Datasheet - Programming & Sensors

Use of thermal cameras for insulation analysis

Why use a thermal camera?

A thermal imaging camera is a useful tool for identifying areas of heat loss in buildings. By capturing infrared images, it highlights temperature differences across the surface of walls, windows, or roofs. This information helps identify weak points in insulation, such as thermal bridges, air infiltration, or degraded materials, which are often invisible to the naked eye.

How does a thermal camera work?

Thermal imaging cameras detect infrared radiation emitted by objects based on their temperature. They translate this radiation into a false-color image, where each hue corresponds to a given temperature range: Red/Yellow: indicate warmer areas, often associated with heat loss - Blue/Purple: indicate colder areas, which may indicate air infiltration or insufficient insulation.

Students can analyze these images to interpret observed thermal variations and identify areas requiring improvement.

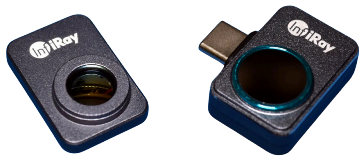
Steps to Effectively Using a Thermal Camera

- Preparation: Make sure the thermal camera is properly calibrated. Choose a time when the temperature difference between indoors and outdoors is significant, such as a cold winter morning or a warm summer afternoon.
- Image Capture: Scan walls, windows, doors, and roofs. Hold the camera steady and maintain a constant distance from the surfaces being viewed.
- Avoid pointing the camera directly at heat sources (radiators, electronic devices), as this can interfere with readings.
- Image Analysis: Look for red or yellow areas on exterior walls, often associated with heat loss. Identify blue areas near windows or doors, which may indicate air infiltration.
- Documenting Observations: For each image, note the location, environmental conditions (outdoor temperature, weather), and relevant comments. If improvements were made, compare the before and after images to observe the changes.

Tips and Precautions

Weather conditions strongly influence the quality of the readings. It is best to avoid capturing images in direct sunlight or strong winds, as these factors can distort the measurements. When shooting, it is recommended to keep the camera perpendicular to the observed surface to limit distortion. Indoors, hot light sources that may interfere with infrared readings should be minimized. Regarding the accuracy of the displayed temperatures, it is important to keep in mind that a thermal camera is primarily designed to detect temperature differences (hot or cold spots), but it does not provide a reliable absolute measurement. Several factors can influence the accuracy: the emissivity setting (the emission coefficient must correspond to the nature of the surface being measured), the distance between the object and the camera, the ambient temperature and the thermal difference between the environment and the device itself, the quality of the lens used, and the selected measuring range (wide range or high resolution).

Choosing the right thermal camera



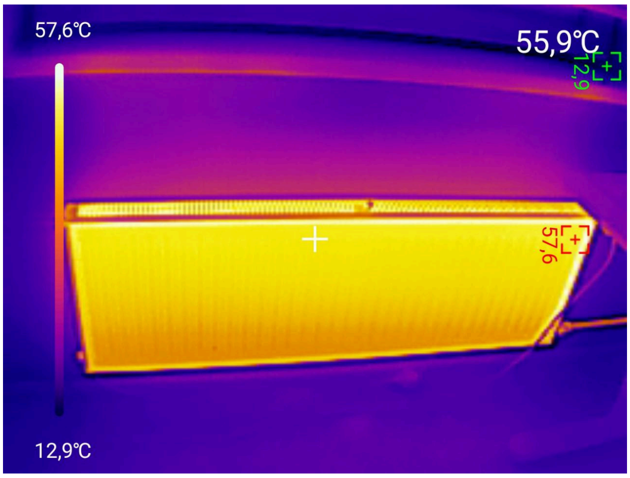
Choosing a thermal imaging camera for this activity depends on the resources available to the teacher and the school. Thermal imaging cameras vary greatly in terms of cost, features, and portability. Teachers are encouraged to explore local solutions, such as borrowing devices from local governments, environmental organizations, or universities. Many cities offer thermal imaging equipment loan programs, allowing students to limit their costs while still gaining access to powerful tools.

For schools looking for affordable and accessible options, smartphone-compatible thermal imaging cameras, such as the Infiray P2 Pro, are a practical solution. These compact devices connect directly to an Android smartphone, transforming it into a thermal imaging tool. They are easy to use, and their portable design makes them ideal for educational settings. While they lack the advanced features of standalone thermal imaging cameras, these devices effectively meet the needs of educational activities where ease of use and mobility are important criteria.

