The Concord Consortium

A Non-Profit Educational Technology Developer

An App to Create Infrared Street View

Charles Xie, PhD
Senior Scientist
The Concord Consortium

CLEAResult Energy Forum, Austin, TX, 2016

Earlier Efforts

- Seeing infrared in maps, *MIT Technology Review*, 2010
- How to create thermal images for millions of homes, *MIT Technology Review*, 2013
- Mobile data collection is so thermal right now, Boston Globe, 10/2/2016

New Technology, New Opportunity

NEXT GENERATION SCIENCE STANDARDS
For States, By States

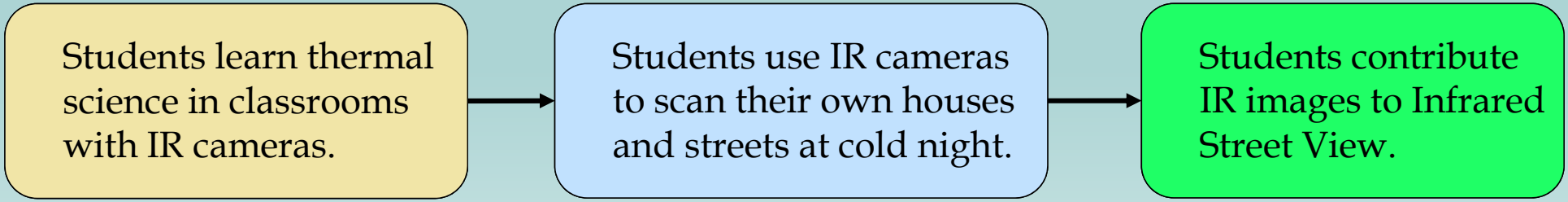
Affordable smartphone-based IR cameras make public participation feasible.

+

New standards call for energizing student learning through authentic science and engineering practices.

* In 2016, IR cameras have launched into educational market (FLIR, Vernier, Pasco, etc.).

An Education Pathway to Infrared Street View

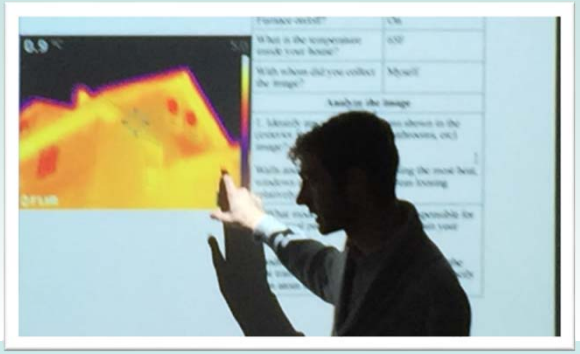


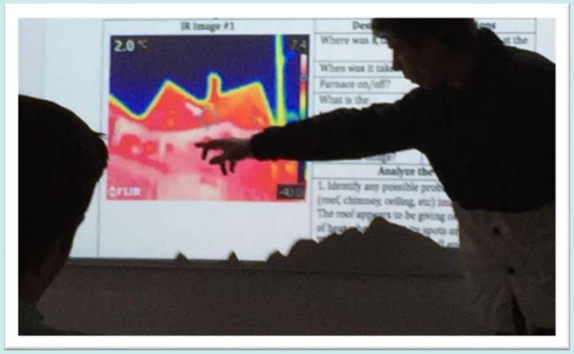
Comparing our approach with previous ones

	Our Approach	Previous Approaches
Strategy	Start with the education of students who may be able to motivate homeowners	Start with IR images
Scalability	Engage a large number of student volunteers (**citizen science** and **crowdsourcing**)	Drive-by trucks or fly-by aircrafts
Holism	Take images of buildings from 360°	Front or aerial images
Appeal	Use virtual reality (VR) to enhance visual effects	2D images
Privacy	Students scan their *own* houses and neighbors' and publish images only when permitted by homeowners	Unsolicited scans may be illegal

Five Reasons Why Students Would Love It

- **A better way to learn.** Everyone learns thermal science in school. IR home inspection is perfect homework.
- **Curiosity.** Students are intrigued by the novel IR view of what surrounds them.
- **Save money**. Students may find problems in building envelopes that are wasting their families' money.
- **Peer effect in social networks**. One student's IR street view may spur another to follow.
- **Industry incentives**. Companies can provide recognitions to encourage participation.





