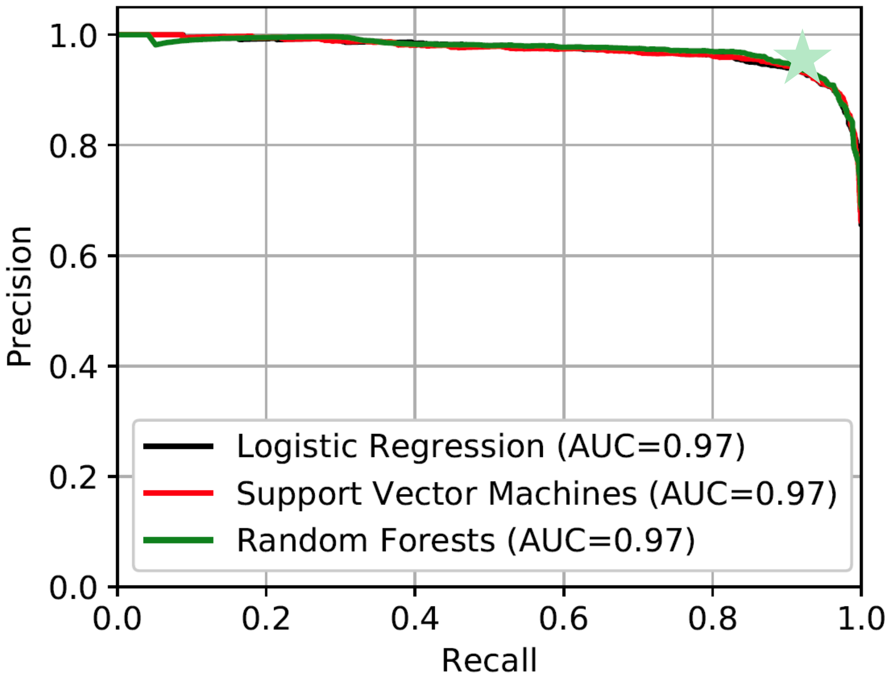
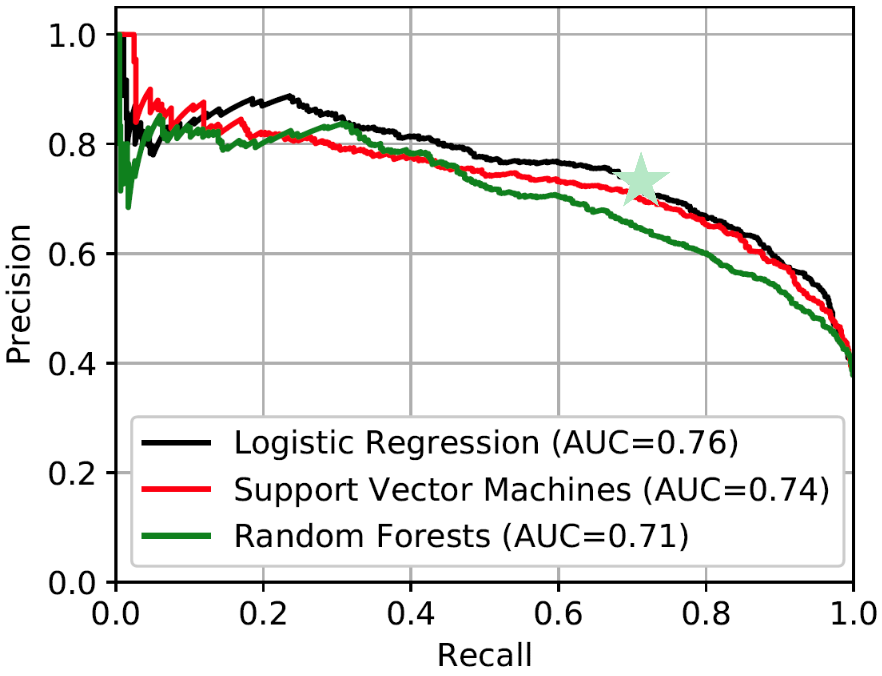
Study Method: Dataset Generation

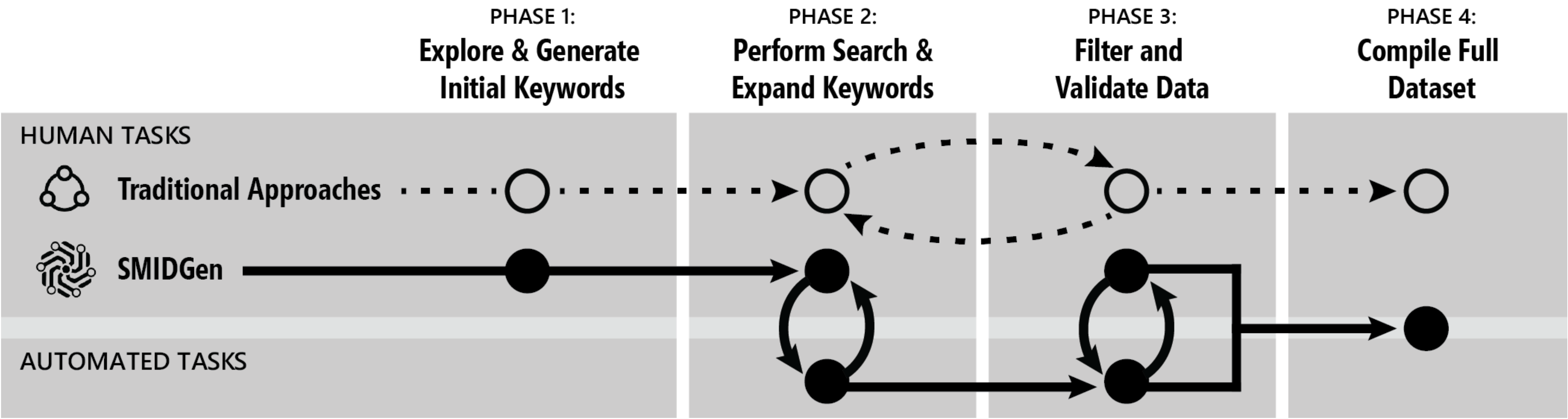
Relevance Classifier: Thermography



Topical Classifier: Everyday Use



STUDY METHOD: DATASET GENERATION



Phase 4: Randomly sample from resulting dataset.

STUDY METHOD: DATASET GENERATION

Topic Codes	Sub-Topic Codes
Content Areas (*N*=10)	Building and Urban Environments, Health and Wellness, Paranormal Investigations, Electronics and Software Projects, Recreational Outdoor Activities and Agriculture, Informal Exploration, Pollution Activism, Vehicles, Research, Security and Emergency Services
Misconceptions (*N*=6)	See Through Objects, Measure Air Temperature, Measure Gases, Faux Filters, Faux Thermal Imagers, Camera Operation Issues
Comments Containing Q/A (*N*=4)	Content Questions, Technical Specifications, Follow-up Request, Other

Average IRR of 0.75 (SD=0.27)

Study Method: Dataset Generation

Additional experiments and methodological decisions:

- How much manual labeling was required for accurate results?
- How well did query expansion work to expand the initial dataset?
- What other features might prove useful for classification?

SMIDGen: An Approach for Scalable, Mixed-Initiative Dataset Generation from Online Social Networks

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Sapna Bagalkotkar[1], Samuel Kushnir[1], Jon E. Froehlich[1]
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Department of Computer Science[1], College of Information Studies[2]
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ABSTRACT
Recent qualitative studies have begun using large amounts of Online Social Network (OSN) data to study how users interact with technologies. However, current approaches to dataset generation are manual, time-consuming, and can be difficult to reproduce. To address these issues, we introduce SMIDGen: a hybrid manual + computational approach for enhancing the replicability and scalability of data collection from OSNs to support qualitative research. We demonstrate how the SMIDGen approach integrates information retrieval (IR) and machine learning (ML) with human expertise through a case study focused on the collection of YouTube videos. Our findings show how SMIDGen surfaces data that manual searches might otherwise miss, increases the overall proportion of relevant data collected, and is robust against IR/ML algorithm selection.

