

Crowdsourcing an Infrared Street View through Citizen Science



Software: Charles Xie, Amos Decker, Bill Zhang, Chenglu Li

Robotics: Wei Li, Yan Gu (UMass Lowell)

Educational Research: Shannon Sung, Sue Huang, Guanhua Chen

Coordination: Elena Sereiviene, Joyce Massicotte

Advisory Board Members

Michael Arquin, CEO, KidWind

David Bursell, Vice President of Global Business Development, FLIR

Emily Kemper, Director of Residential Solutions, CLEAResult

Cathy Lachapelle, Founder, STEM Education Insights

Ron Lasser, Professor of Engineering, Tufts University

Jan Mokros, Senior Scientist, Science Education Solutions

Peter Wong, Former Director of Food Initiative at Museum of Science

We appreciate your time on advising this project!

Research & Development

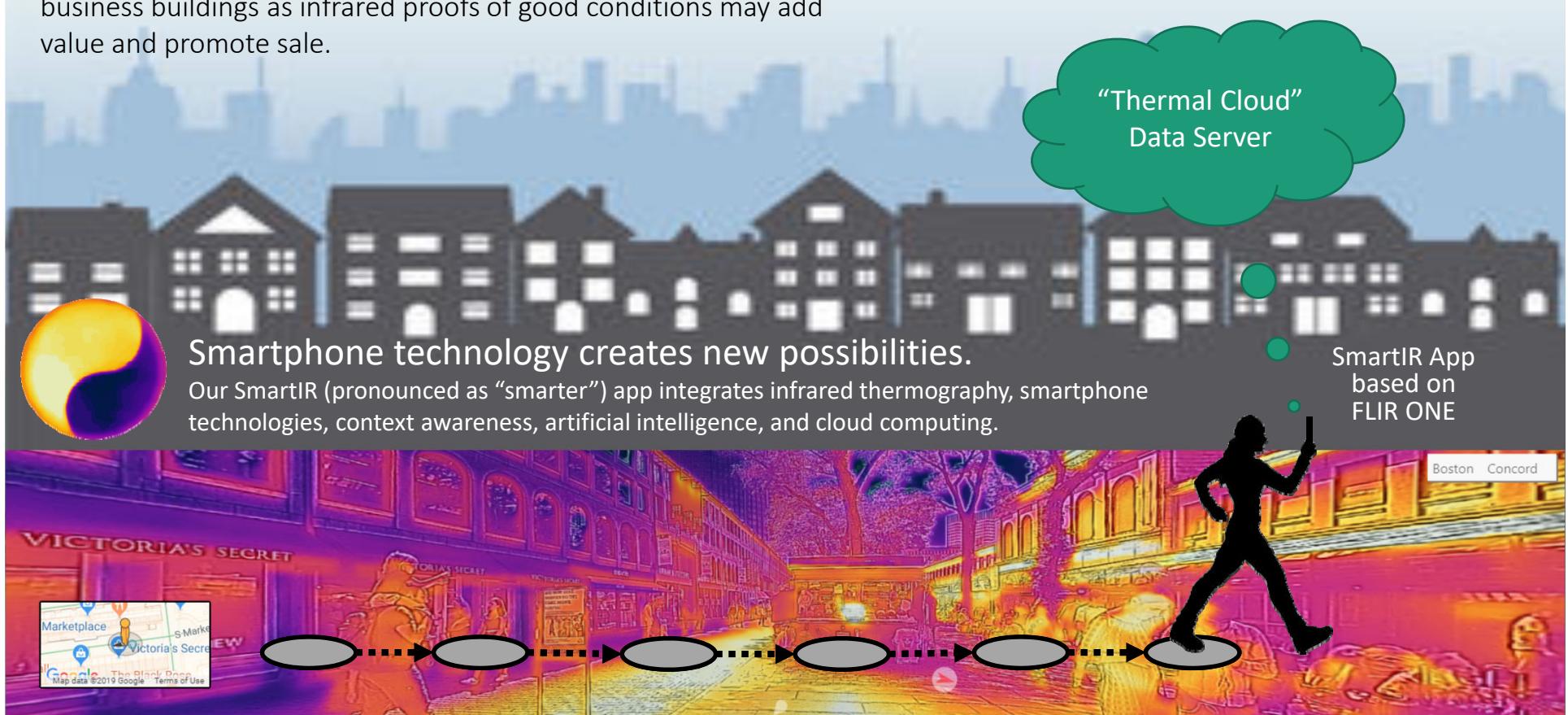
What problems are we trying to solve?

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.