Student reactions

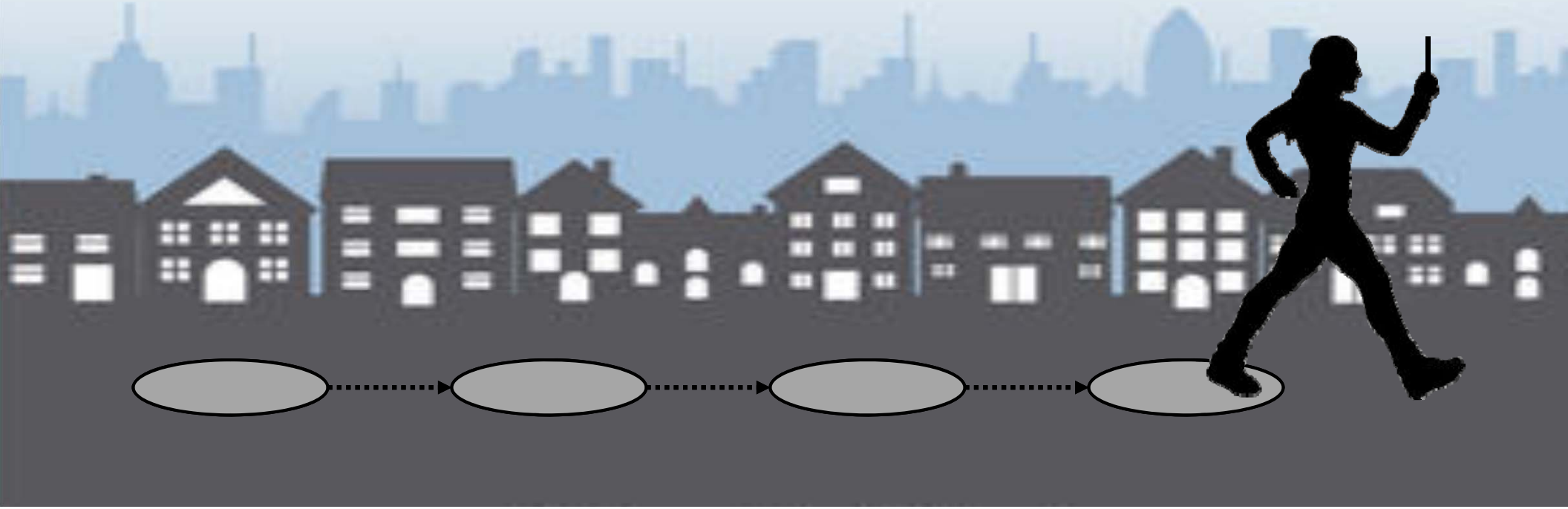
"It felt as if I was getting some amazing experience that professionals do and I am only in high school."

"It really helped me understand the material I was learning and it may also save my family a lot of money."

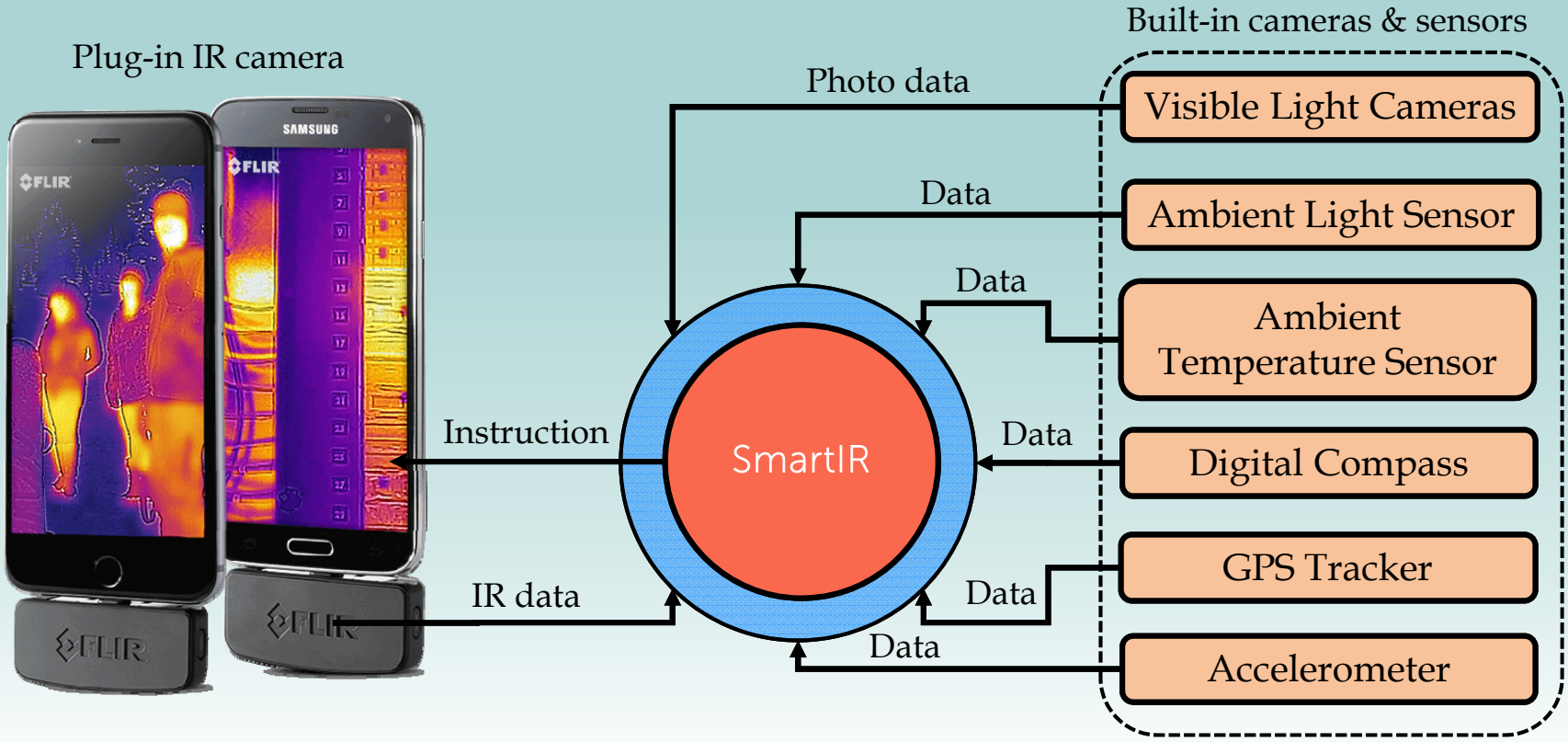
"I found it particularly interesting to examine the energy efficiency of my home and see the application of thermodynamics in a real world environment."

