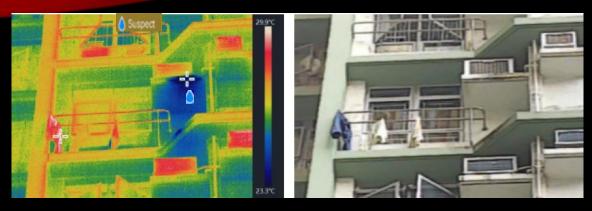# SMARTTHERM: REVOLUTIONIZING PUBLIC SERVICE INSPECTIONS
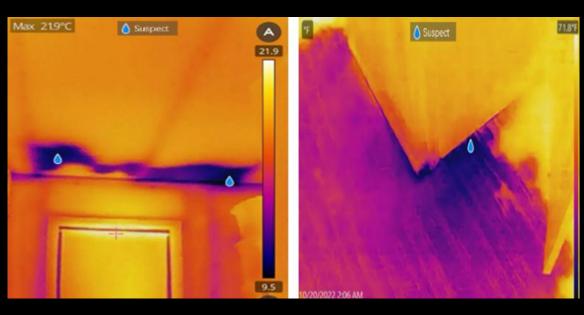
Advanced Thermal Imaging for Water, Insulation, Electrical, and PCB Diagnostics
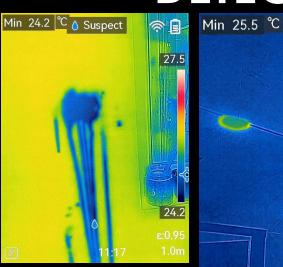
# WHAT IS SMARTTHERM

- SmartTherm is an advanced AI-driven thermal imaging solution developed to enhance public service operations by automating the detection of various anomalies across multiple applications. It integrates big data and thermal imaging technologies to provide precise, efficient, and user-friendly diagnostics.

- Purpose: Addresses key challenges in public services by identifying issues such as water dripping and seepage, insulation defects and electrical panel maintenance needs, enhancing safety, reliability, and cost-effectiveness.
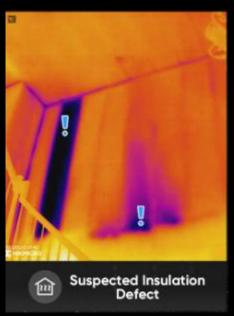
# WATER DRIPPING AND SEEPAGE DETECTION



**•Water Leak Detection**

The algorithm can detect common water leak scenarios such as roof leakage, pipe leakage, and bathtub leakage.

- **Working Principle**:
  - Water's high thermal conductivity and evaporation effect create cooler areas (1–5°C lower than surroundings), detectable as blue or purple spots in thermal.
  - The camera scans surfaces (walls, ceilings, floors), using deep learning to classify leaks into:
    - **Structural Anomalies**: Localized dripping (e.g., ceiling leaks).
    - **Water Pipe Leakage**: Broader seepage (e.g., floor or wall diffusion).
  - ΔT algorithms measure temperature differences, flagging anomalies.
- **Image Reference**: The provided image illustrates diverse leak scenarios (ceiling, wall, floor with/without carpet), with "Suspect" markers aiding AI-driven identification.
- **Process**: Scan area, AI processes thermal data, upscales images, and generates reports.
- **Public Service Example:** Detects a 1-5°C cooler spot in a public housing wall, indicating a pipe leak, preventing mold.

# INSULATION DEFECT DETECTION



Suspected Insulation Defect

•**Insulation Defect Detection**
Scene: The insulation efficiency of the house is reduced due to abnormal insulation layer or structure. It can identify wall, ceiling, and floor surfaces hidden behind drywall where insulation is missing, damaged, or improperly installed.

**Insulation Defect Detection**

- **Working Principle**:
    - Poor insulation allows heat transfer, creating temperature gradients (e.g., 3–10°C cooler in winter) detectable as blue or purple areas.
    - The camera maps thermal radiation across building surfaces, recognizing heat loss patterns via deep learning.
    - ΔT algorithms compare defective areas to insulated regions, triggering blue alerts.
- **Process**: Scan during temperature differentials (e.g., cold weather), AI flags defects, and upscales images for clarity.
- **Public Service Example**: Identifies a 5°C cooler area near a community center window, enabling insulation upgrades.

