Crowdsourcing an Infrared Street View through Citizen Science

Advisory Board Meeting
Concord, MA
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We appreciate your time on advising this project!

Research & Development

What problems are we trying to solve?

Hypothesis

People are unaware of the energy waste in their homes or communities as heat transfer across the building envelope is often unnoticeable—until it is revealed by a thermal camera. An infrared street view, like Google's Street View, can become an Internet magnet that draws people's attention to energy efficiency – *the fifth fuel* —and hopefully ignites large-scale changes. For instance, people may improve the thermal efficiency of their home or business buildings as infrared proofs of good conditions may add value and promote sale.

Challenge

Unfortunately, previous IR scanning startups have all failed commercially (e.g., Essess and Sagewell). We need to develop a new technology and find a new business model that can engage building owners effectively, runs at a low cost, and is scalable worldwide.

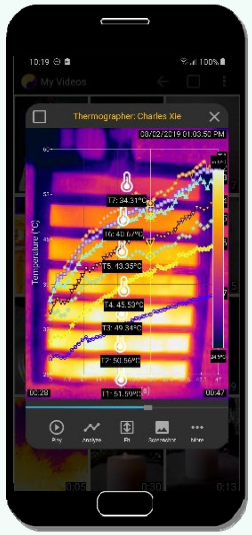
If we create the technology, then who will use it?

A new way

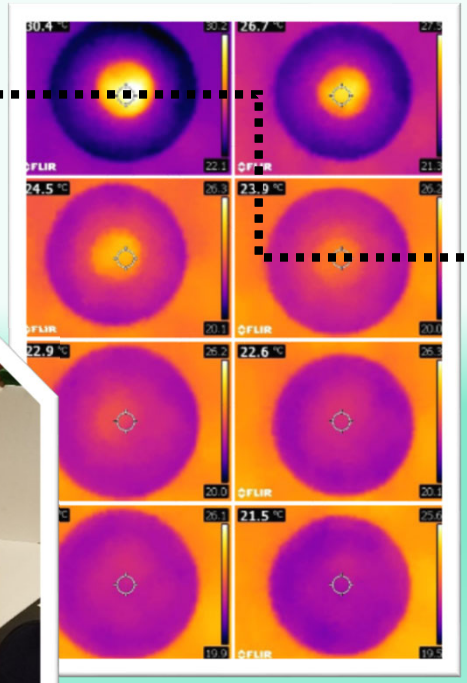
Based on new technology, our project aims to integrate energy efficiency, STEM education, and citizen science to make it possible to engage students to crowdsource an Infrared Street View, accomplishing something that would otherwise take a giant company like Google to do.

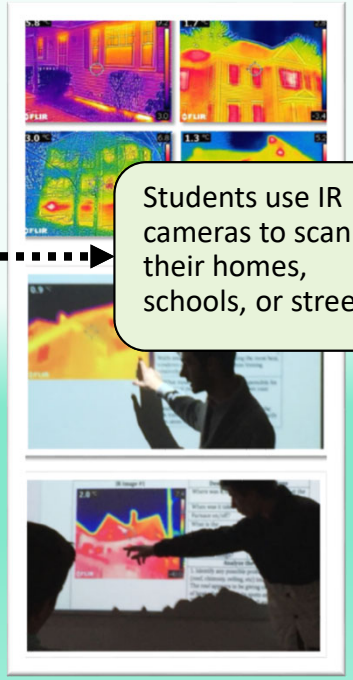
IR cameras to physical science can be as instrumental as microscopes to biological science.

Everyone has to learn heat and temperature in school. There is no better tool for teaching thermal energy and heat transfer than an IR camera.



Students learn science concepts in classrooms with IR cameras.