Author Keywords
Qualitative data collection; mixed-initiative; social media; user-generated content; machine learning; query expansion

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

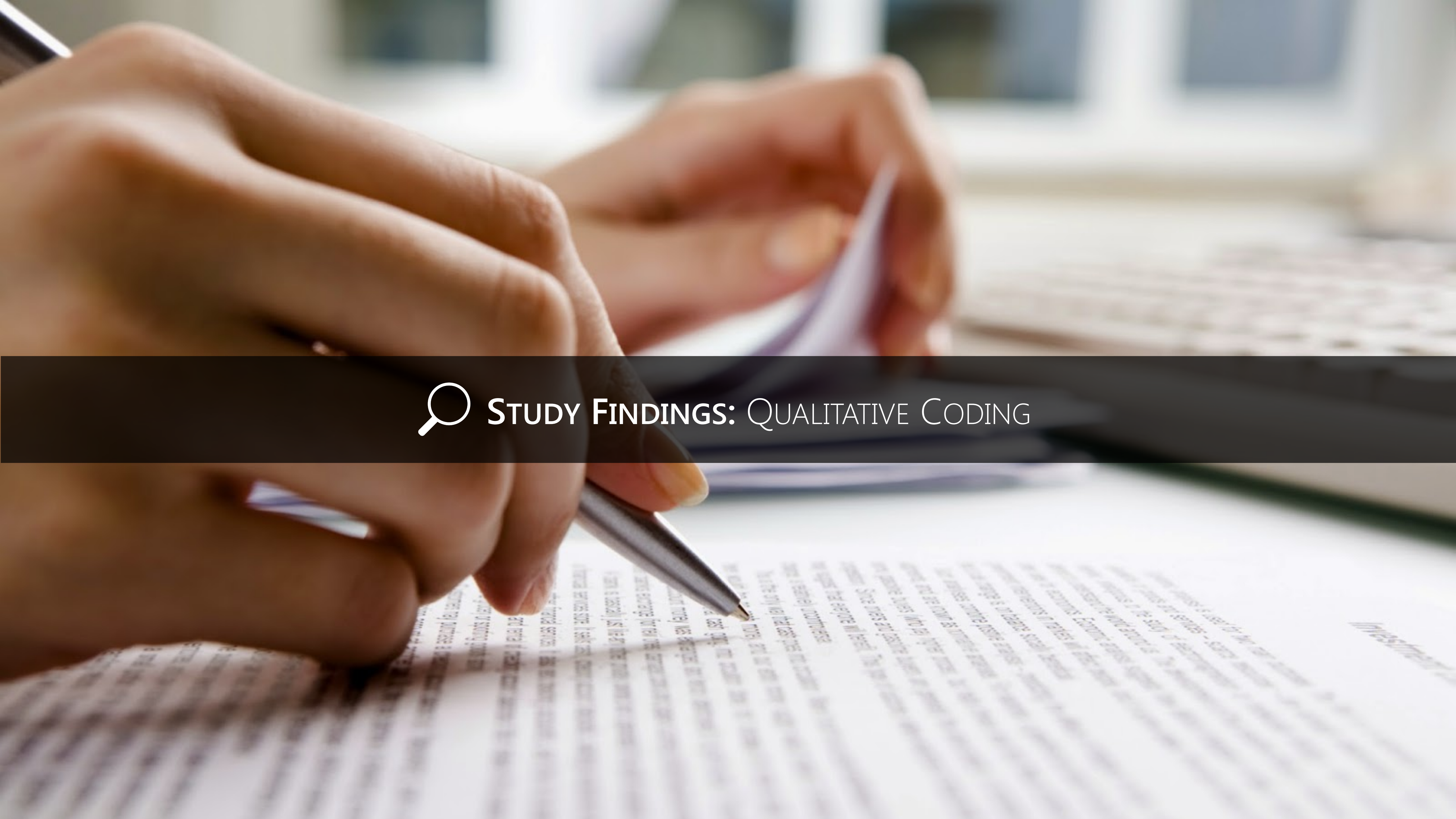
INTRODUCTION
Online Social Networks (OSNs) such as *Twitter*, *YouTube*, and *reddit* have emerged as valuable data sources for qualitative studies of everyday interactions with technology [2,3,6,14]. By studying user-generated content, researchers get access to naturalistic data about end-users and populations that are otherwise challenging to observe [16]. However, modern OSNs generate millions of content pieces and hundreds of hours of video every minute [22]. Researchers face challenges related to scale, noise filtering [20], rapidly evolving vocabularies that hinder comprehensive searches [11], and restricted access to proprietary platforms (*e.g.*, rate limits on queries) [10,19].

Typically, these challenges are addressed through time-intensive manual searches, often costing hundreds of researcher-hours [2,6], or focusing on small, downsampled datasets (*e.g.*, 100 videos [3]) that risk missing insights or misrepresenting a domain or topic.

To assist researchers in constructing OSN-based datasets for large-scale qualitative analysis, we introduce *SMIDGen: A Scalable, Mixed-Initiative Dataset Generation* approach. SMIDGen combines algorithms in information retrieval (IR) and machine learning (ML) along with a traditional qualitative coding process to assist with data collection and filtering. SMIDGen has four phases: (i) manually exploring an OSN and generating keywords to bootstrap data collection, (ii) computationally expanding these queries to increase domain/topic coverage, (iii) mixed-initiative data labeling and training to construct automated models, and (iv) applying these models at scale to generate a final dataset that is larger and more diverse as a result.

After describing each of these phases, we demonstrate their application and utility through a detailed use case on YouTube: studying non-professional "everyday uses" of thermal cameras. Our findings suggest that the automated query expansion in Phase 2 contributes new data that we would have otherwise missed, and the classification models from Phases 3 and 4 accurately identified domain and topic relevance. We also show that the SMIDGen approach is robust against algorithm selection, which facilitates implementation, and that one need not manually label an entire dataset to achieve performance enhancements. We close with a discussion of SMIDGen and OSN data collection highlighting key strengths, limitations, and suggestions for improving performance.

QUALITATIVE STUDIES OF OSN CONTENT
Research involving data from OSNs generally derives insights from quantitative analyses of word frequencies, network structures, and other measurable artifacts [9,13]. However, recent studies have demonstrated the value of harnessing user-generated content (*e.g.*, videos, images) as a source of naturalistic data for large-scale qualitative research on how end-users interact with technology [2,3,6,14]. The topic ...