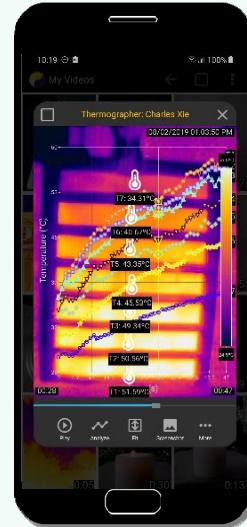
If we have the technology, then who will use it?

A new way

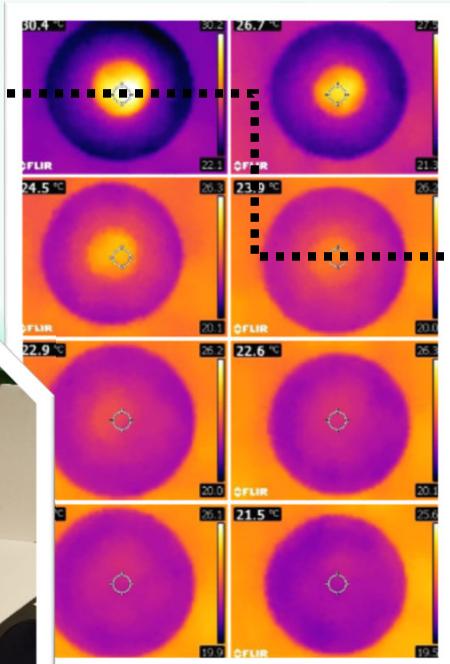
Based on new technology, our project aims to integrate energy efficiency, STEM education, and citizen science to make it possible to engage students to crowdsource an Infrared Street View, accomplishing something that would otherwise take a giant company like Google to do.

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.

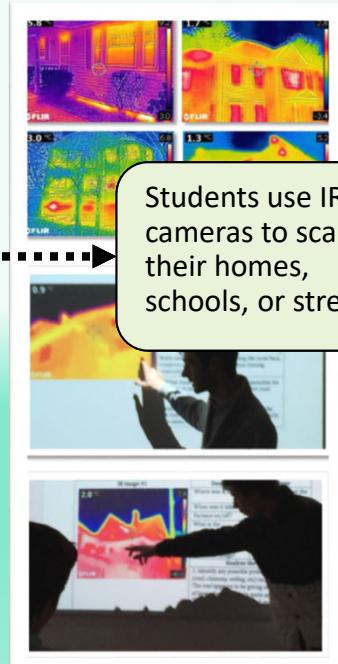


Students learn science concepts in classrooms with IR cameras.



An IR experiment to observe thermal equilibrium

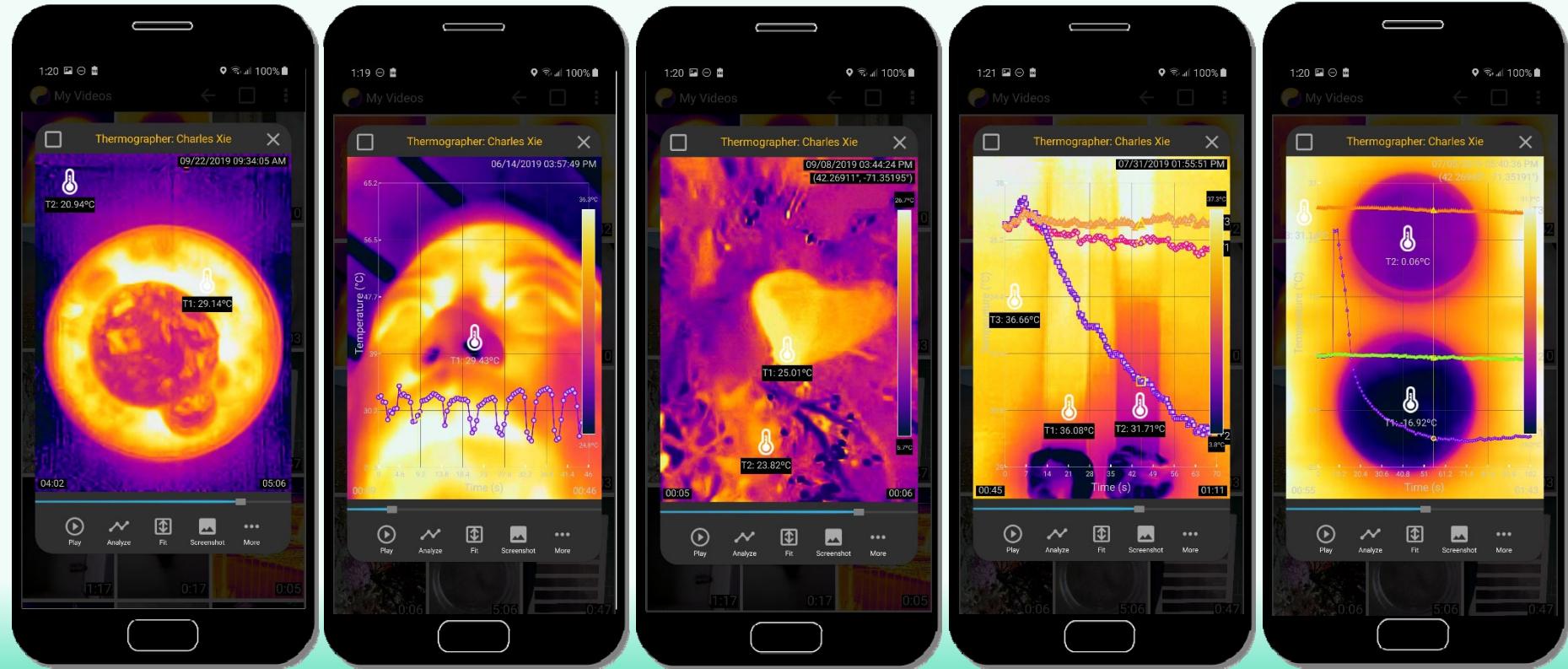
Students use IR cameras to scan their homes, schools, or streets.