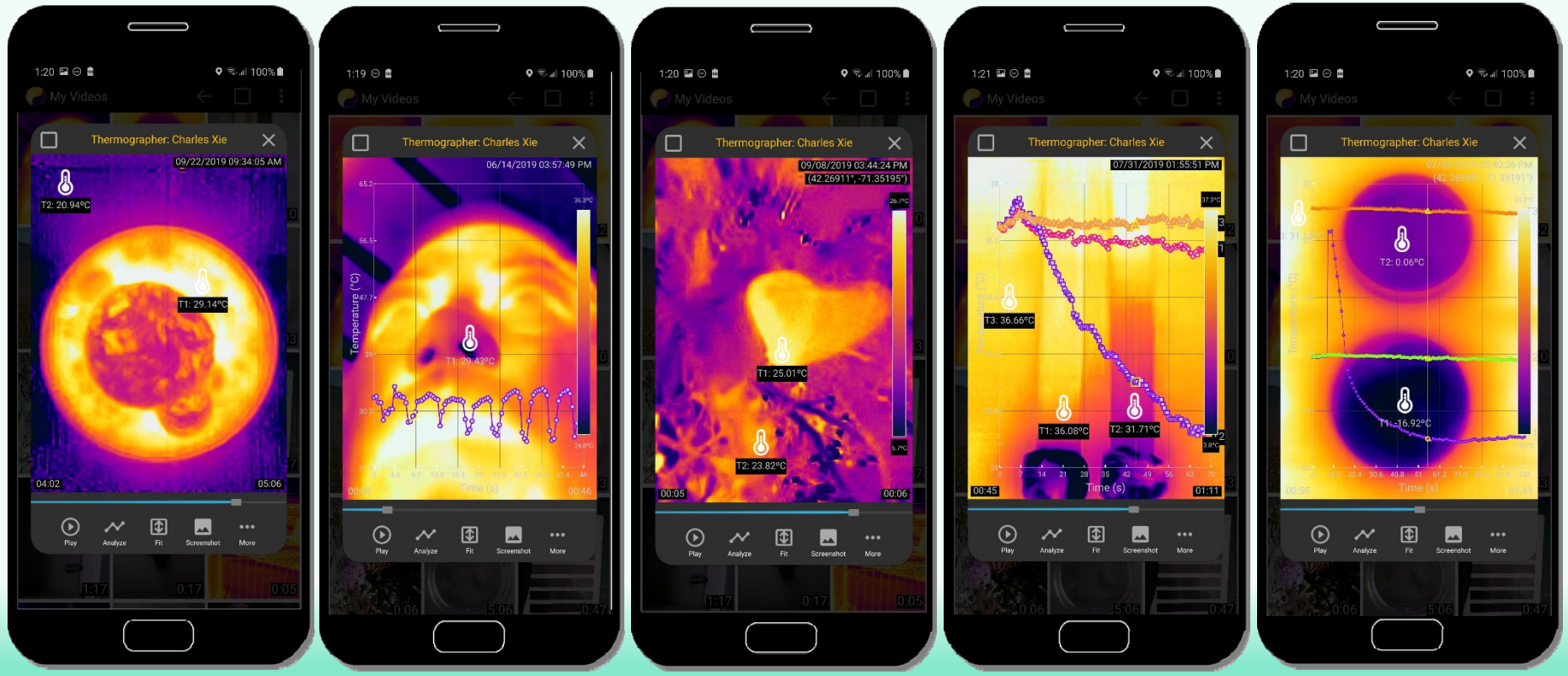
Students use IR cameras to scan their homes, schools, or streets.

An IR experiment to observe thermal equilibrium

Formal-informal pathways from school science to citizen science

Students contribute IR images to the Infrared Street View (with parents' permission).

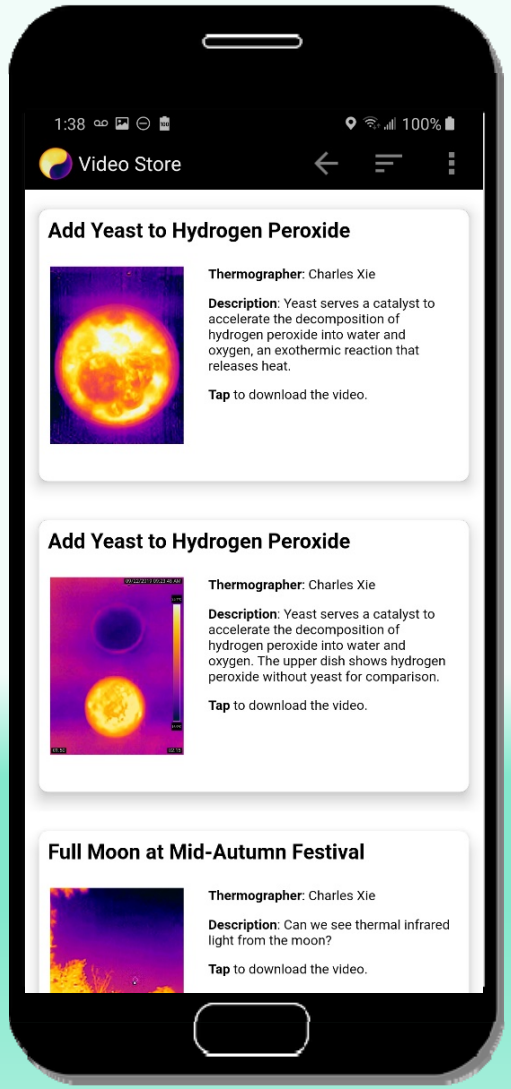
Incredible science through an infrared camera