Study Findings: Qualitative Coding

STUDY FINDINGS: QUALITATIVE CODING

Categories	Dataset (N=675)	Average Duration (SD)	Median Views	Contains Misconceptions	Q&A in Comment
Informal Exploration	46.5% (314)	2.28 (5.11)	507	9.8% (31/314)	27.7% (87/314)
Outdoor Recreation & Agriculture	16.1% (109)	3.24 (7.50)	807	0.9% (38/109)	34.8% (38/109)
Electronic or Software Project	11.9% (80)	3.03 (4.70)	368	1.2% (1/80)	28.7% (23/80)
Buildings and Urban Observations	11.1% (75)	3.06 (4.11)	351	4.0% (3/75)	24.0% (18/75)
Vehicles	6.5% (44)	1.90 (2.48)	822	0.0% (0/44)	27.2% (12/44)
Paranormal Investigations	2.8% (19)	4.30 (4.25)	2327	10.5% (2/19)	63.1% (12/19)
Emergency Applications	2.1% (14)	1.09 (1.05)	637	7.14% (1/14)	28.5% (4/14)
Health and Wellness	1.8% (12)	5.19 (7.49)	2116	0.0% (0/12)	0.3% (4/12)
Research	0.9% (6)	1.02 (0.80)	385	0.0% (0/6)	16.6 (1/6)
Pollution Activism	0.3% (2)	0.34 (0.03)	103	0.0% (0/2)	0.0% (0/2)

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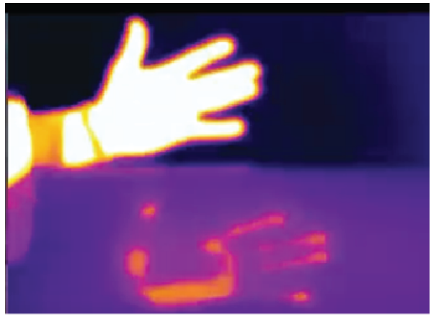
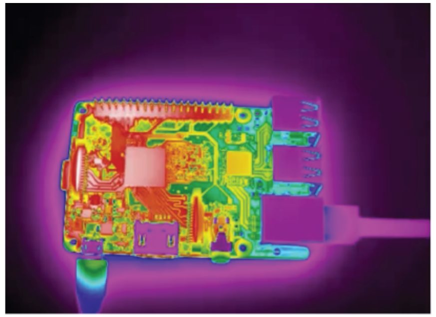
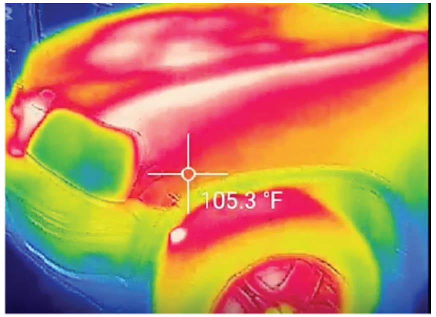
STUDY FINDINGS: QUALITATIVE CODING


Informal Exploration (46.5%)


Outdoor Recreation & Agriculture (16.1%)

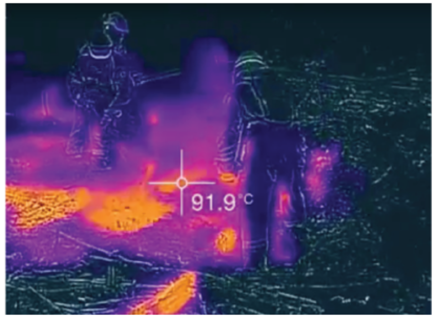
Buildings & Urban Environments (11.1%)


Small Electronics (11.9%)

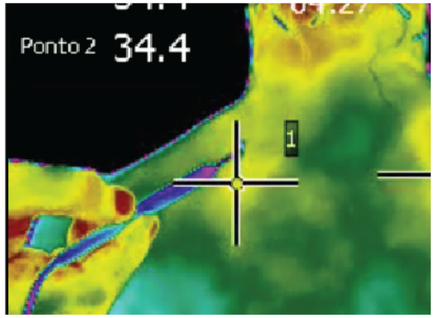


Vehicles (6.5%)

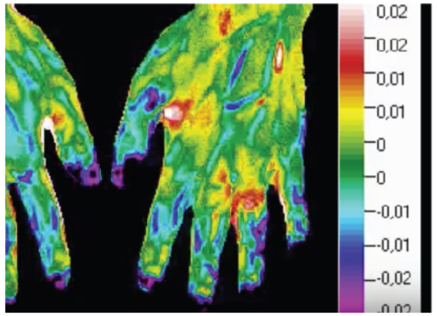
Paranormal Investigations (2.8%)



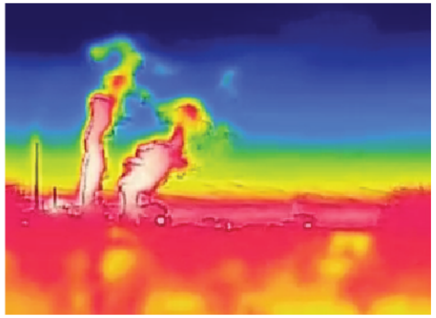
Emergency Applications (2.1%)



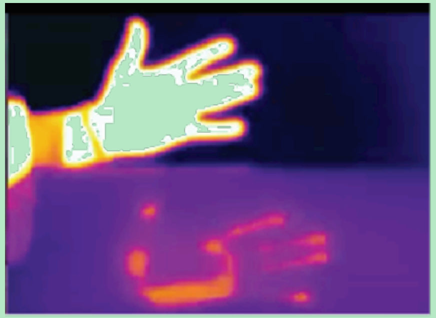
Health and Wellness (1.8%)



Research (0.9%)


Pollution Activism (0.3%)

Study Findings: Qualitative Coding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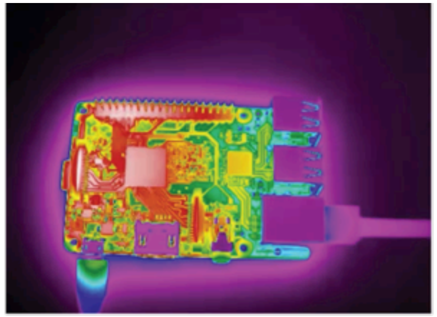
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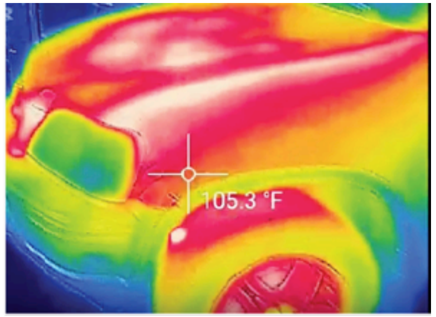

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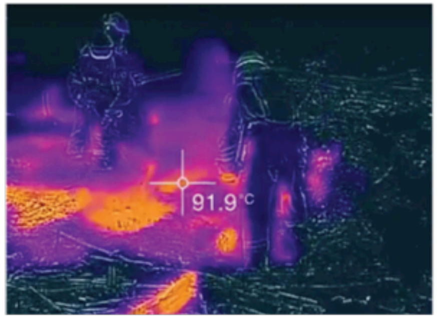

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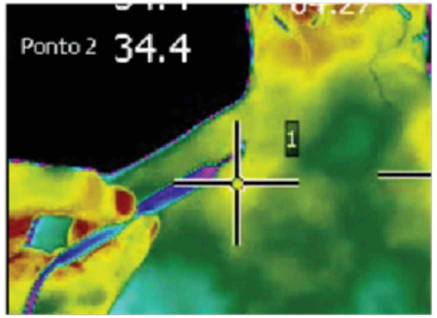

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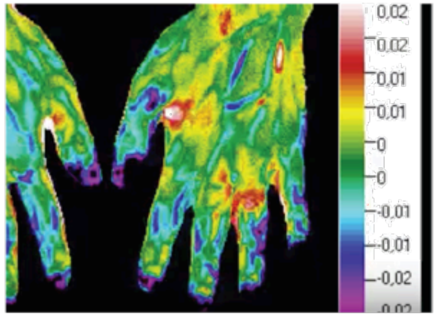
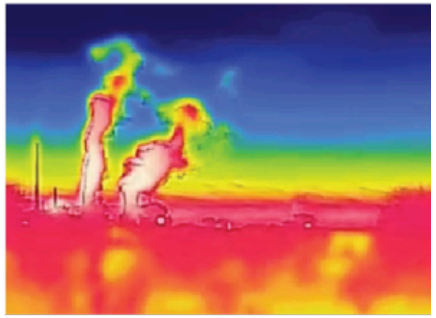

