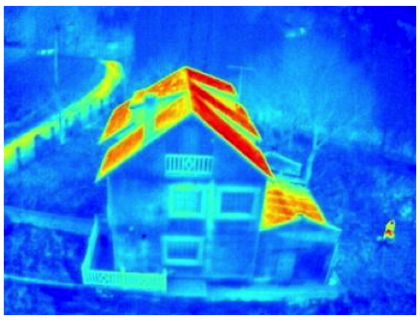
Is my home leaking energy? Exploring the role of smartphones in thermography

by MANASWI SAHA, YUAN SU, SHENG YANG, RUICHI YU, AND KRISTINE ROGERS



Is my home leaking energy?

Have you ever worried about financial or health issues stemming from potential building defects? That was the case for Ralph, a homeowner, who was shocked by his skyrocketing utility bills in the wintertime. After doing some research online, he suspected that his house may have an insulation problem. But is it really the problem? He knows he can hire a professional to perform a thermographic energy audit, but he found that these could cost him between $300-500, with an average waiting time of weeks. Is there something he can do himself to determine the cause of these high energy bills?

Introduction

Our homes are important to us—they are places where we spend time and build memories. As of 2010, more than 40% of energy consumption in the US was from buildings [1]. $20-30\%$ of energy can be saved by implementing basic energy efficiency strategies [2]. Among other reasons, many buildings were made long ago, when building codes were different and energy efficiency wasn't a significant consideration. The US Department of Energy (DOE) recommends professional energy audits to identify issues and possible mitigations which, however, are expensive and sometimes inaccessible.

A team of researchers in the University of Maryland's Human-Computer Interaction Lab (HCIL), led by Prof. Jon Froehlich and PhD student Matthew Mauriello, is exploring the role of smartphones augmented with thermal cameras to make thermography more widely accessible. The research team is working on developing techniques for anyone to perform "thermography" – the study of heat distribution, which is currently limited to experts with professional-grade equipment. Thermography identifies invisible issues, such as air and water leakage, or poor insulation, which can be present in a structure. Integrating this capability into common technology has the potential to create new Human-Building Interactions (HBIs) [3] by expanding the average household's ability to: (i) perform energy audits themselves, (ii) survey public infrastructure, and (iii) contribute to urban energy analysis. Households, neighborhoods, and even cities (in the future) could take advantage of do-it-yourself (DIY) energy analysis to help understand their energy profiles.

DIY & Crowdsourced Thermography

In the early phase of this research, the team identified several exciting new trends in thermal data collection [4]: (i) commercial innovations are bringing about revolutionary thermal cameras, (ii) researchers have invaluable opportunities for data collection, and (iii) professional thermographic data collection is developing to its full potential with the help of crowdsourced information from city residents. These observations drove the project team to explore the role of smartphones in thermography.

The long-term vision of this research is to assess the feasibility of building interactive tools to identify problems with aging infrastructure, and help audit the built environment by supporting motivated citizen science/DIY volunteers to perform thermographic scans of their cities. Work-

ing with volunteers may enable new sorts of analysis (e.g., tracking temporal thermal flows in buildings) due to the larger volume of images that are taken over different times and locations.

To understand the role of DIY/citizen science volunteers in urban energy analysis and potential motivating factors, the research team designed a four week pilot field study [5] to examine (i) volunteers' interests and experiences, (ii) their ability to use smartphone-based thermal cameras, and (iii) their ability to capture energy analysis data. The team piloted its procedure with three graduate students who had little or no experience using thermal cameras. Pilot participants received limited training and were encouraged to explore their environment over the course of four weeks. At the end of the pilot study, the research team debriefed the participants about their experience. The participants were found to be curious, and were motivated to investigate air/water leakages in buildings (Figure 1). Expanding beyond this initial study, the team has now conducted a larger field study with external participants and are in the process of analyzing the collected data.

Figure 1: A participant found a water leakage problem when investigating a small drip on the wall. The thermal image revealed that the problem was much more severe than what was visible to the naked eye [5]

Conclusion

Even in its early phases, we can see this project making strides to harvest information from thermal cameras to help us better understand our home and environments. Homeowners can identify previously invisible problems, such as air leakage or poor insulation, using thermographic data from their own phones—without having to hire a professional. A major part of conducting thermographic inspections is to interpret the captured thermal data to identify issues and take actions to address them. This project is making efforts to address this challenge by developing interactive tools that would guide them through out the auditing process and suggest mitigation strategies to deal with the identified issues.

In addition to bringing about new HBIs, this project's future goals aim at boosting thermographic data collection at an urban scale. Using DIY volunteers and crowdsourcing strategies, data collection can scale quickly. Volunteers can document the urban environments that they navigate anyway, capturing invaluable thermographic data that could assist large-scale urban energy analysis—a goal that would otherwise be too expensive and time-consuming to achieve.

With the amazing work already underway by the HCIL research team, it will be exciting to see how this research project will continue to develop—and the eventual impact it is likely to have in identifying and reducing wasteful energy usage.

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