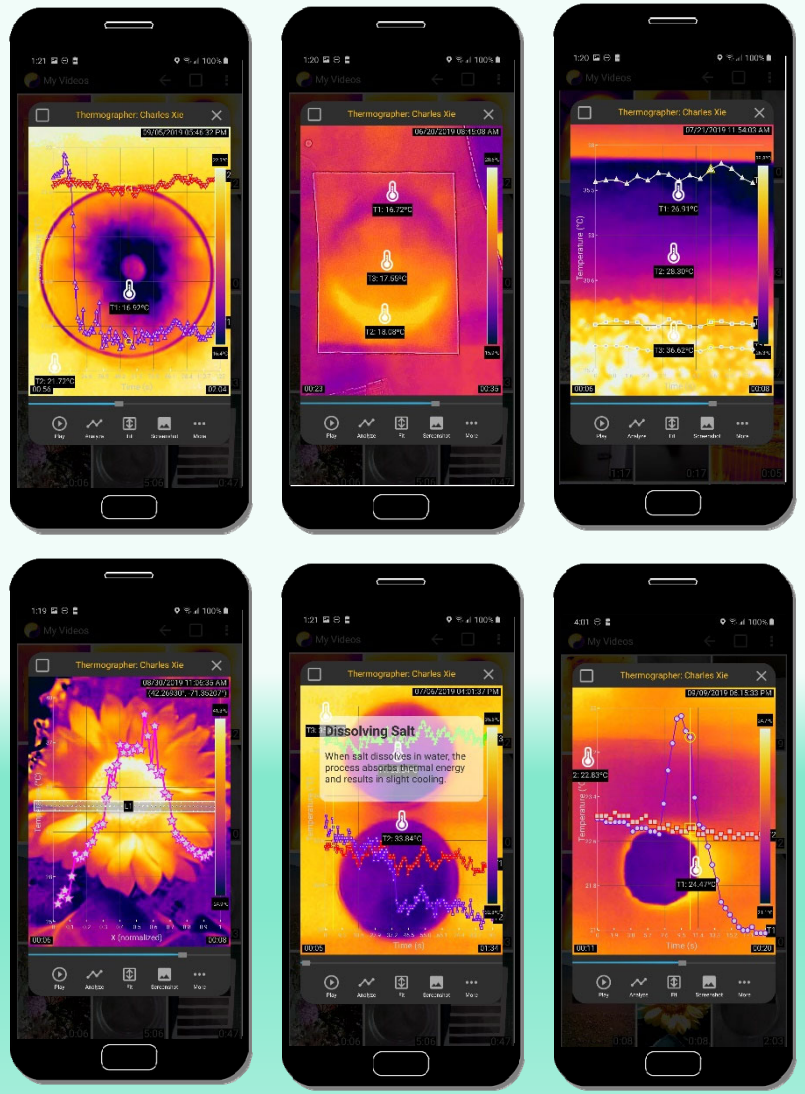


Anything that leaves a trace of heat leaves a trace of itself under a thermal camera.

"*Captivating, intriguing, and thought-provoking*" –Journal of Chemical Education on our paper "Visualizing Chemistry with Infrared Imaging" (2011)

In-app video store:
Numerous recorded observations for download and analysis





Physics

Chemistry

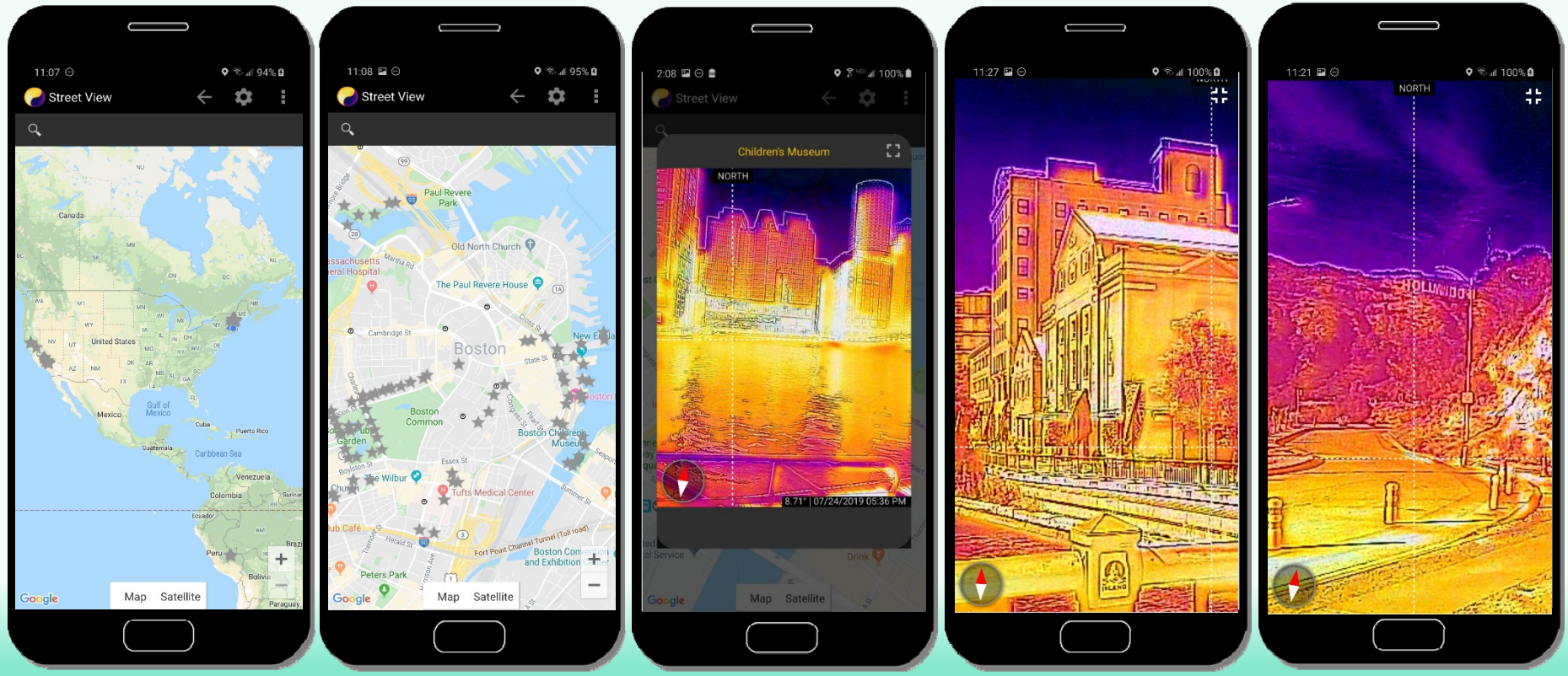
Biology

Geoscience

Engineering

...