Research (0.9%)

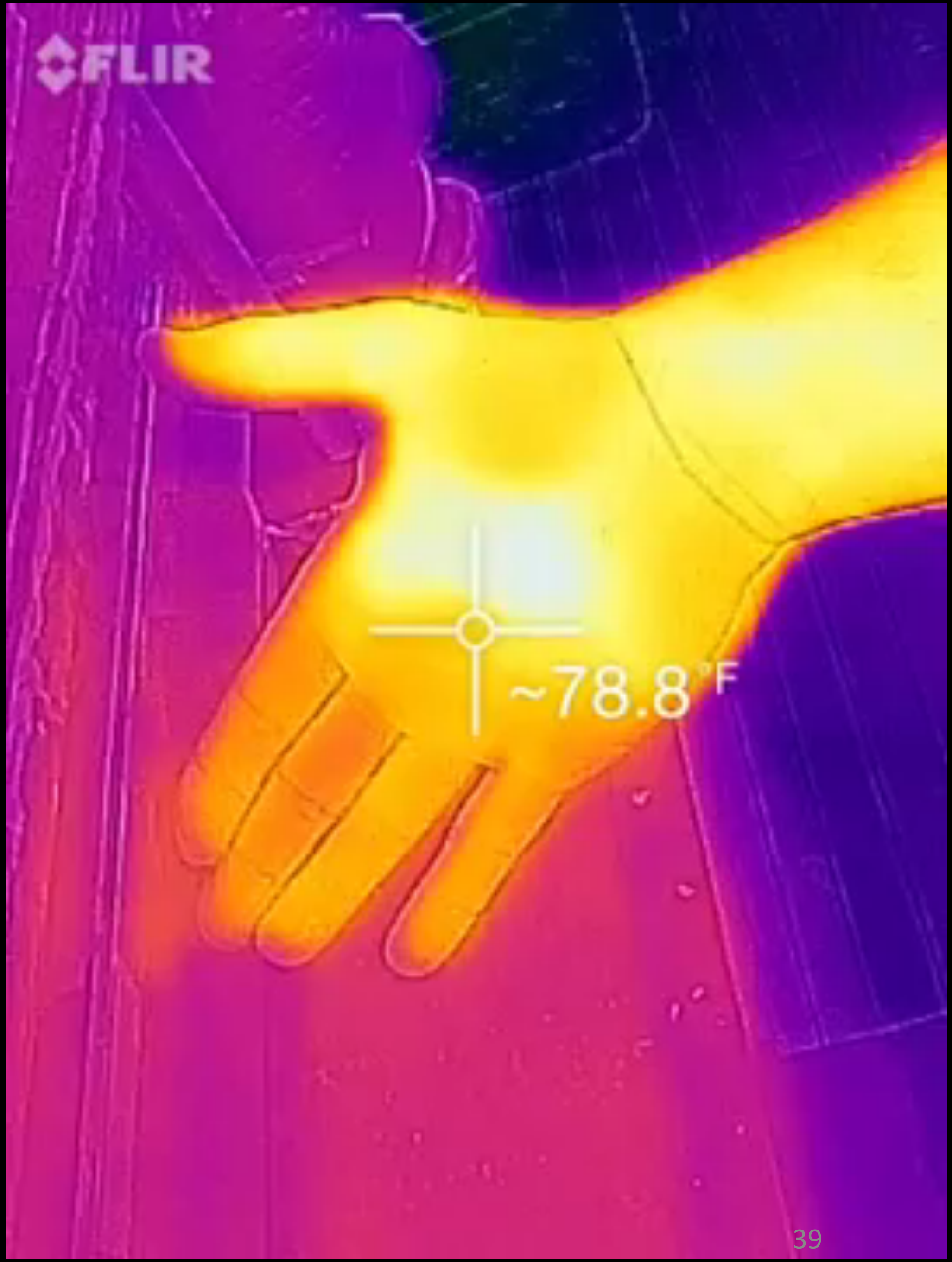

Pollution Activism (0.3%)

"Can a Thermal Camera See Through water?"

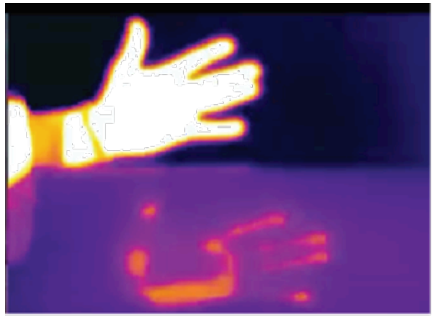
"I'm going to dip my hand down into the aquarium, right into the water, and let's see what happens. I'm going to **calibrate the camera first**.

(Dips hand in aquarium.)

Yeah the surface of the water really reflects the heat away. But we can actually see my hand is heating the very surface of the water. […] So yeah, the thermal camera doesn't see through water very well, **but it is sensitive enough that you can** actually see my hand warming up the water. **Pretty cool**."



Study Findings: Qualitative Coding



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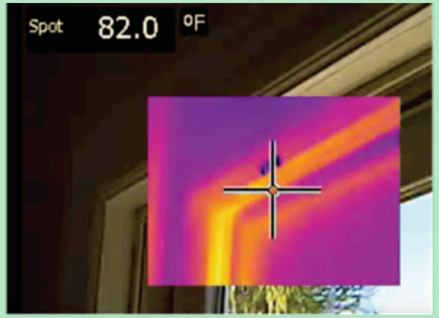
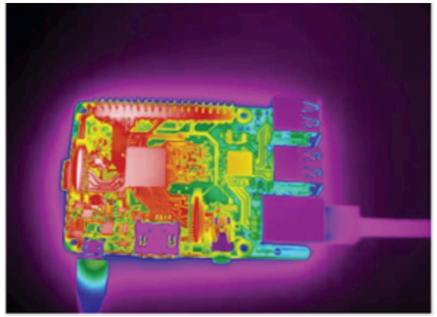


Buildings & Urban Environments (11.1%)



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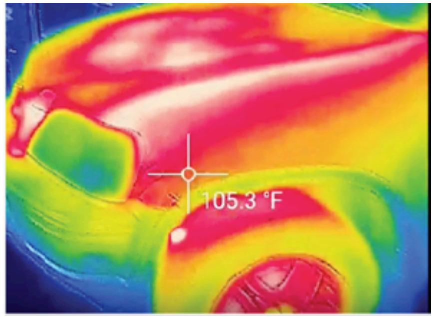

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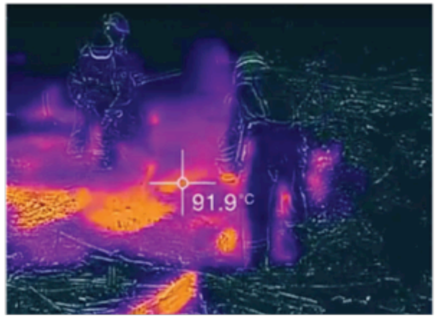

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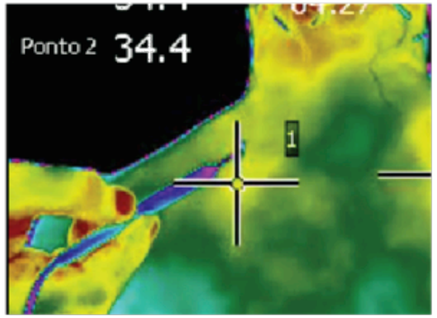

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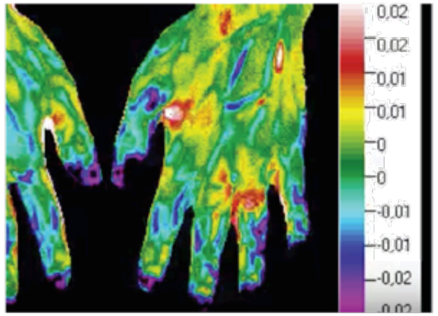