Formal-informal pathways from school science to citizen science

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

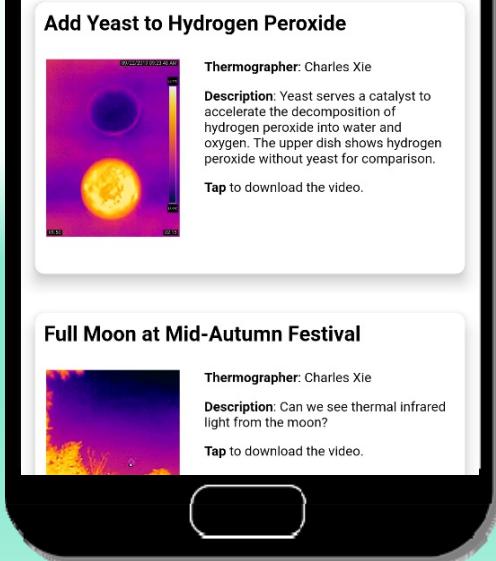
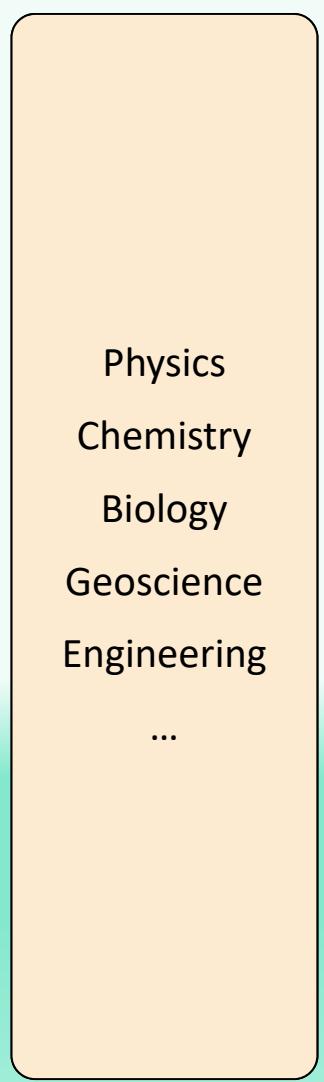
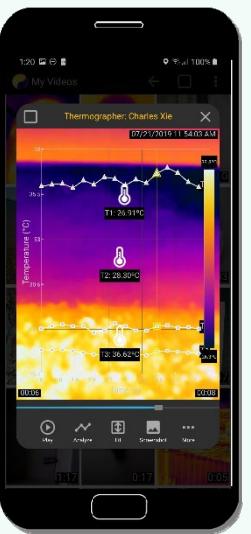
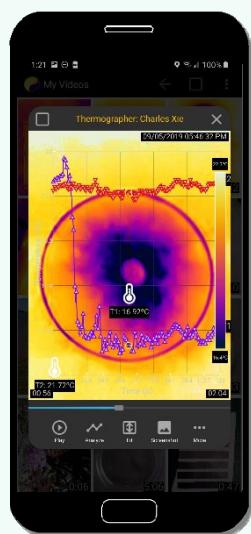
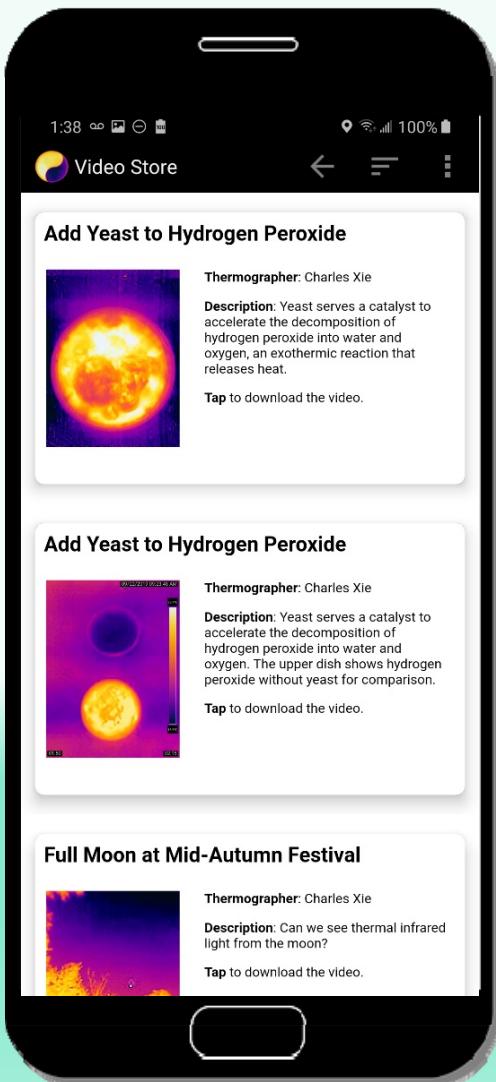
Incredible science through a thermal camera



