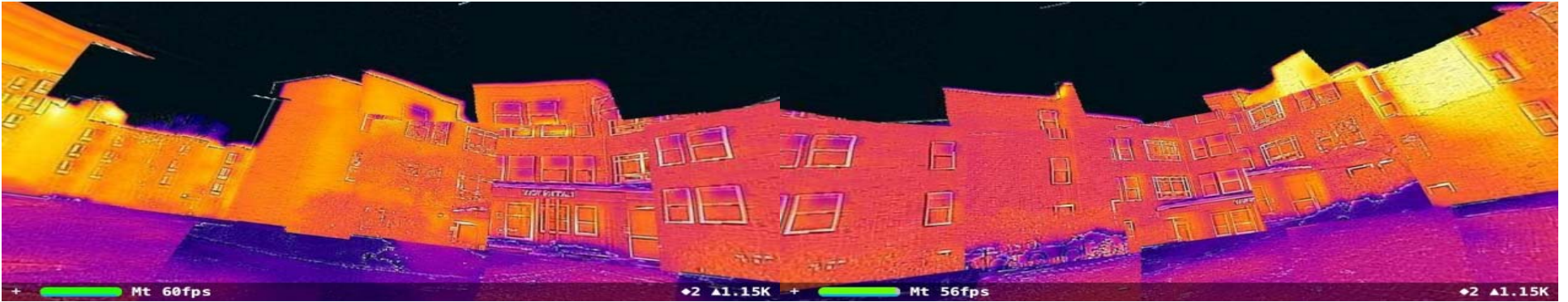


Crowdsourcing an Infrared Street View with the SmartIR App



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The Concord Consortium

An award-winning project

* *National Science Foundation grant* [#1712676](#)

* *U.S. Department of Energy (Winner of the 2016 JUMP Smartphone Innovation Challenge)*

Phase I: Prototype development, 2016-2017 (no funding)

Phase II: Full development, 2018-2019 (\$500,000 from NSF)



What problem 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 an IR 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 triggers large-scale changes. For instance, people may be more inclined to 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 projects 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.

Smartphone technology creates exciting new possibilities.

Our SmartIR (pronounced as “smarter”) app integrates infrared thermography, smartphone technologies, context awareness, artificial intelligence, and cloud computing.

“Thermal Cloud”
Data Server

SmartIR App
based on
FLIR ONE



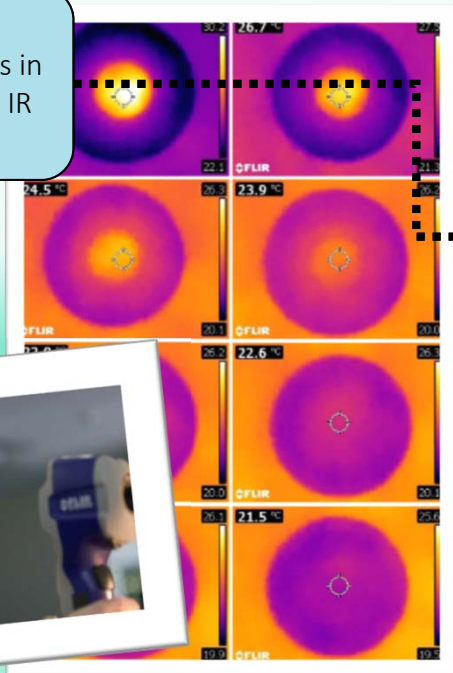
If we have the technology, then who will use it?

A new business model

Based on the SmartIR technology, our innovative business model aims to integrate energy efficiency, STEM education, and citizen science to make it possible to engage millions to crowdsource an Infrared Street View, accomplishing something that would otherwise take a large company like Google to do.

Students learn science concepts in classrooms with IR cameras.

Right: An IR experiment to observe thermal equilibrium

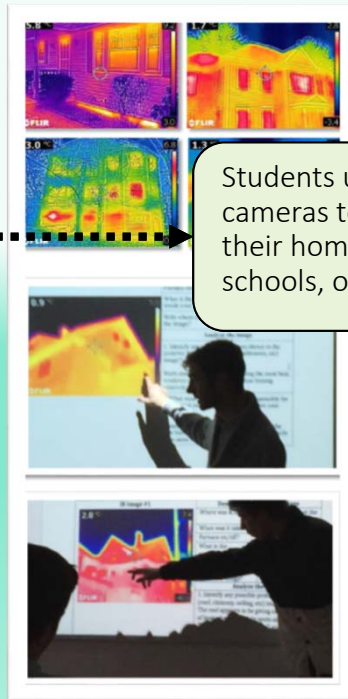


IR cameras to physical science education can be as instrumental as microscopes to biology education

Everyone has to learn heat and temperature in school. There is no better tool for teaching thermal energy transfer than an IR camera and there is no better real-world application than inspecting students' own homes.