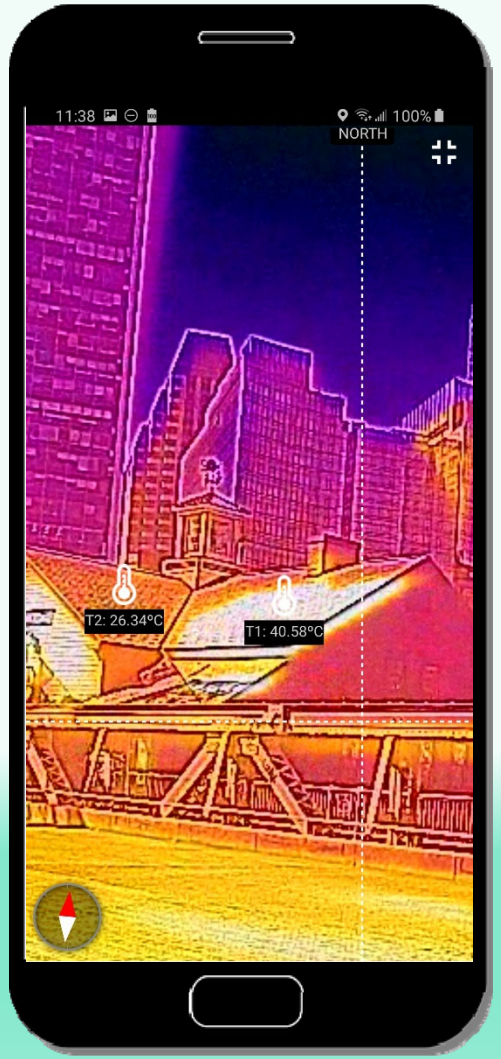
Experimental infrared street scans in multiple locations

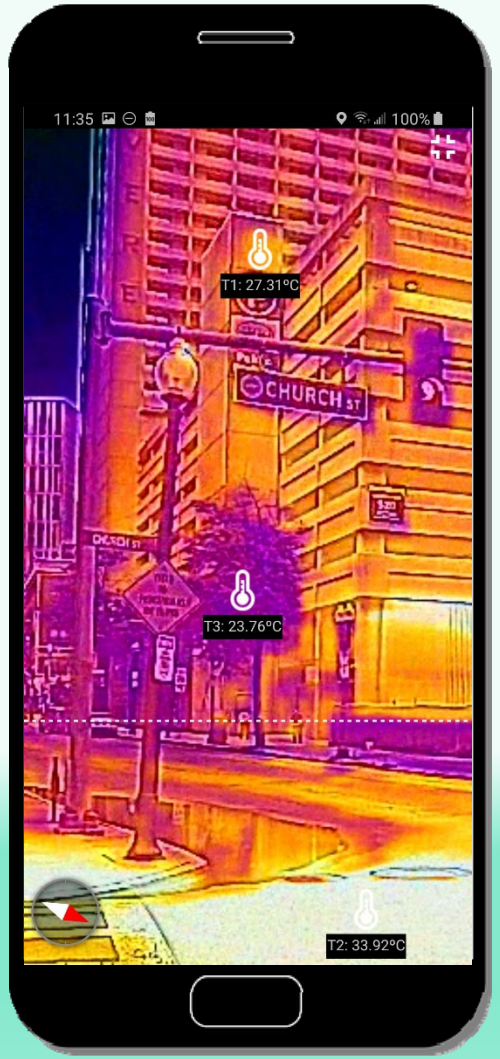


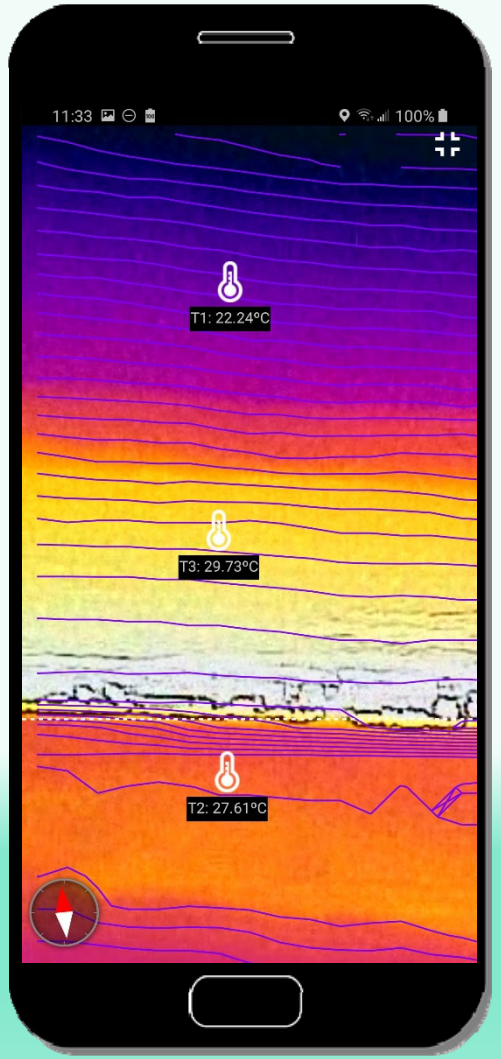
East Coast, West Coast, South America

(Android version)

What can we see from infrared street views?