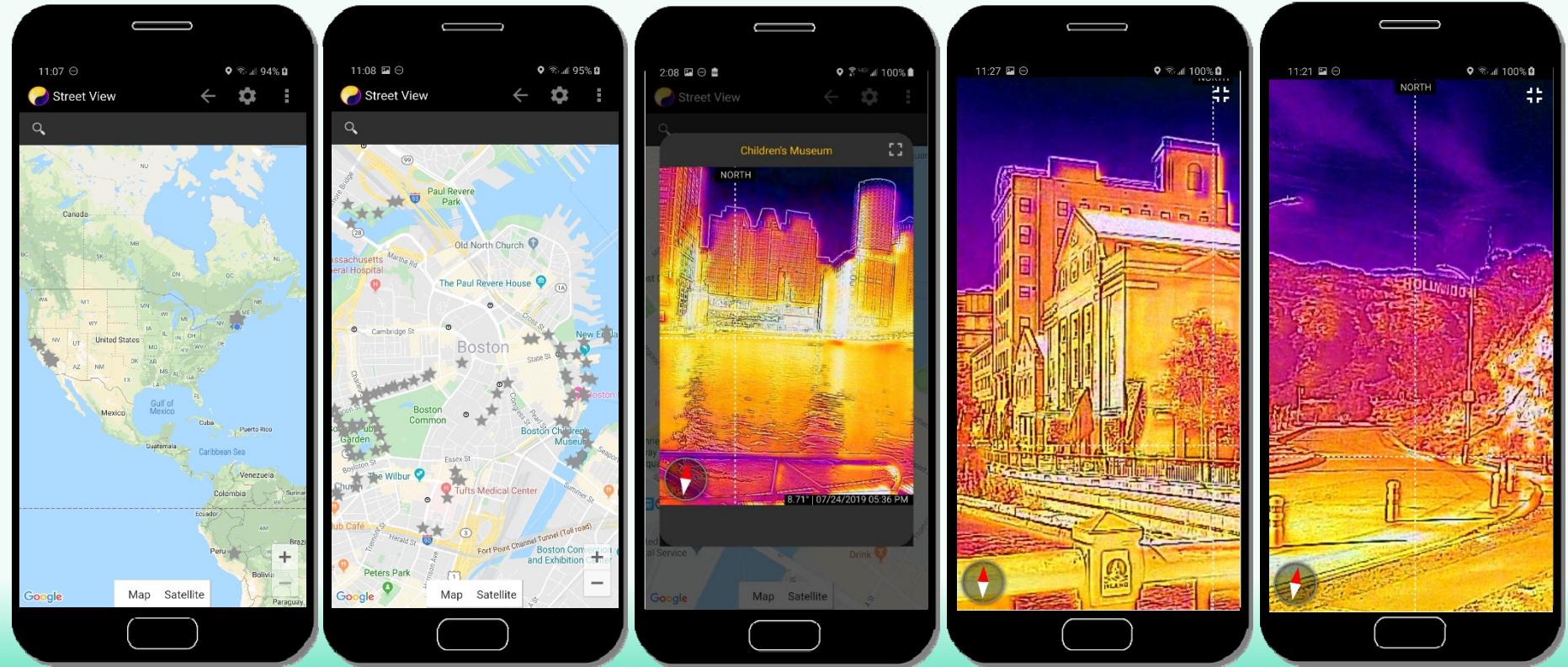
Anything that leaves a trace of heat leaves a trace of itself under a thermal camera.