Thermal Data Visualization: Sample Images

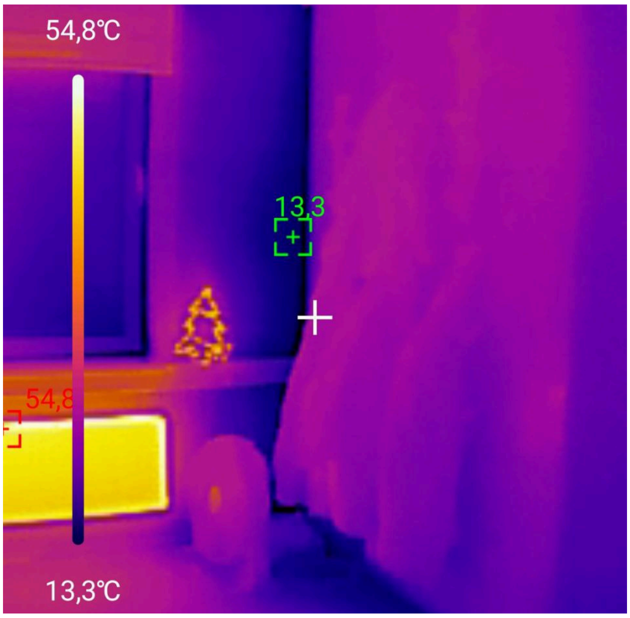
Below are examples of real thermal images. They illustrate common situations: thermal bridges, air infiltration or heat loss through walls and windows.

Radiator and surrounding wall



- Description: This image shows a radiator acting as a localized heat source, with temperatures above 55°C, while the surrounding wall remains significantly cooler. It highlights significant thermal concentration, which can reveal inefficiencies in heat distribution within the room.
- Key point: This type of image allows you to assess whether the insulation around the radiator is sufficient or whether heat loss is occurring through adjacent walls.

Heat loss through windows

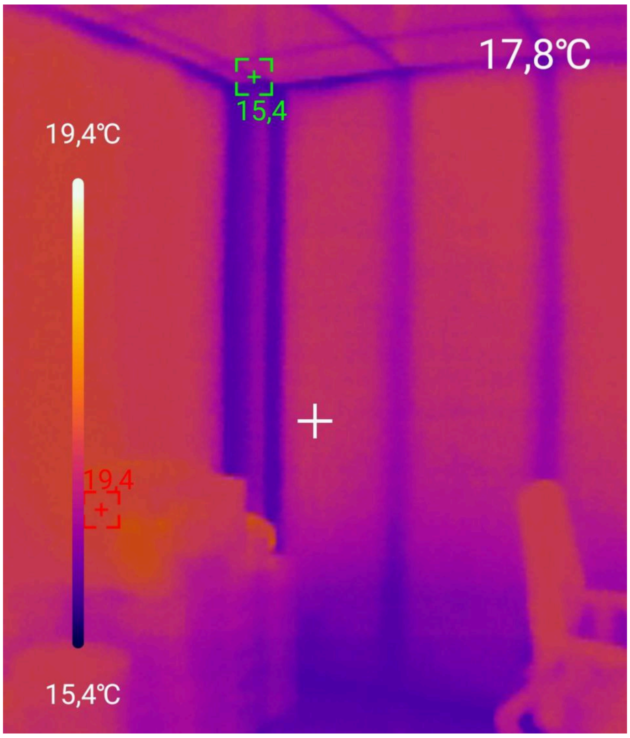


- Description: A thermal image of a window shows significant temperature differences. Bright areas, above 54°C, indicate significant heat loss from the window frame and wall corner.
- Key point: This observation highlights the importance of good caulking and double-glazed windows to limit heat loss.

Stairwell with thermal bridges

- Description: In this thermal image of the stairwell, thermal bridges are clearly visible near the ceiling and door frames, with temperatures ranging from 22°C to 11°C. These variations indicate insufficient insulation at structural junctions. The entire stairwell is low in temperature, making it likely an area of significant heat loss.
- Key point: Identifying thermal bridges allows you to target insulation interventions to improve the building's energy efficiency.

Cold spots in a room



- Description: This thermal image of a room reveals cold areas, around 15°C, along the ceiling corners, and warmer areas, around 19°C, near the furniture. This distribution suggests uneven heating, possibly related to partial or ineffective insulation.
- Key point: Analyzing these variations helps identify locations where additional insulation or better distributed ventilation could be considered.

Practical Guide: Using the Infiray P2 Pro for Thermal Analysis

The Infiray P2 Pro is a compact thermal imaging camera designed for Android smartphones. Its simple interface and portability make it ideal for educational activities related to thermal insulation and energy efficiency. Below is a detailed guide on how to use it effectively for thermal analysis.

Getting started with the Infiray P2 Pro.

Before attempting any thermal imaging activity, it's important to check that the Infiray P2 Pro is compatible with the device you intend to use. This camera connects via a USB-C port, so you'll need to make sure your smartphone has this type of connector and runs Android.