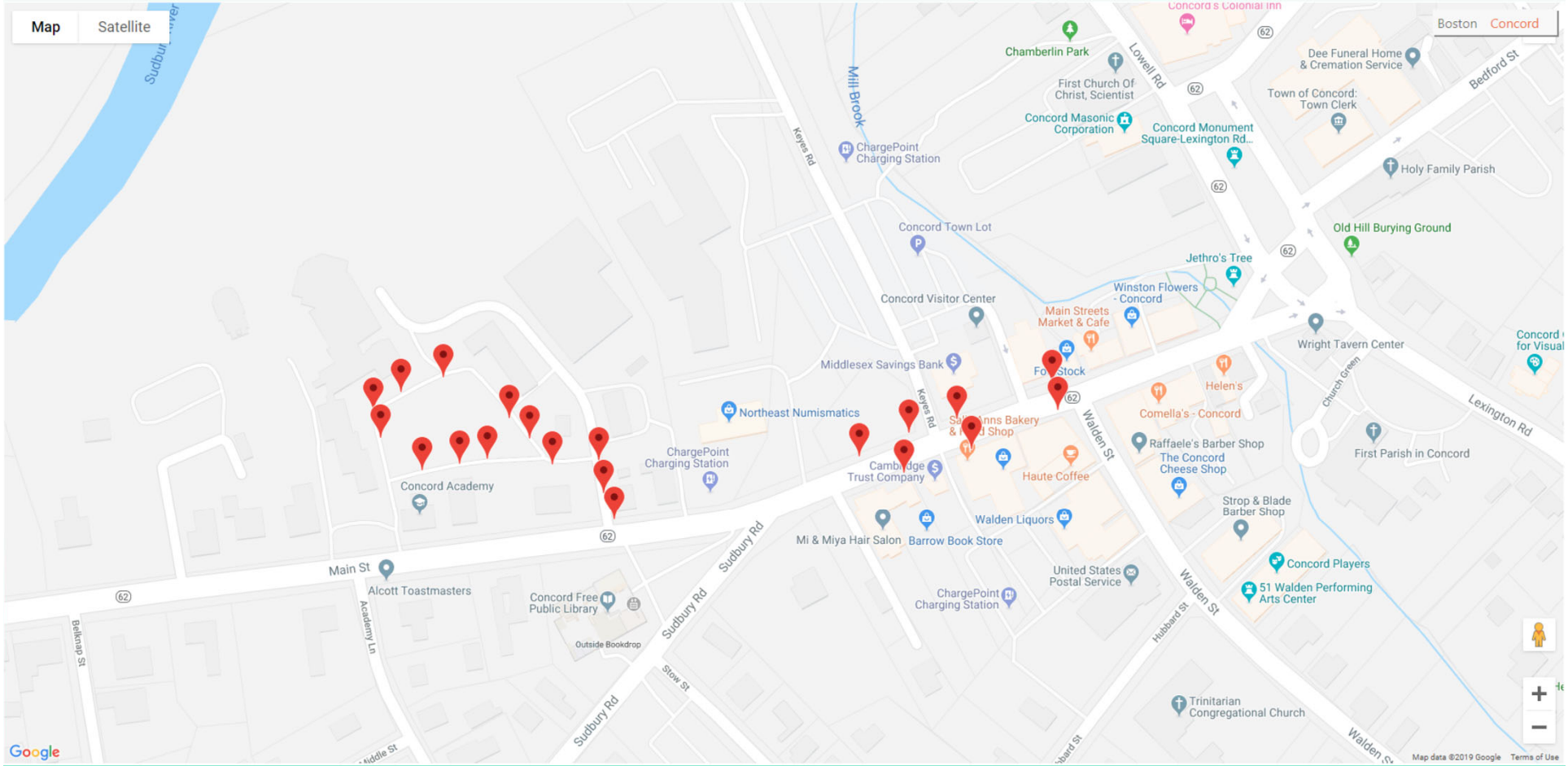




Solar potential, urban heat island, interesting patterns, wandering ghosts☺, …

An alpha version on the Web