"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

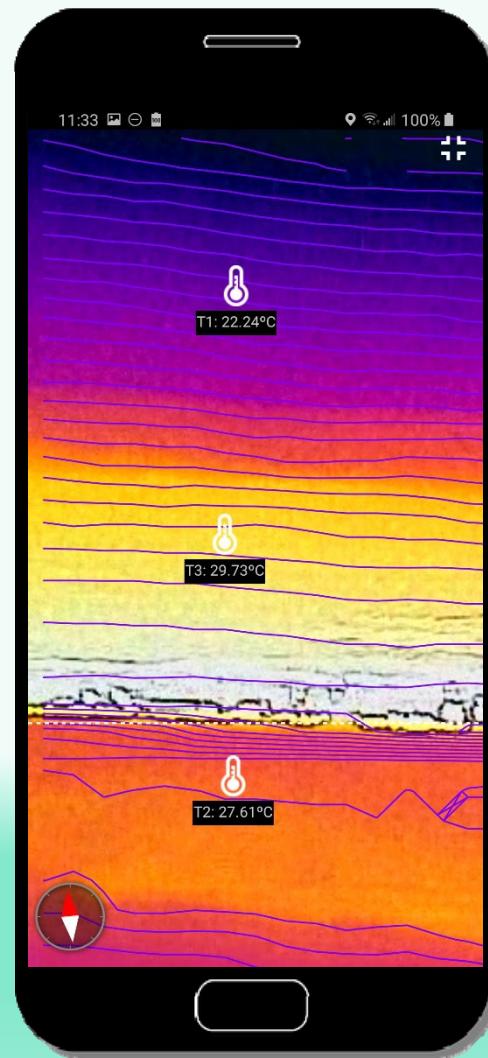
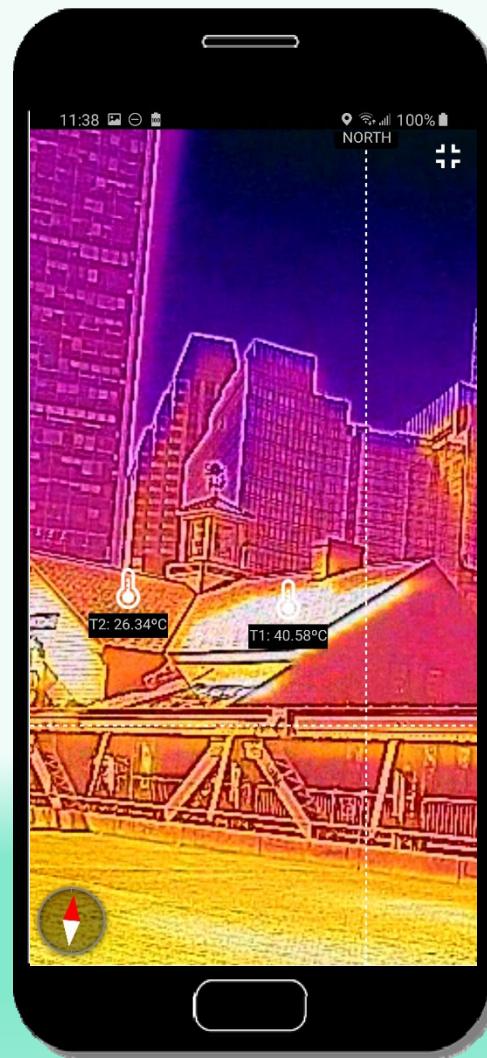


Experimental infrared street scans in multiple locations



East Coast, West Coast, South America
(Android version)