Nothing tends so much to the advancement of knowledge as the application of a new instrument.

– Sir Humphry Davy (1778 - 1829), a British chemist who discovered five chemical elements



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



Workbench thermal imaging to examine the absorption of light energy by different colors printed on a piece of paper

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

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

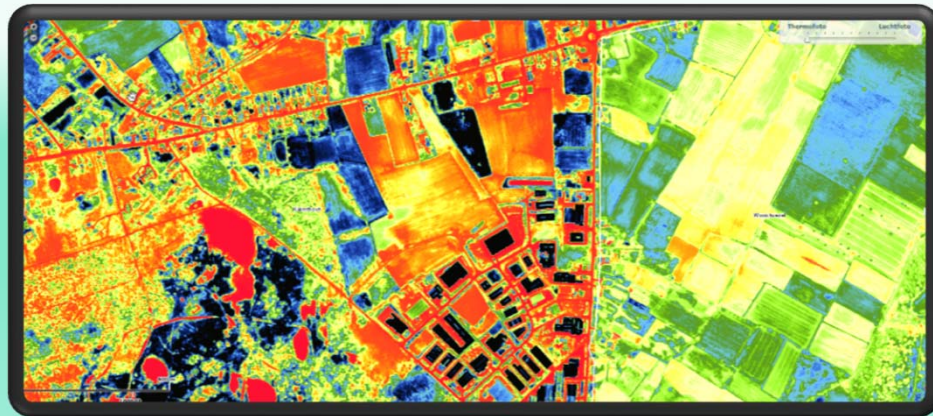
If we collect tons of IR images, then what?

Create an Internet spectacle

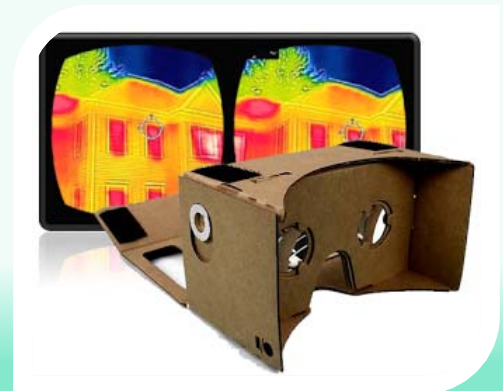
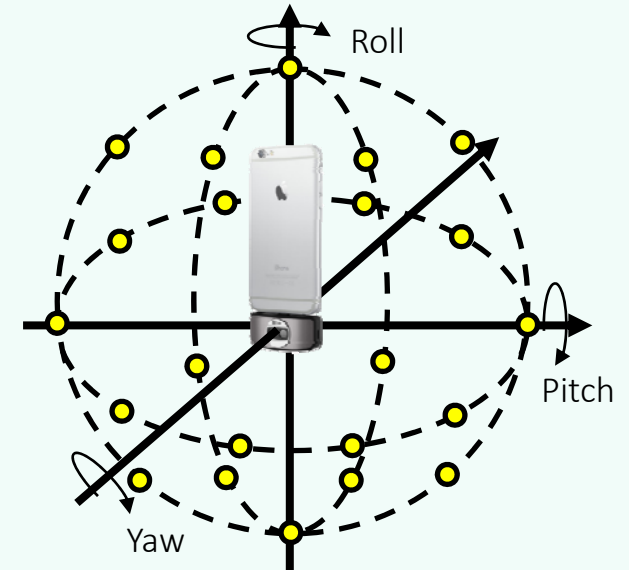
We are inventing a virtual infrared reality (VIR) technology that seamlessly stitches 360° infrared images (stereoscopic or not) to bring unforgettable viewer experiences to the public through the Internet and also allows anyone to create such content on their own using our SmartIR app.

Create an thermographic information system (TIS)

Geotagged and timestamped thermal data are aggregated to create TIS (x, y, z, T, t) , a geographic information system GIS $(x, y, z, *)$ augmented by temperature data (T) from different times (t) . TIS provides data visualization and analytics to reveal energy use at micro, meso, and macro scales.



A heat map of city scale



Marketing through a curiosity hook

What would the world look like if we could only see thermal infrared light?