Start by downloading the Infiray app from the Google Play Store. This app provides access to all of the camera's thermal imaging features. Once the app is installed, connect the Infiray P2 Pro to your smartphone's USB-C port. Open the app to activate the camera, then follow the on-screen instructions to complete setup.

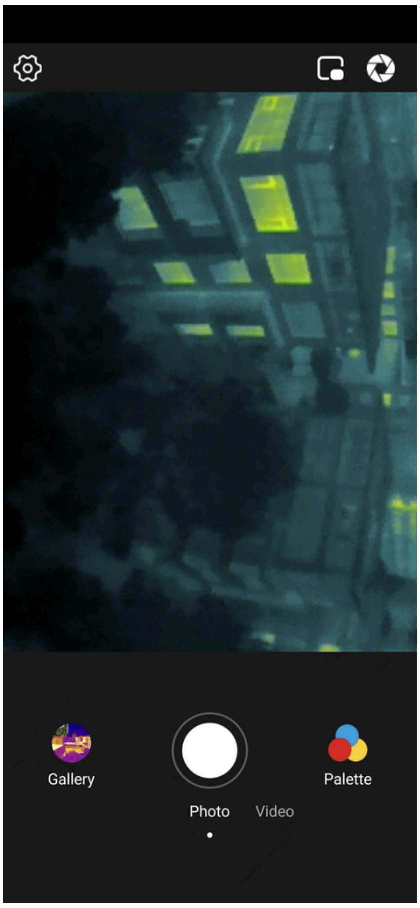
At this stage, it is recommended to perform a camera calibration, as the accuracy of temperature readings depends on correct adjustment.

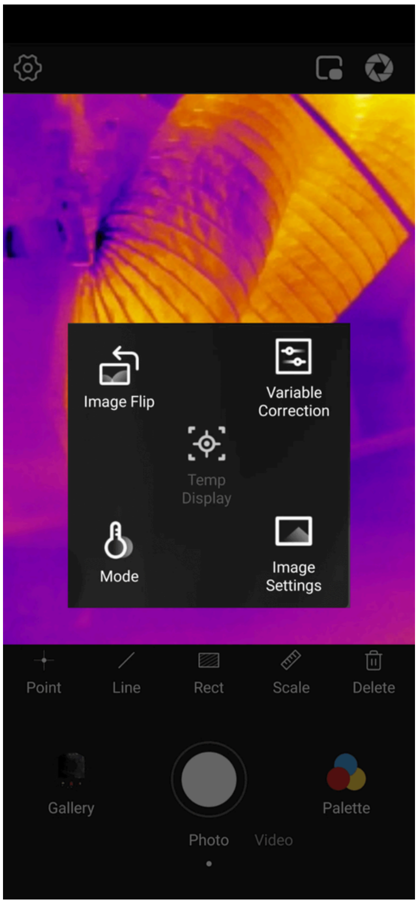
Camera setup for insulation analysis.

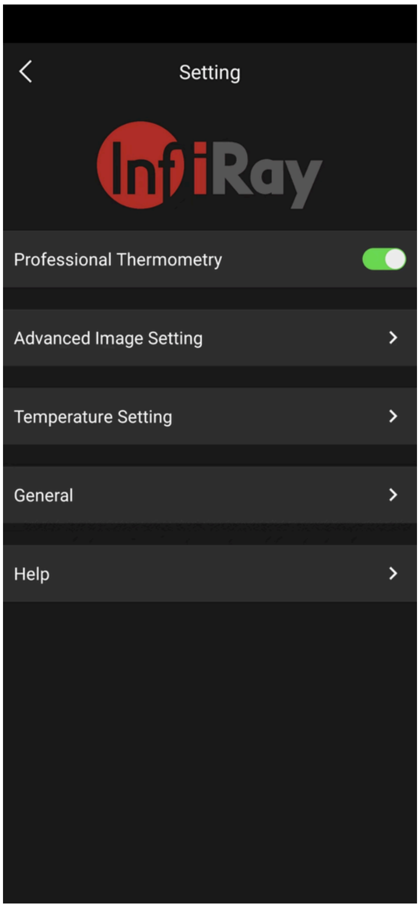
Thermal imaging requires precise setup to reliably highlight temperature differences. Once the camera is activated, it must be adapted to the environment being analyzed.

- Calibration: The app guides the user through this first step, which aligns the camera sensors with ambient conditions to ensure consistent readings.
- Temperature range: This should be adjusted according to the context. For an indoor environment, a range of -10°C to 40°C is generally appropriate. For outdoor analysis, particularly during winter or summer, a wider range may be necessary.
- Color palette: The choice of palette affects the readability of the thermal image. A palette like “Ironbow” is often used because it highlights hot areas in bright red and cold areas in blue, making it easier to identify thermal differences.

