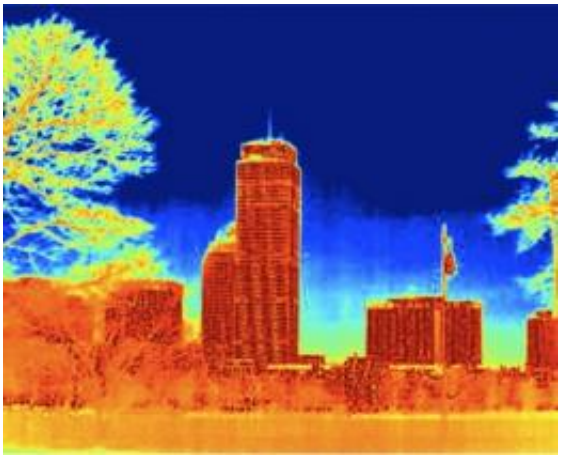
The big picture on energy loss

March 16 2011, By David L. Chandler



An image of the Boston skyline taken with the MIT researchers' thermal imaging system. Credit: Long Phan

Getting an energy audit of a home or a commercial building can be a time-consuming and labor-intensive process. But new techniques and technology developed by a team of MIT researchers have streamlined the process, allowing for scans of large groups of buildings — or even entire cities.

The project uses a vehicle with automated cameras that take thermal infrared images of every building as it moves along, similar to the way Google Street View vehicles obtain visual imagery. Researcher Long Phan and Research Scientist Jonathan Jesneck, working with Professor Sanjay Sarma, developed the system, which they have used over the last few months to scan the entire city of Cambridge and an army installation

(Fort Drum in New York). The team, from MIT's Department of Mechanical Engineering Field Intelligence Laboratory, presented a summary of their work so far at the MIT Energy Conference on March 5.

The idea is to quickly identify the buildings that are most inefficient, by detecting the heat escaping through walls, roofs, doors and windows in a way that allows detailed, quantitative comparisons of the rate of heat loss. That will make it possible to target remediation efforts at the worst buildings, thereby getting the most out of any efficiency-improvement spending.

Phan says that many existing programs to improve home energy efficiency simply throw money uniformly at the problems — for example, allowing a tax credit of up to $2,000 per home for improvements such as replacing windows or adding insulation — with no verification process to measure the actual energy-use improvements that resulted in savings.

As Sarma says, that approach is "like saying there's a heart-disease problem in the city, so everyone should take aspirin." Instead, he says, this system would identify which houses could benefit the most — in effect, saying "this man doesn't need an aspirin, but that one needs two."

The new approach will make it possible to "identify where the energy gushers are," Phan says, so that efforts can be directed where they will have the most impact. To do that, the team has developed "a non-invasive, high throughput remote energy diagnostics system," he says.

That "non-invasive" aspect is a key difference from typical home energy audits, which often take a few hours and involve inspecting every part of the home, from the basement to the attic, and often require special equipment such as door blowers to measure air leakage. Even then, while

such audits can determine where the energy losses are and suggest ways of reducing them, they do not provide quantitative estimates of the projected savings resulting from a given change (adding insulation, replacing windows, or installing a new heating system, for example).

The new process begins by photographing buildings with a system the team developed to get high-resolution, long wave infrared images using an inexpensive, low-resolution camera. Normally, the cost of high-resolution far-infrared cameras is prohibitive for such widespread use — such cameras can cost $40,000 each. As a substitute, the team developed a novel patent-pending technology called “Kinetic Super Resolution” that uses a computer to combine many different images taken with an inexpensive low-resolution IR camera (costing less than $1,000), that produces a high-resolution mosaic image.

“We needed to develop new methods” to improve resolution, Phan says. The technique is similar to systems developed by NASA to produce enhanced resolution from images taken by robotic spacecraft on other planets. As a result, “we can now break the cost barrier” for widespread use of thermal imaging, he says.

They are also developing software that would then translate those images into an estimate of the costs of making improvements, and the return-on-investment that would be achieved by doing so. To do this, they have enlisted the help of a local company called Green Guild that does energy audits and retrofits, tapping into the company’s database on the costs of the work done and resulting energy savings. They have also used online home-improvement stores’ listings to compile a database of the costs of all the materials needed for such work.

Last summer, Boston Mayor Thomas Menino announced plans for a scan of every single building in that city. Boston “wants to be the green city of the world,” Phan says, “to show they can turn a very old city very green.”

That project, which the team still hopes to carry out, is awaiting funding.

Gabe Shapiro, director of community relations for a nonprofit group called Next Step Living, says that “Being able to show vivid images of uninsulated walls and air flowing in from gaps in their home's envelope is one of the most powerful motivators that drive customers to adopt weatherization recommendations.” But that only happens if people know they can get such images. “Projects like the one that the MIT team is undertaking in the city of Boston allow for targeted outreach to homes with high-savings potential through sharing of exterior infrared images. These images displaying obvious areas of heat loss will undoubtedly drive the residents who need it most to get their homes assessed and take the necessary steps to make their homes more energy efficient.”

“We want to not only determine where these leaks are, we want to fix the leaks and verify the energy savings,” Phan says. “We’ll provide a numerical solution, saying your window is leaking this much, and costing you this much in energy."

The citywide scanning of Cambridge, which had to be done at night in wintertime in order to see the effects of heated air escaping from buildings, has just been completed. “There is big potential here,” Phan says. “If you could make homes even 2 percent more efficient, that translates into billions of dollars saved.”

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Provided by Massachusetts Institute of Technology

Citation: The big picture on energy loss (2011, March 16) retrieved 18 April 2024 from https://phys.org/news/2011-03-big-picture-energy-loss.html

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