# ELECTRICAL PANEL MAINTENANCE INSPECTIONS

**Electrical Panel - Fuse Inspection**

AI dual-mode detection: Combines image recognition and ΔT algorithms to pinpoint overloaded/degraded fuses via absolute temperature alerts and relative differential warnings.
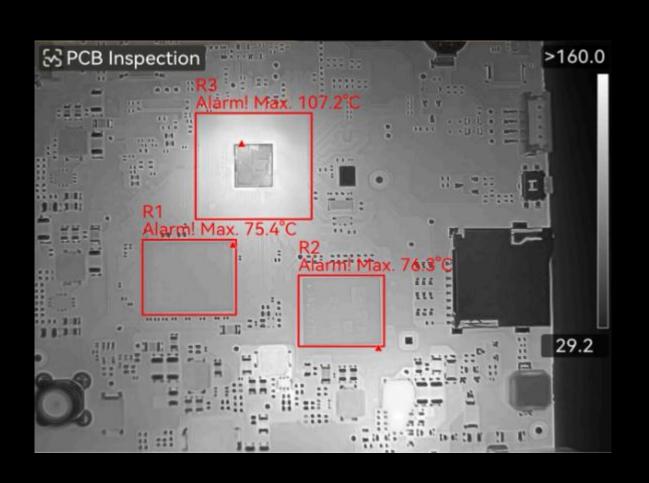
**Electrical Panel - Terminal Inspection**

Micro-temperature sensing: Detects 0.5°C variations from poor contacts using resistance-heat modeling.

**Electrical Panel Maintenance Inspections**

- **Working Principle**:
  - Electrical resistance (Joule's law: ( $P = I^2R$ )) causes hot spots in overloaded fuses or poor terminal contacts.
  - SmartTherm uses:
    - **AI Dual-Mode Detection**: Image recognition identifies components; ΔT algorithms detect absolute (e.g., >70°C) and relative (e.g., 10°C differential) anomalies.
    - **Micro-Temperature Sensing**: Detects 0.5°C variations in terminals using resistance-heat modeling.
  - Red alerts flag faults, with upscaled images showing precise locations.
- **Process**: Scan panel during operation, AI processes data, and generates reports.
- **Public Service Example**: Detects a hotter fuse in an electrical panel, preventing an outage.

# PCB INSPECTIONS



**PCB Inspection**
Pre-configured templates + AI calibration enable batch screening of components (ICs, resistors/capacitors) to identify shorts, cold joints, and overloads.
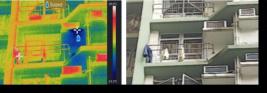
**Advanced capabilities:**
•10-zone templates per PCB (e.g., power modules, signal areas).
•Differentiates normal/abnormal heating via copper-layer thermal conduction models.
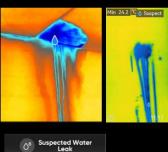•Setup efficiency: Reduces new PCB calibration from 30+ minutes to ≤5 minutes through template reuse.
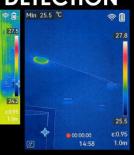
- **PCB Inspections**: **Working Principle**:
  - Defective PCB components (e.g., short circuits, cold solder joints) generate abnormal heat patterns due to increased resistance or poor thermal conduction. For example, a short circuit produces a hot spot, while a cold joint may show uneven heat distribution.
  - The thermal camera captures infrared radiation to create a temperature map of the PCB surface.
  - SmartTherm uses **micro-temperature sensing** to detect $0.5°C$ variations, employing resistance-heat modeling to predict heat patterns based on current flow and material properties.
  - Deep learning identifies specific components (e.g., chips, solder joints) and flags anomalies like overheating or insufficient heat transfer.
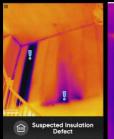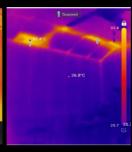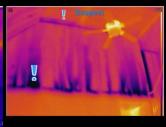
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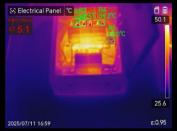
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# SmartTherm

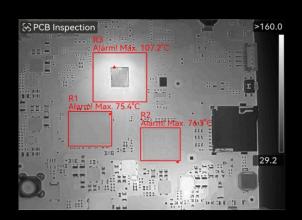# ELECTRICAL PANEL MAINTENANCE INSPECTIONS



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