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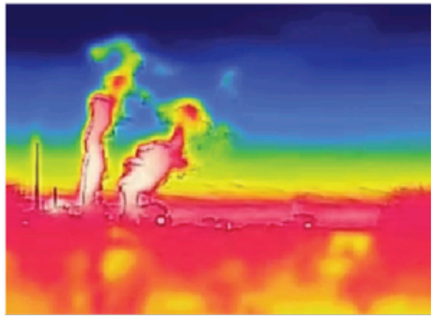


Pollution Activism (0.3%)

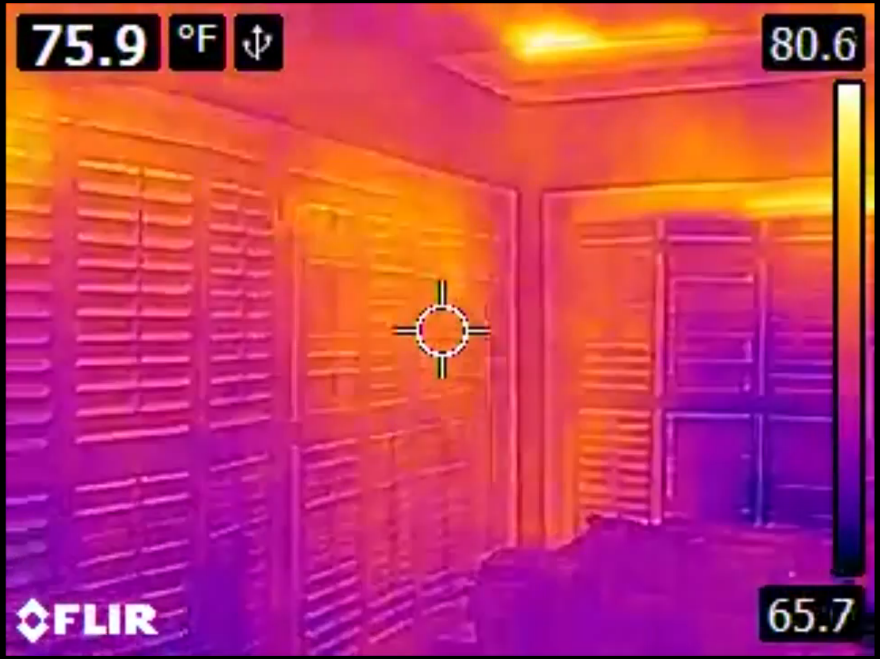
“DIY Home Energy Audit with an IR Camera”

“Now, something of great interest…and these are the types of things that are really cool to discover when you’re doing these types of audits.

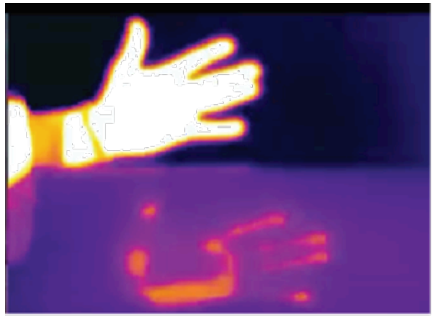
Here in the ceiling, we can see areas that are significantly warmer than the areas around them. **Sometimes this is bleed-through from the heat coming from the windows**.

(left corner)

This, however, indicates that the insulation does not cover all the way to the corner of the house. So, we’re missing some insulation here.”



Study Findings: Qualitative Coding



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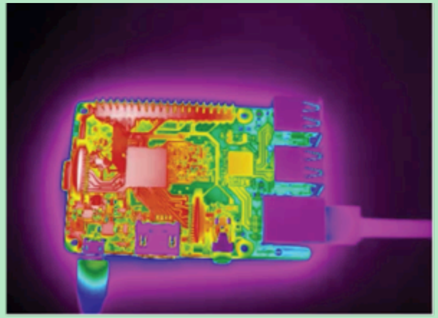

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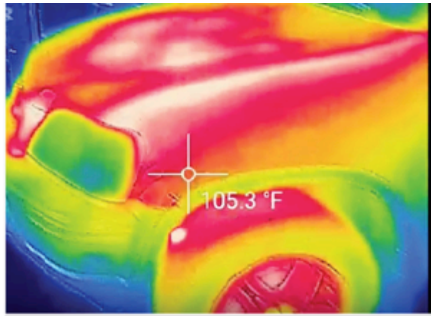

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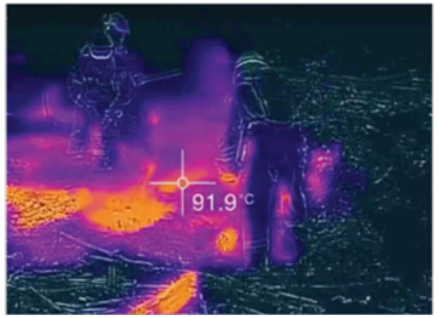

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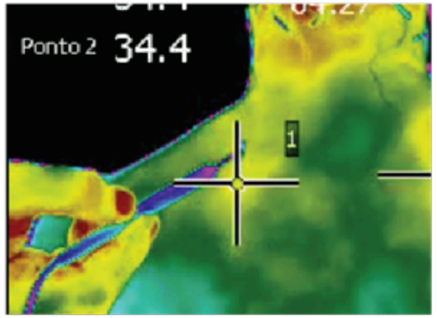

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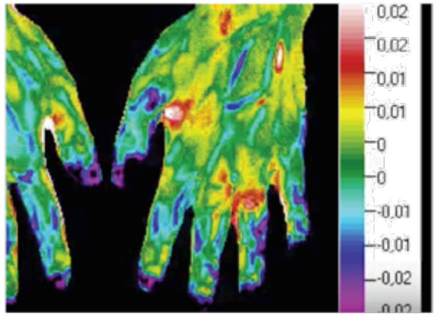

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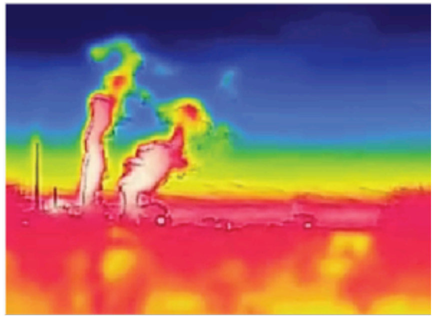


Pollution Activism (0.3%)

“Raspberry Pi 3 Heat & TORTURE Test”

“I set up the i7 to compensate for the emissivity for the chip itself as well as the apparent reflective temperature… **this should ensure accurate readings…**”

(Begins stress test)

“The temperature spikes up quite quickly and when it hits the 80°C mark it starts to throttle the speed…”

STUDY FINDINGS: MISCONCEPTIONS

Only 36 of 675 (5.6%) of videos contained misconceptions about thermography.