Our Innovation: The SmartIR App

- **Simple user interface** allows users to create IR street views and upload them to a server.
- **Sensor-based intelligence** walks novices through thermography to avoid common mistakes and get the job done.
- **Virtual infrared reality (VIR) technology** enables users to create virtual reality content based on IR images. VIR immerses users as if they acquired *true thermal vision*!
- **Cloud-based computation** processes IR images to create seamless IR street views in Google Maps (e.g., rescale heat maps to ensure identical temperature range across images).



Highlight #1:
Just-In-Time Instruction to Guide Users

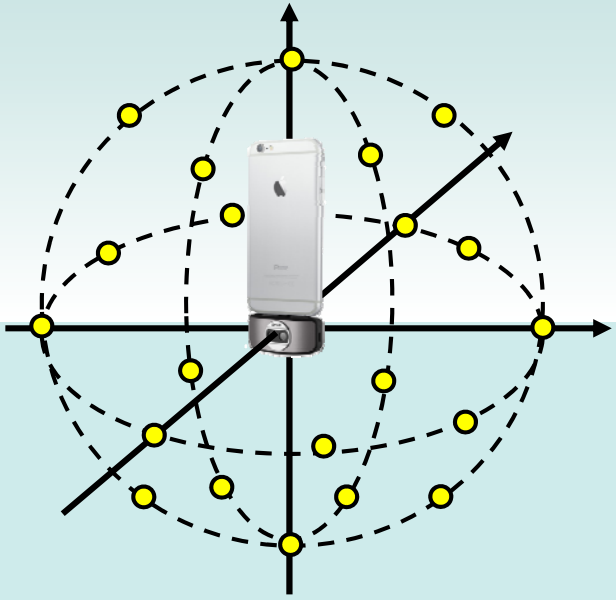


How it works: 1) Sensors and cameras collect multiple sources of data; 2) machine learning infers what users may be doing by analyzing these data; and 3) SmartIR guides users in real time based on the results.

Simple examples: Use phone clock and/or ambient light sensor to accept only nighttime images; use weather data and/or ambient temperature sensor to detect indoor-outdoor temperature difference; use motion sensors to check if the IR camera is still enough for taking quality images.

Highlight #2:
True Thermal Vision in Virtual Infrared Reality

How it works: 1) Based on using the orientation sensor to detect the direction of the IR camera, SmartIR shows dots on the screen that prompt users to aim at and then take snapshots; 2) the snapshots are knit by the app to create 360° panoramic VIR view ("thermogram sphere"); and 3) a VIR for a location is tagged with GPS coordinates and becomes available in Google Maps.



The dot array guides users to follow the trace to create a thermogram sphere.

Can VIR be better than 2D IR images in promoting the energy efficiency business?

Our Team

Multidisciplinary expertise and track records in thermal science, infrared thermography, software engineering, cleantech business, curriculum development, educational research, dissemination, and fund raising.

We have published five papers on IR imaging and have created three science apps in the areas of nanotech, heat transfer, and solar energy that have 1M+ users in total.

- Dr. Jie Chao, Learning Scientist, Researcher
- Joyce Massicotte, Home Energy Advisor and Project Manager
- Dr. Saeid Nourian, Computer Scientist, Developer
- Dr. Corey Schimpf, Learning Scientist, Postdoc Researcher
- Dr. Charles Xie, Computational Physicist, Lead & Developer

Thank you for your time!