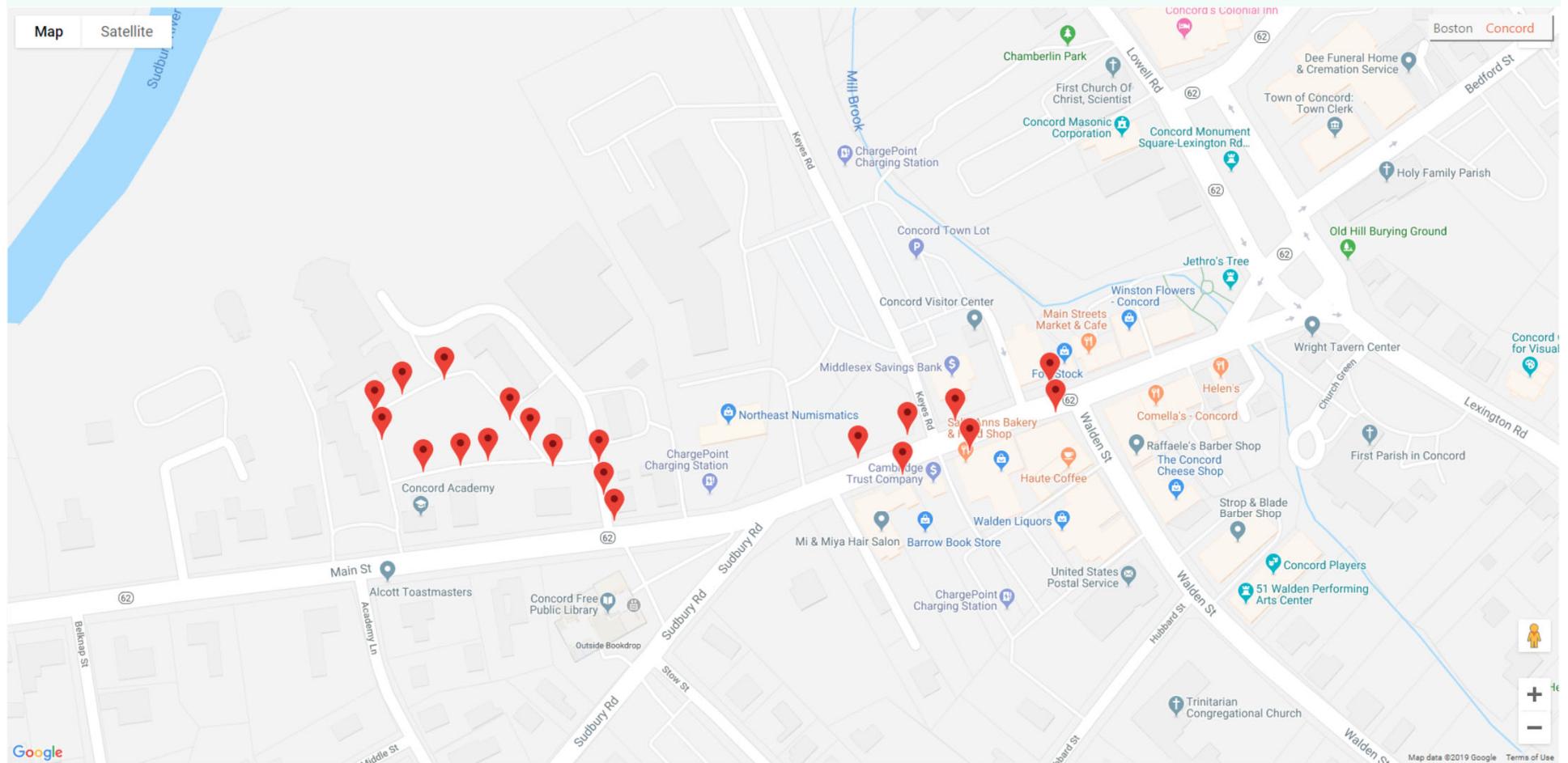
What can we see from infrared street views?



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

A Web-based version

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



2D markers in Google Maps

A Web-based version

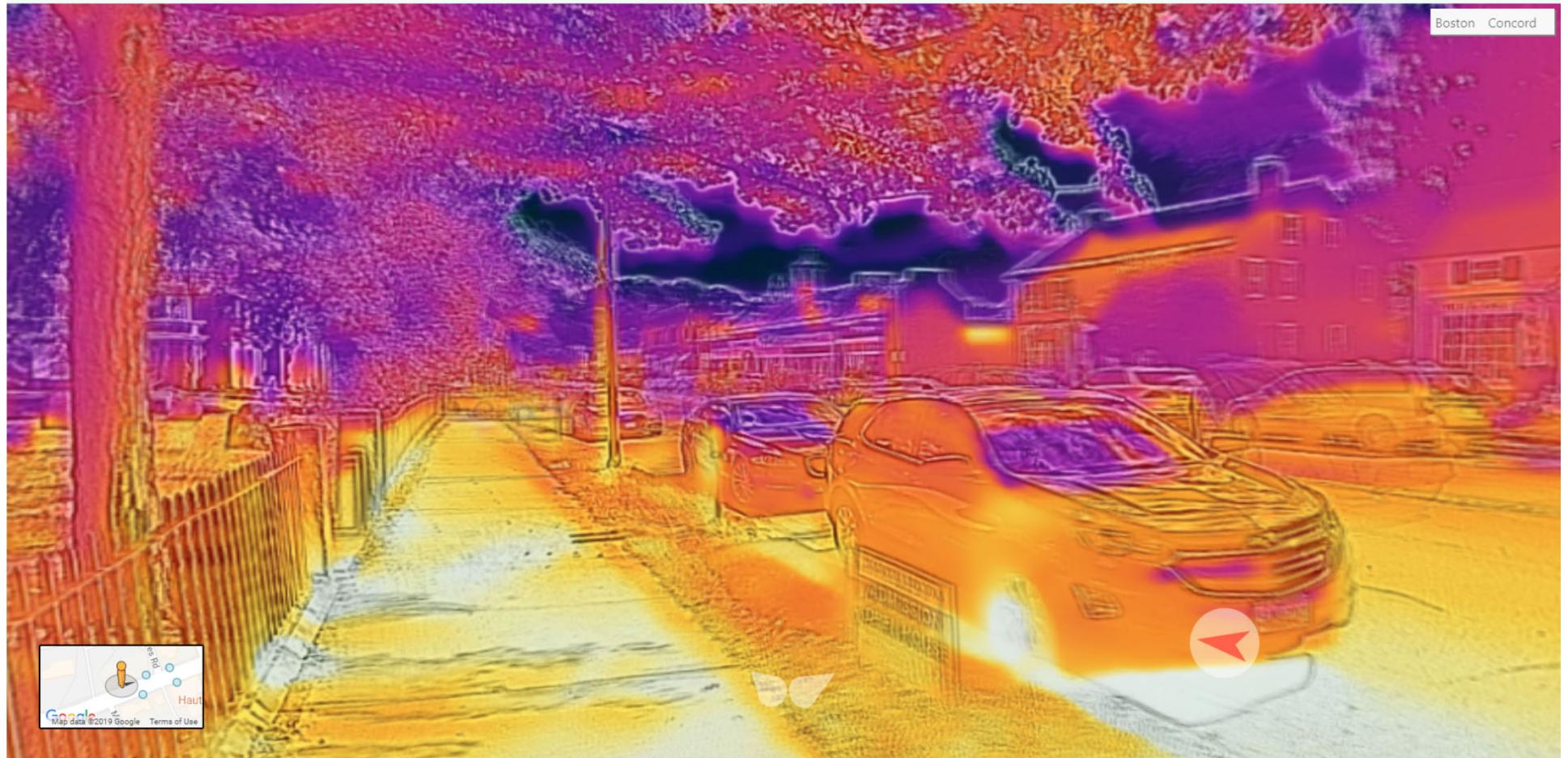
<http://energy.concord.org/irstreetview/>