- 31% - Could image/measure gases (e.g., flatulence)
- 21% - Could directly measure air temperature (vs surface temperature)

Study Findings: Misconceptions

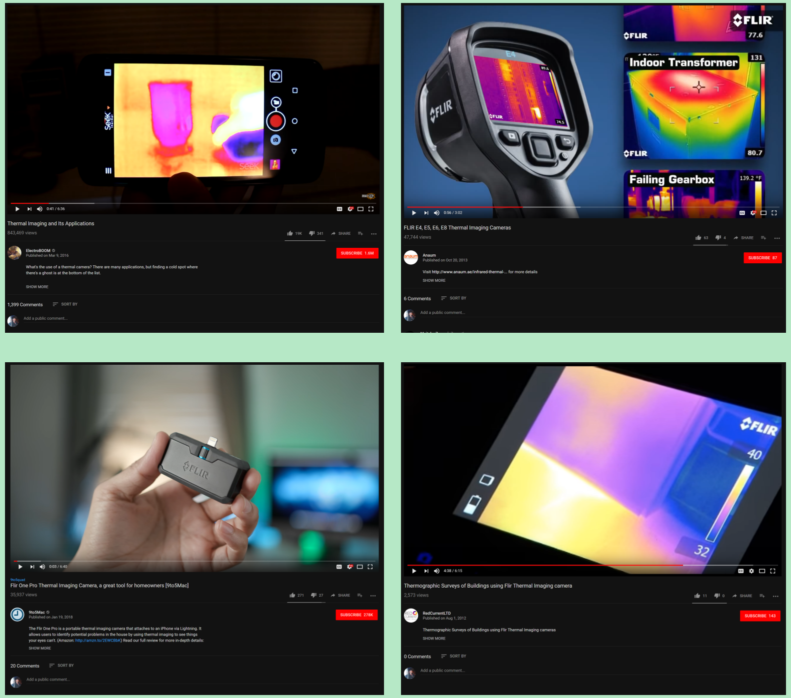
Only 36 of 675 (5.6%) of videos contained misconceptions about thermography.

- 31% - Could image/measure gases (e.g., flatulence)
- 21% - Could directly measure air temperature (vs surface temperature)
- 14% - Could "see through" walls or clothing
- 11% - Impact of thermal reflectivity (e.g., making it difficult to image glass)
- 5% - How to use specific features

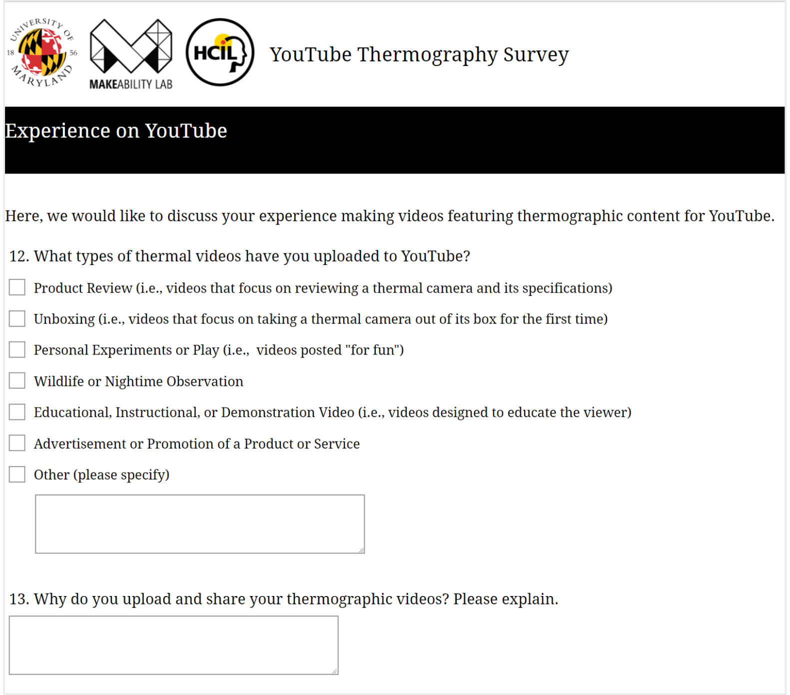
STUDY FINDINGS: COMMENT THREADS

Question Type	Number Asked	Number Answered	Who Responded		
			Original Poster	Other Poster	Both
Technical Specification	41.9% (153/365)	53.6% (82/153)	75.6% (62/82)	12.2% (10/82)	12.2% (10/82)
Content	29.9% (109/365)	58.7% (64/109)	62.5% (40/64)	12.5% (8/64)	25.0% (16/64)
Other	19.5% (71/365)	71.8% (51/71)	55.9% (28/51)	21.6% (11/51)	22.5% (12/51)
Follow-Up Request	8.8% (32/365)	50.0% (16/32)	62.5% (10/16)	18.7% (3/16)	18.7% (3/16)

Study Method: Two-Part Study



Part One:
Dataset Generation & Qualitative Coding


YouTube Thermography Survey

MAKEABILITY LAB

HCIL

Experience on YouTube

Here, we would like to discuss your experience making videos featuring thermographic content for YouTube.

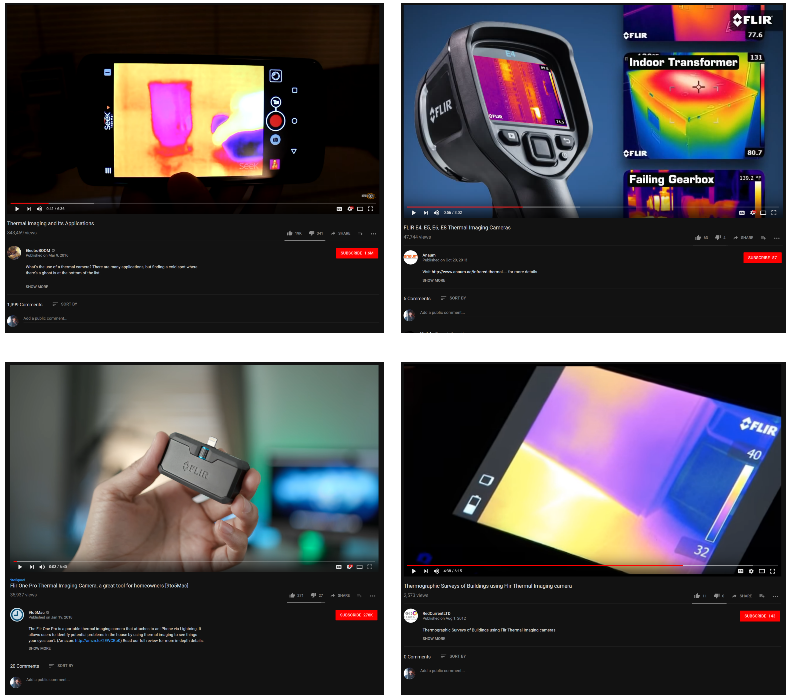
12. What types of thermal videos have you uploaded to YouTube?

- ☐ Product Review (i.e., videos that focus on reviewing a thermal camera and its specifications)
- ☐ Unboxing (i.e., videos that focus on taking a thermal camera out of its box for the first time)
- ☐ Personal Experiments or Play (i.e., videos posted "for fun")
- ☐ Wildlife or Nightime Observation
- ☐ Educational, Instructional, or Demonstration Video (i.e., videos designed to educate the viewer)
- ☐ Advertisement or Promotion of a Product or Service
- ☐ Other (please specify)