http://energy.concord.org/irstreetview/



2D markers for infrared panoramas in Google Maps

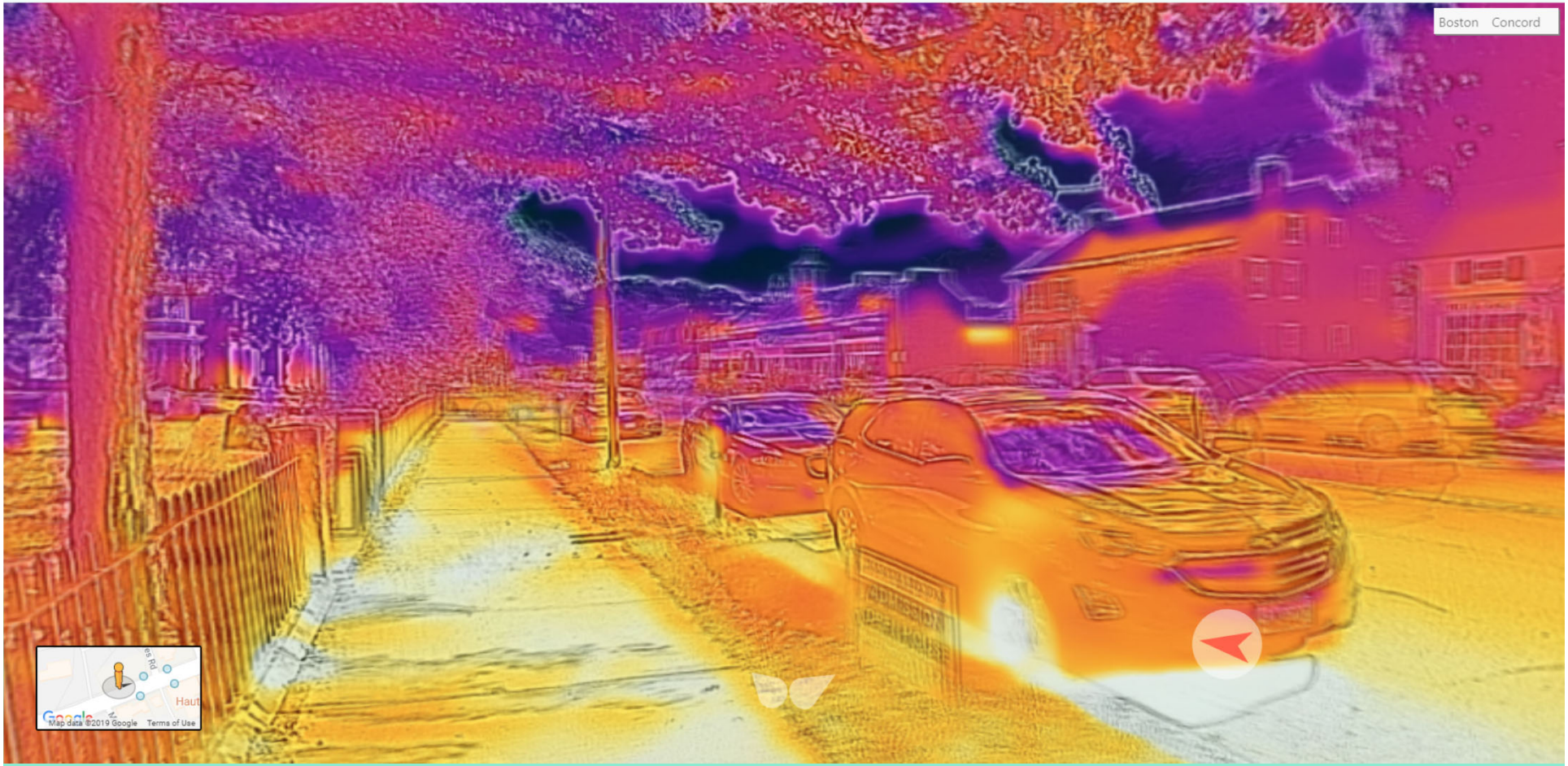
Switch between Google Street View and Infrared Street View