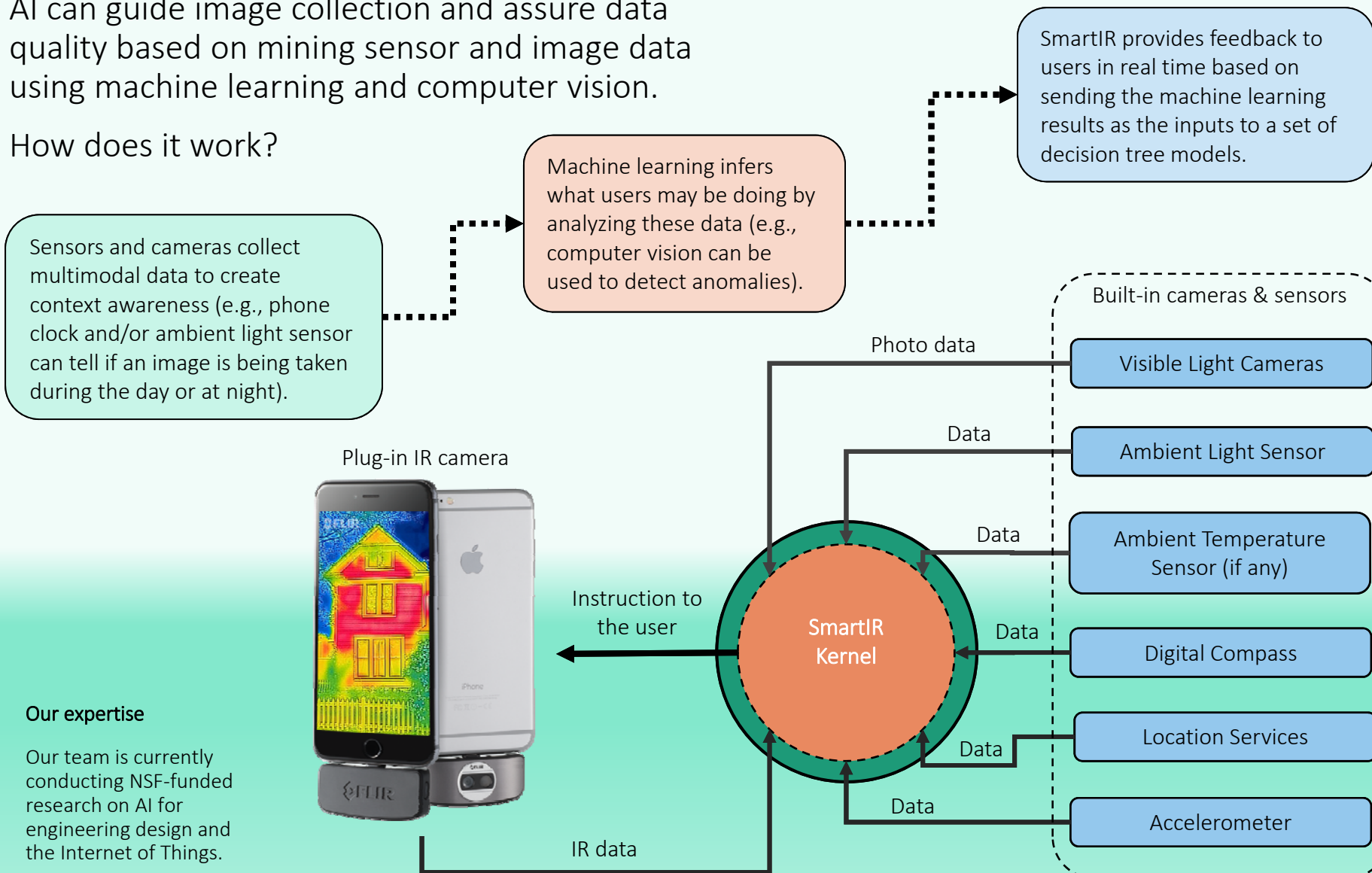
[YouTube](#)

How can we get good data?

Artificial intelligence to help

AI can guide image collection and assure data quality based on mining sensor and image data using machine learning and computer vision.

How does it work?



Our expertise

Our team is currently conducting NSF-funded research on AI for engineering design and the Internet of Things.

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 <i>own</i> 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)

Our expertise

We are a multidisciplinary team of scientists, engineers, and educators who work at the interface between STEM education and energy industry. Most importantly, to the best of our knowledge, we may currently be the only team that is still actively pursuing the vision of the Infrared Street View!