13. Why do you upload and share your thermographic videos? Please explain.

Part Two:
Online Survey of Content Creators

Study Method: Two-Part Study



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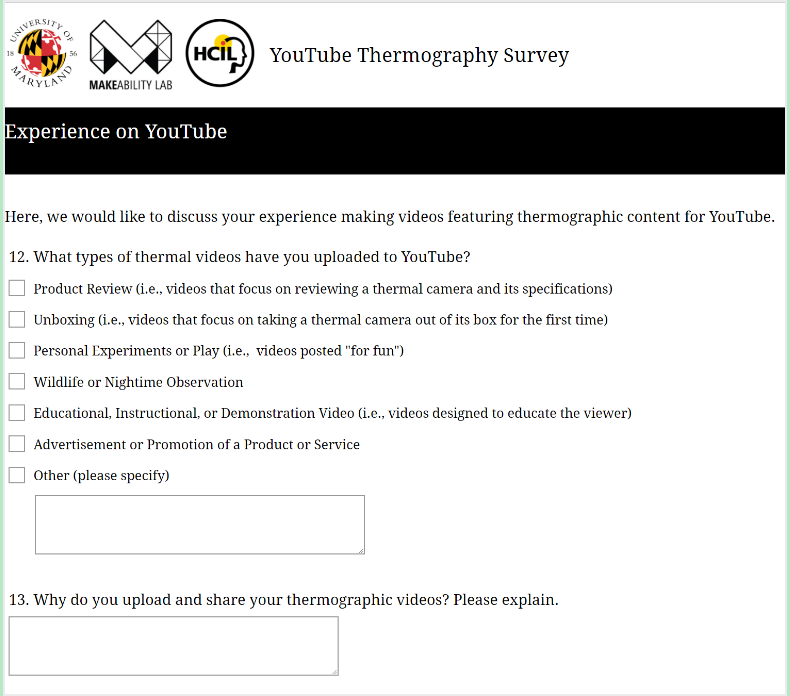
Dataset Generation & Qualitative Coding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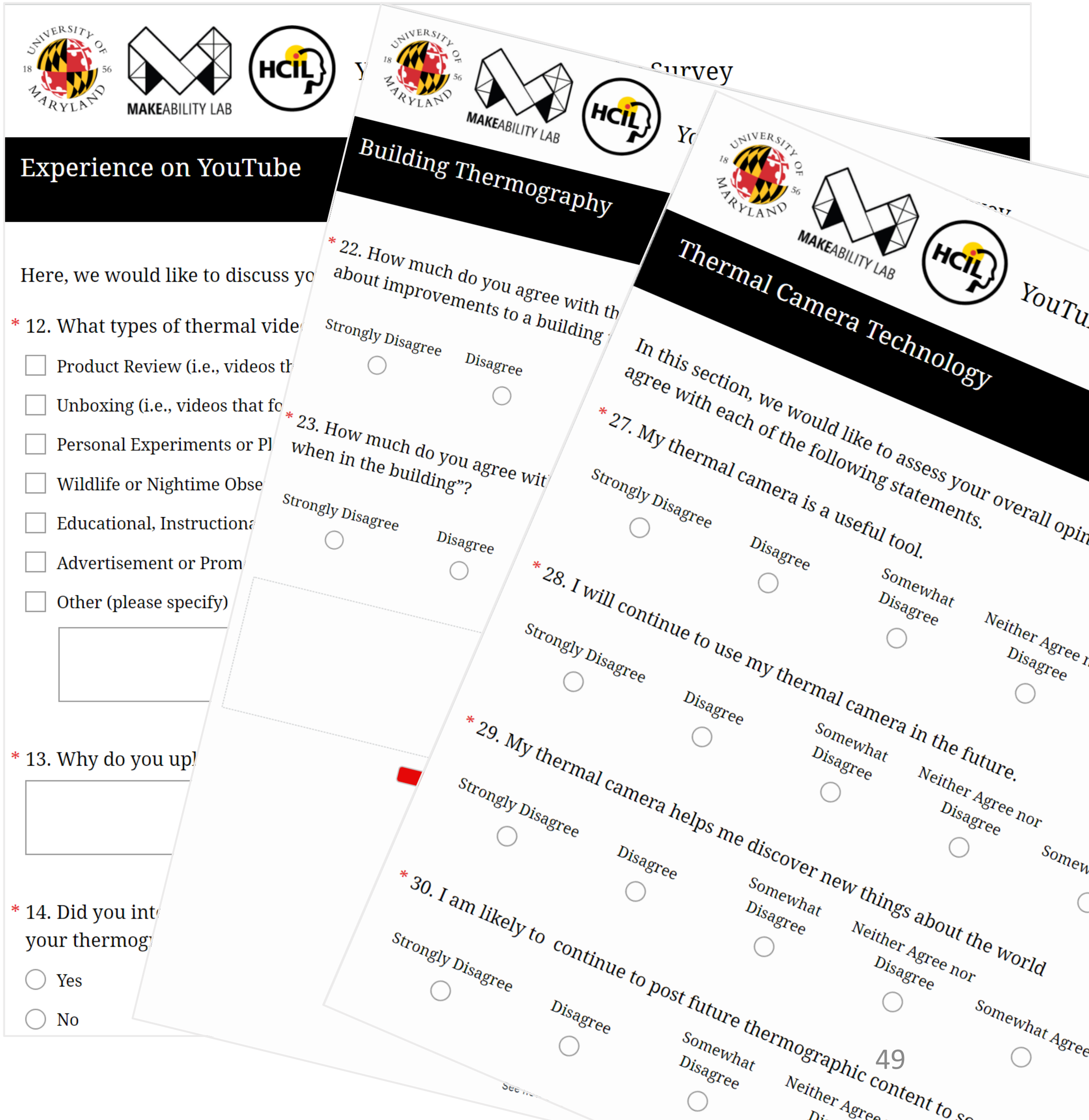
13. Why do you upload and share your thermographic videos? Please explain.

Part Two:
Online Survey of Content Creators

Study Method: Online Survey

- Content creators with videos in our n=1000 random sample were sent requests to participate
- 79 content creators responded (7.7% response rate)
- 48 respondents identified as non-professionals (61%)