http://energy.concord.org/irstreetview/

3D markers for infrared panoramas in Google Street View

Immersive thermal vision in Infrared Street View

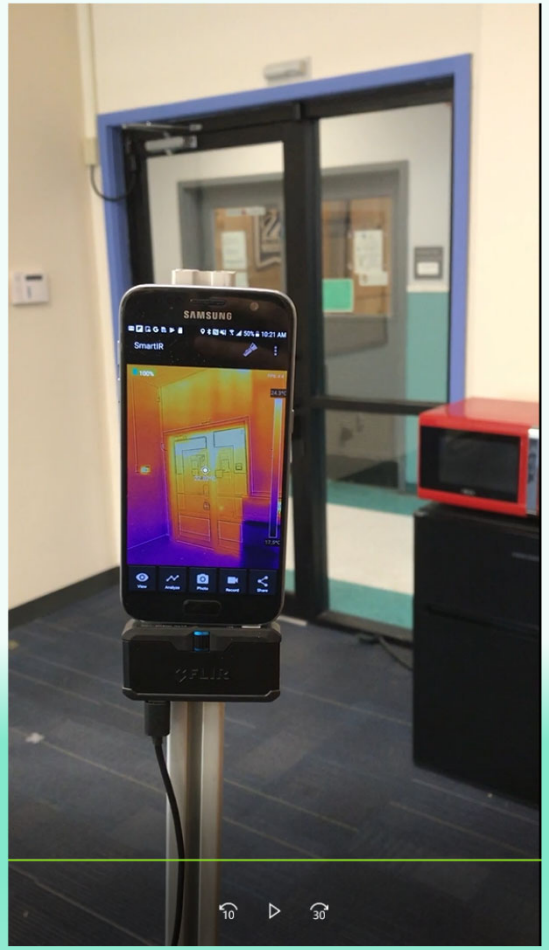
http://energy.concord.org/irstreetview/

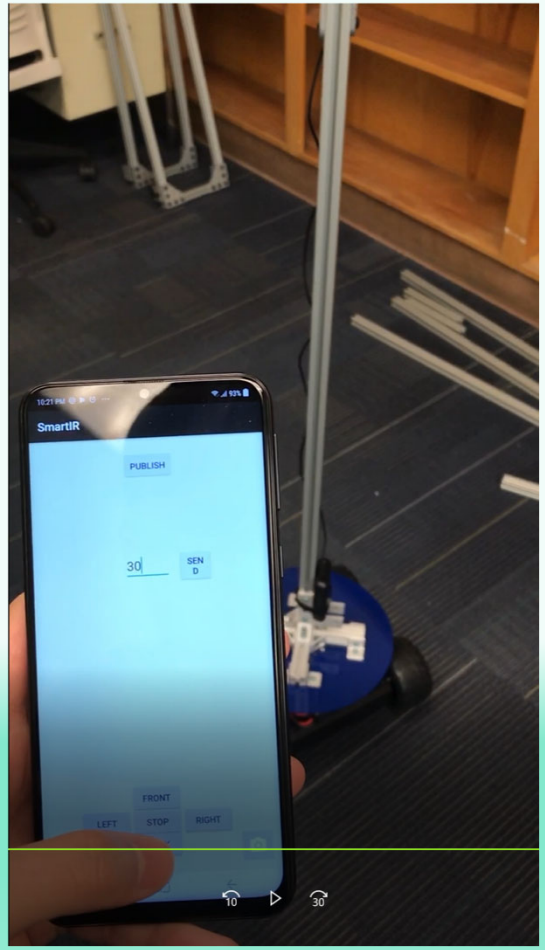


An infrared panorama rendered with WebGL with hotpots and arrows to create an immersive experience of walking in the world with a thermal vision

Automating thermal scanning for large-scale applications

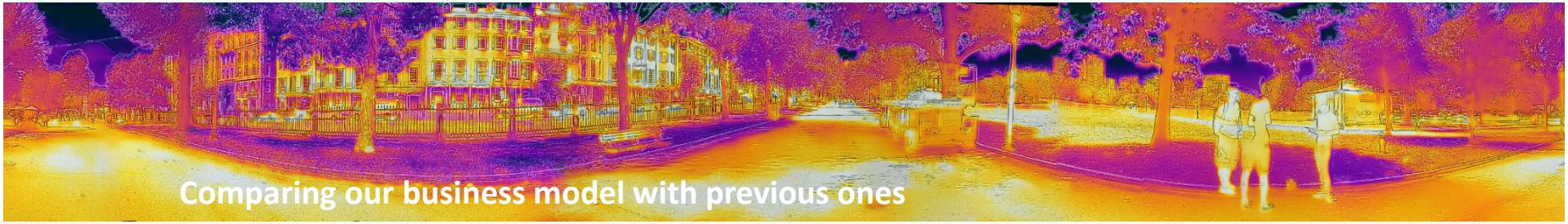
Manual scanning is tedious and error-prone. We need robots.





Contracted to the Robotics and Locomotion Lab at UMass Lowell

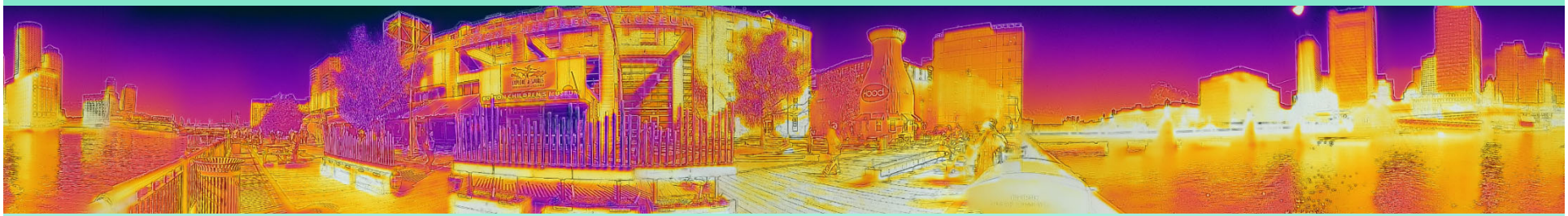
What makes us think that we would have a better chance?



	Our Model	Previous Models
Strategy	Start with the education of students who may be able to motivate homeowners (and who are future homeowners) and teach them how to interpret an IR image based on simpler school experiments about the science of conduction, convection, radiation, and so on, thus building customers' trust in and appreciation of IR thermography.	Start with IR images
Scalability	Engage a large number of students and volunteers (crowdsourcing through citizen science projects)	Drive-by trucks or fly-by drones
Holism	Take images of buildings from 360° angles	Front or aerial images
Appeal	Use 360° panoramic views and 3D virtual reality to enhance the visual effects	2D images
Privacy	Students scan their *own* houses, their neighbors' houses, or public buildings in their towns, and publish images only with permission by building owners and managers.	Unsolicited scans

Who may want it?