These parameters can be adjusted during the analysis, especially if conditions change.







Carrying out thermal inspections.

Once setup is complete, the Infiray P2 Pro can be used to inspect different areas of a building to identify potential heat loss.

Start by observing the walls and windows. Look for hot spots—often represented in red or yellow depending on the color scheme chosen—on the walls, which can indicate a heat leak. Around windows, colder areas may indicate drafts or insufficient insulation.

Continue the analysis by focusing on roofs and doors, which are also common points of heat loss. Pay particular attention to junctions between materials, such as door frames or roof joints, where thermal bridges can occur.

The application allows you to select a specific point on the image to obtain the corresponding temperature. This function is useful for measuring thermal differences on the same surface and documenting the observed heat transfer patterns.

Document observations.

Thermal imaging is all the more relevant when the data collected is well structured. Once the images have been captured, it is essential to document them rigorously to enable effective subsequent analysis.

- Image annotation: For each thermal image, note the precise location, environmental conditions (such as outside temperature or wind speed), and observations made at the time the image was taken.
- Comparing conditions: It is useful to capture images of the same location in different contexts—for example, before and after an insulation intervention—in order to visualize the evolution of thermal performance.

The Infiray application offers features to organize and classify data systematically, allowing you to keep a clear record of each reading without losing important information.

Analysis of the results.

After the inspection, it is important to analyze the collected data to draw relevant conclusions. Start by identifying recurring heat loss patterns in certain areas of the building, such as windows or poorly insulated walls. Identify the points where temperature differences are most marked. Then compare these observations with data from laboratory experiments conducted during previous insulation phases. This comparison allows you to assess the extent to which the observed thermal behaviors confirm the expected performance of certain materials. Finally, based on this analysis, suggest concrete measures to improve insulation: sealing gaps, adding insulating materials, replacing windows with more energy-efficient models.

Integration of the thermal camera into the activity

Thermal imaging cameras offer a visual yet scientifically rigorous approach to exploring the principles of heat transfer and insulation. Their use in the activity translates theoretical concepts into concrete observations, facilitating a better understanding of energy efficiency and sustainability issues.

Below you will find specific ways to integrate thermal imaging in a relevant way into the progress of the activity:

Guided exploration and demonstration.

Begin with a classroom demonstration of the thermal imaging camera to familiarize students with its operation in a controlled environment. For example, illustrate the temperature differences between a cup of hot water and a cold surface.

Compare surfaces made of different materials (metal, wood, foam) to highlight variations in thermal conductivity. This hands-on introduction helps students connect thermal imaging to fundamental science concepts.

Structured data collection

- *Indoor Analysis: Organize students into small groups to analyze different areas of the school building, such as walls, windows, and doors. Assign specific roles (camera operator, note-taker, data analyst) to ensure active participation from everyone.*
- *Outdoor Analysis: Extend the activity outdoors. Students can compare thermal emissions between walls exposed to the sun or shade, or observe the effects of wind and light on surface temperatures.*

Analyse comparative

- *Before/After Scenarios: Have students document the same location before and after an intervention (adding insulation, caulking a window, etc.). Comparing thermal images allows students to visualize the concrete impact of the actions taken.*

- *Material Comparison: Conduct controlled experiments to compare the performance of different insulating materials tested in the laboratory with observations made in the field. For example, students could evaluate a school wall against an experimentally insulated wall.*

Integration with other tools.

Combine thermal imaging with temperature and humidity sensors. This allows students to cross-reference thermal images with numerical data, providing a more comprehensive and accurate analysis of thermal variations.

Encourage critical thinking.

Organize group discussions where students interpret their results and reflect on their meaning. Ask questions such as:

- *Why do some areas show more heat loss?*
- *What external elements can influence the results (weather, materials, orientation)?*
- *Which interventions would be most effective and why?*

Invite students to discuss the limitations of thermal imaging, including its dependence on environmental conditions or the difficulties of interpretation in the absence of context.

Engaging Students Through Technology

- *Gamification: Turn the activity into a challenge: for example, “Identify the greatest heat loss” or “Design the best insulation solution.” Promote creativity and scientific reasoning.*
- *Use of digital tools: If the application associated with the thermal camera allows it, encourage the use of overlay or live annotation functions to enrich the images or videos produced and enhance the clarity of their analyses.*

By integrating thermal imaging into the activity, students develop both technical skills and a concrete understanding of the application of science to real-world problems. The activity becomes more dynamic, collaborative, and anchored in contemporary issues such as sustainable development and the energy transition.