Camera Ownership

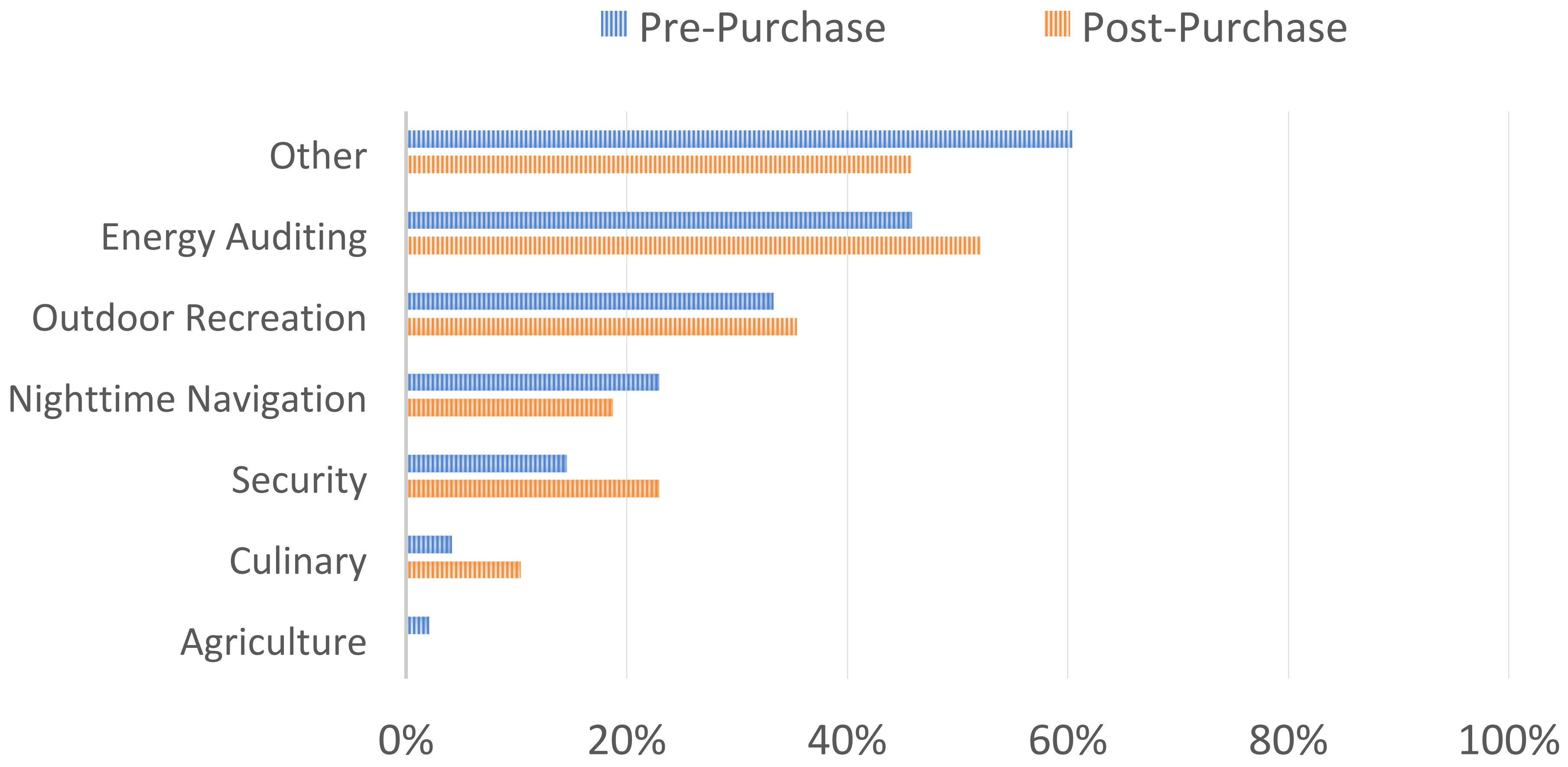
52%

(*N*=25) reported owning smartphone-based thermal camera attachments.

Others reported using:

- Standalone Handhelds (16%)
- Integrated directly with smartphones (4%)

Study Findings: Reasons for Acquiring & Using Thermal Cameras



Attitudes on Utility

97%

(*N*=46) thought their thermal camera was a useful tool that helped them learn and discover.

Most believed they:

- Would continue to use their thermal cameras
- Would continue to post content to YouTube

Reasons for Posting

46%

(*N=22*) posted videos to YouTube to directly engage with the YouTube community about thermal cameras.

Others reported:

- For "Fun"
- Wanting to share with friends and family
- "Because I can"

Reactions to Posting

50%

(*N=24*) reported interacting with other YouTube users online.

Interactions were beneficial in some way:

- Intrinsically valuable
- Good for getting information or feedback
- Exploring new uses

Conclusions: Discussion

Like previous work, we found that found that **user-generated videos offered** an otherwise inaccessible **window into user behavior with an emerging technology**.

In particular, **novice users** expressed positive attitudes toward thermal cameras and **performed diverse activities** ranging from imaging pets and beverages to investigating electrical failures and home improvements.

And, contrary to previous work, we found that **users successfully investigated technological limitations and largely correctly interpreted their data**.

CONCLUSIONS: DESIGN RECOMMENDATIONS

- Provide contextually relevant information
- Encourage exploration
- Anticipate and prevent misconceptions
- Enable social supports

Conclusions: Limitations

- Video analysis is limited to the YouTube community
- Videos in our dataset likely represent the most interested non-professional thermal camera users
- Survey results limited by self-selection bias

CONCLUSIONS: RESEARCH OUTCOMES

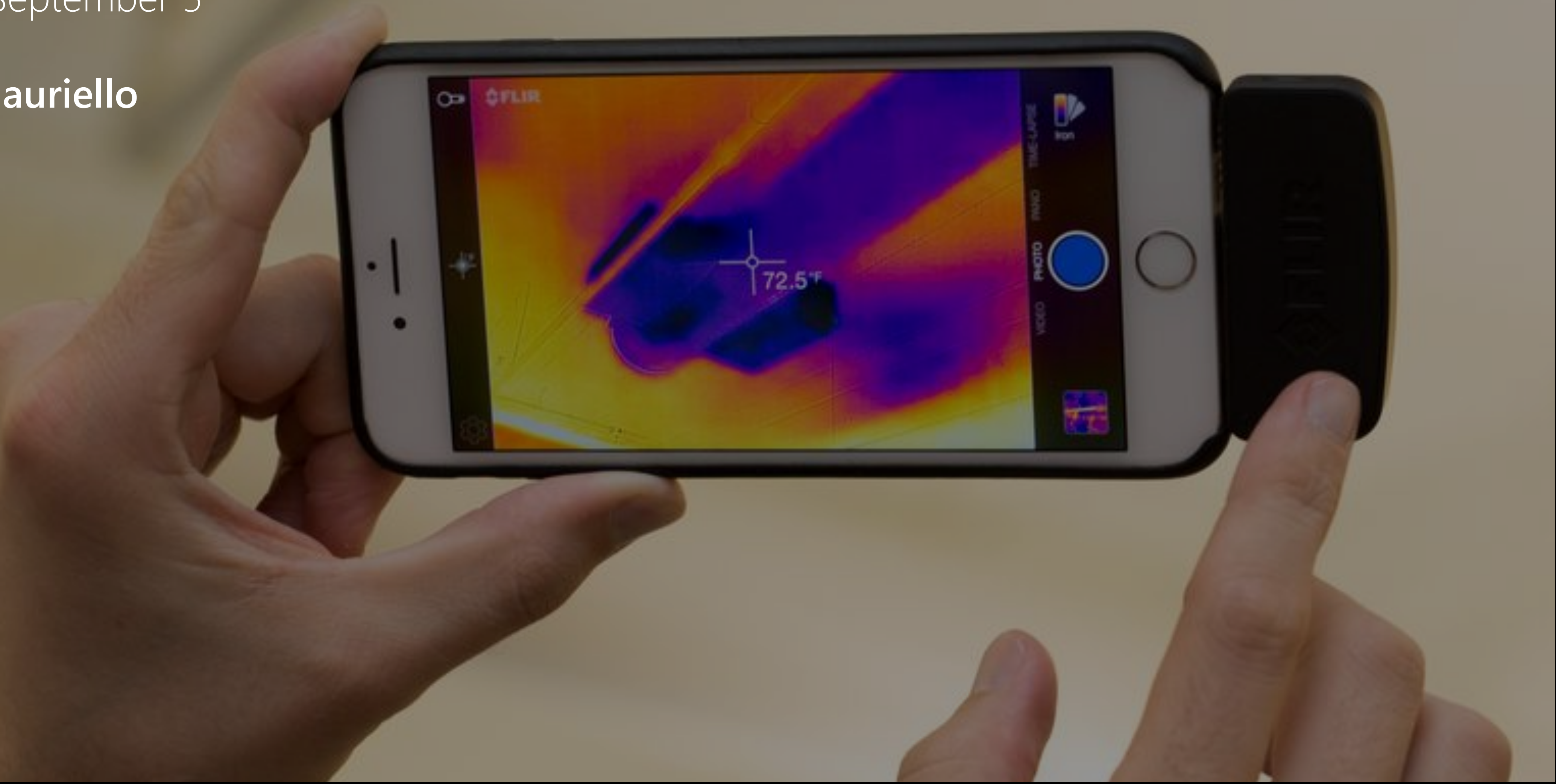
- **Characterizations of the common thermal camera uses** and adoption patterns of novice end-users
- **A manual+computational approach to sampling** user-generated content from OSNs (specifically YouTube) for qualitative analysis
- **Four design recommendations** to help promote technical understanding and proper use.

A Large-Scale Analysis of YouTube Videos Depicting Everyday Thermal Camera Use

MobileHCI 2018 | September 5th

Matthew Louis Mauriello
@mattm401

Brenna McNally
Cody Buntain
Sapna Bagalkotkar
Samuel Kushnir
Jon E. Froehlich



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HCIL Human Computer Interaction Laboratory
MAKEABILITY LAB
DUB
UNIVERSITY of WASHINGTON