- Real estate (infrared proofs of building conditions)
- Energy efficiency companies (customer acquisition)
- Governmental research (thermographic information system)
- Schools and colleges (inquiry-based, project-based learning for solving real-world problems)
- Amateur thermal lovers (believe it or not, they are out there in the winter)



Teacher Professional Development, School Implementations, & Educational Research

Teacher professional development workshop in York, ME, June 2019

NARST 2020 workshop proposal accepted

(*Next Generation Labs for Next Generation Science Standards: Mobile Sensing as an Example*)

143 students in a diverse local high school

October 2019

How can we collect data to support educational research?

Data mining to the rescue

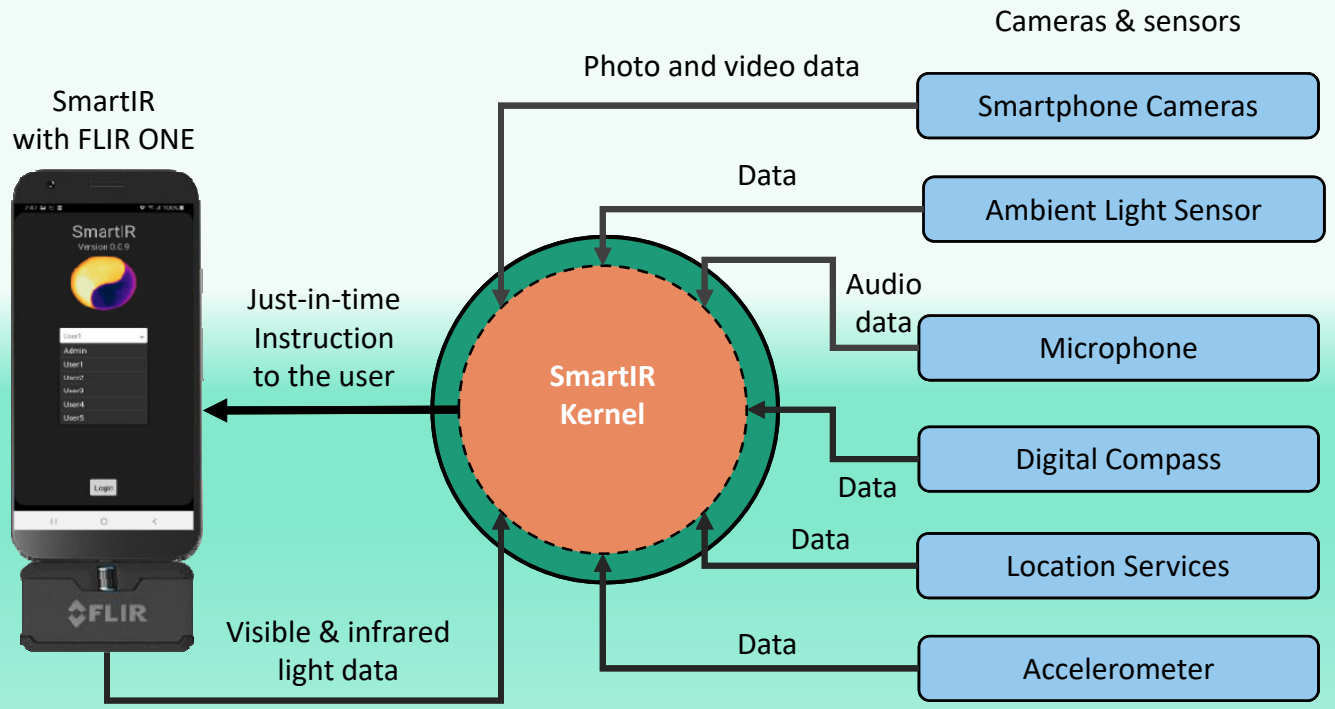
SmartIR collects fine-grained sensor and gesture data that are being mined to understand learning in the formal and informal contexts and across.

Onboard sensors, attached cameras, POV screencast, and user interface logger collect multimodal data to create **context awareness**.

Machine learning infers what users may be doing by analyzing these data (e.g., computer vision can be used to detect anomalies).

SmartIR provides **feedback** to users in real time based on sending the machine learning results as the inputs to a set of decision tree models.

Point-of-view (POV) screencast allows researchers to see what students saw and hear what they said during their activities, particularly suitable for educational research in informal settings where it is infeasible to follow and observe students.



Future plans in the no-cost extension year

Goal: Focus on citizen science

Strategy: Collaborate with informal science educators

In talk with the following folks:
David Sittenfeld, Vicked Hot Boston, Museum of Science
Darlene Cavalier, SciStarter, Arizona State University
Jeremy Hoffman, Chief Scientist, Science Museum of Virginia

Goal: Develop artificial intelligence for automatic thermal analysis

Strategy: 3D thermal mapping onto building envelopes

Construct 3D dynamic thermal models of buildings

Goal: Disseminate results to educator communities

Strategy: Publications and presentations

Submit papers to *Journal of Science Education and Technology*, *Computers & Education*, *Science Teacher*, … Open a SciStarter project

Thank you very much for your time!