3D markers in Google Street View

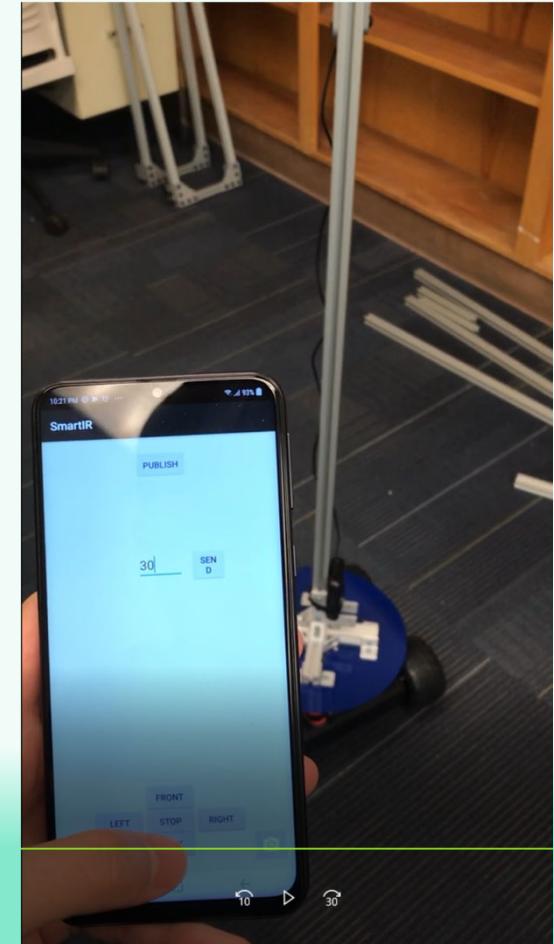
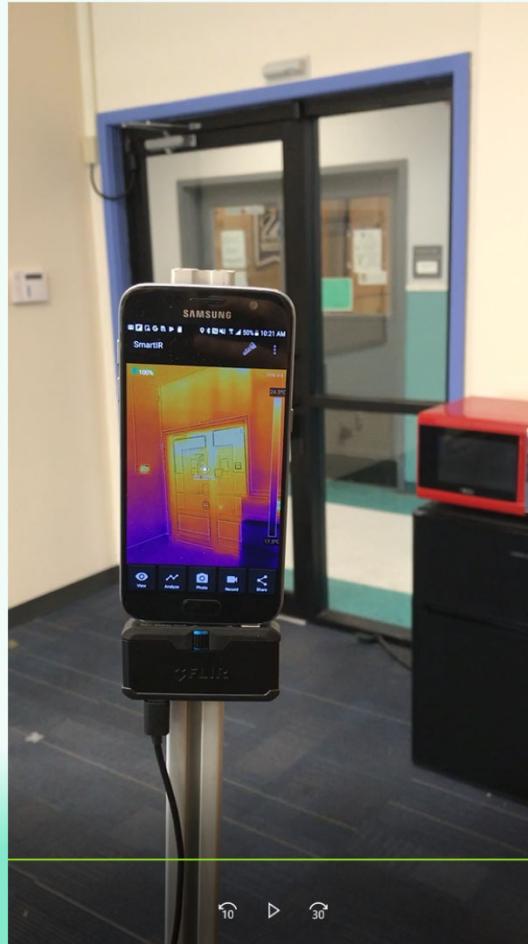
A Web-based version

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



Infrared Street View rendered with WebGL

A robot to automate thermal scanning for large-scale applications



Contracted to the Robotics and Locomotion Lab at the University of Massachusetts Lowell

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



Comparing our business model with previous ones

	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)

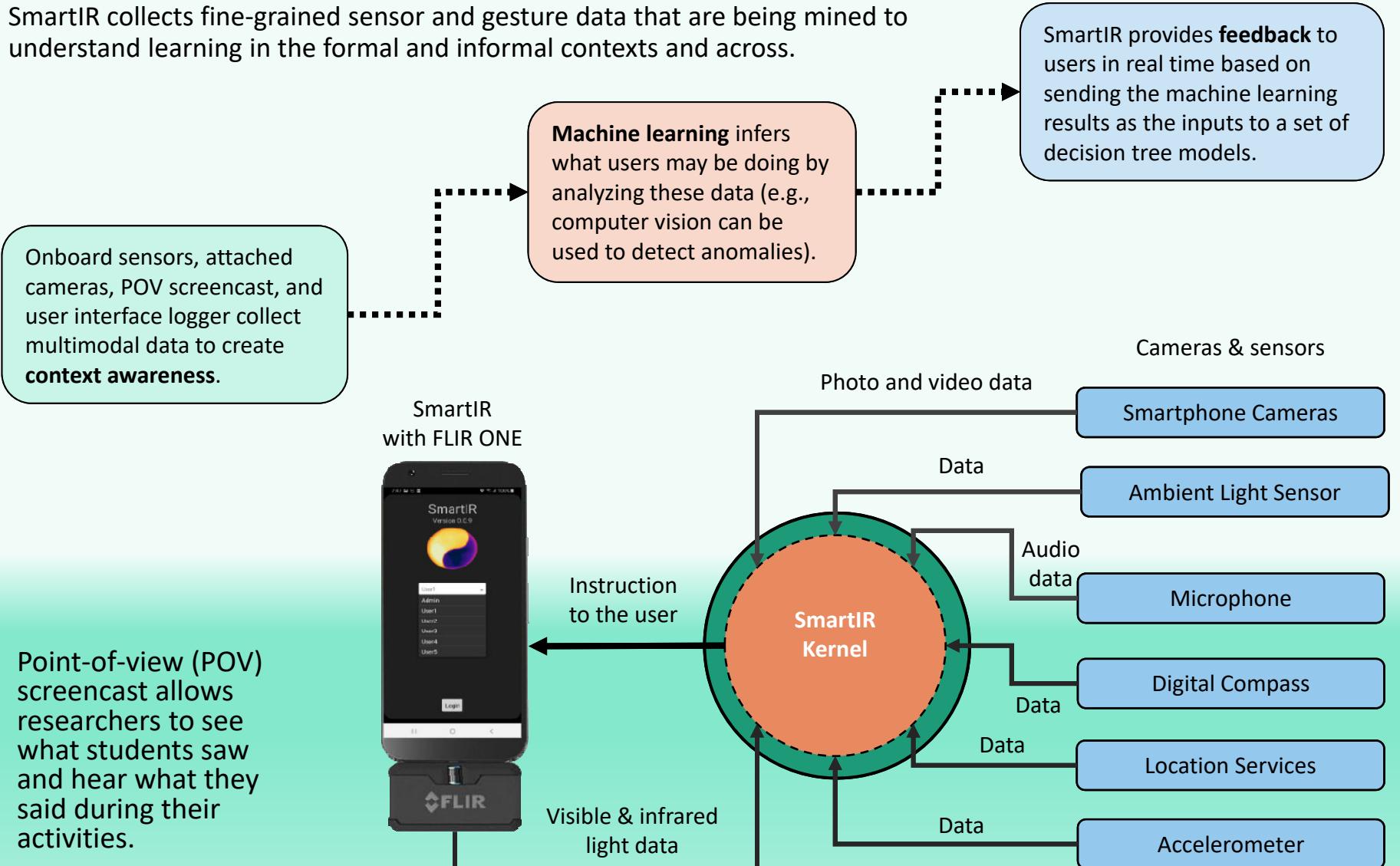


143 students in a local
high school, October 2019

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.



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: Thermal mapping

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*, ...

**Thank you very much for
your time!**