

Thermal Imaging Applied to Building Pathology Documentation: An Initial Modeling Approach



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BACKGROUND:

- **Construction industry:** 1/3 of world's natural resources; 40% of all landfill waste¹
- **LEED Platinum** certified buildings: **Material & Resources** is the lowest scoring category²
- **Carbon footprint:** reusing is smaller than demolishing and building again³
- Encouraging the reuse of existing buildings is a relevant, contemporary, and **urgent subject**⁴
- **NYC One City Built to Last:** buildings that should last well **beyond 2050:** energy **efficiency** is **key**⁵
- **Costs:** reusing buildings are **not** for sure lower than the costs of demolition and reconstruction⁶
- **Identifying pathologies:** **first step** of rehabilitation (**infrared thermography**)
- **Radiation X temperature:** **accuracy** depends on the **emissivity** of each material
- **Thermal images:** may be **difficult to interpret** (emissivity, image angle, heat/light sources, etc.)

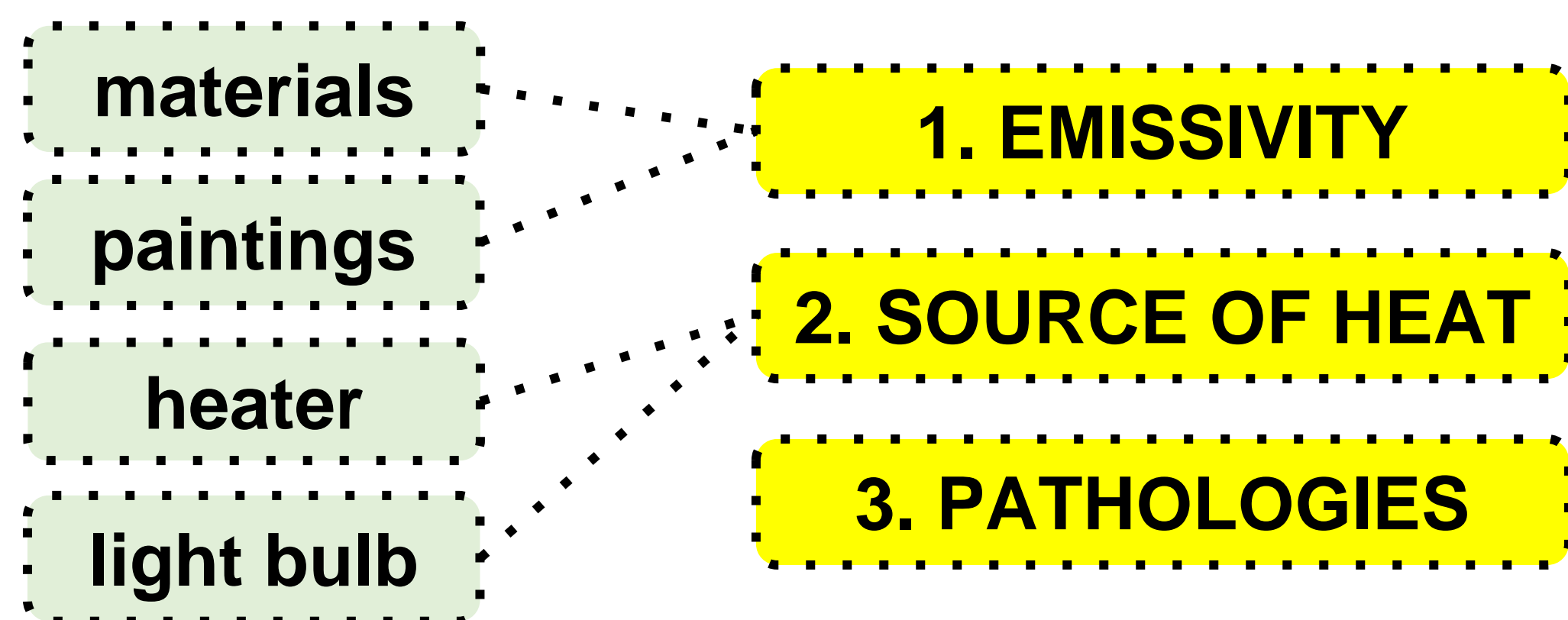
GOAL:

- Create **AI Model**⁸ to identify materials and ultimately **map pathologies** of one particular building - future application in other buildings

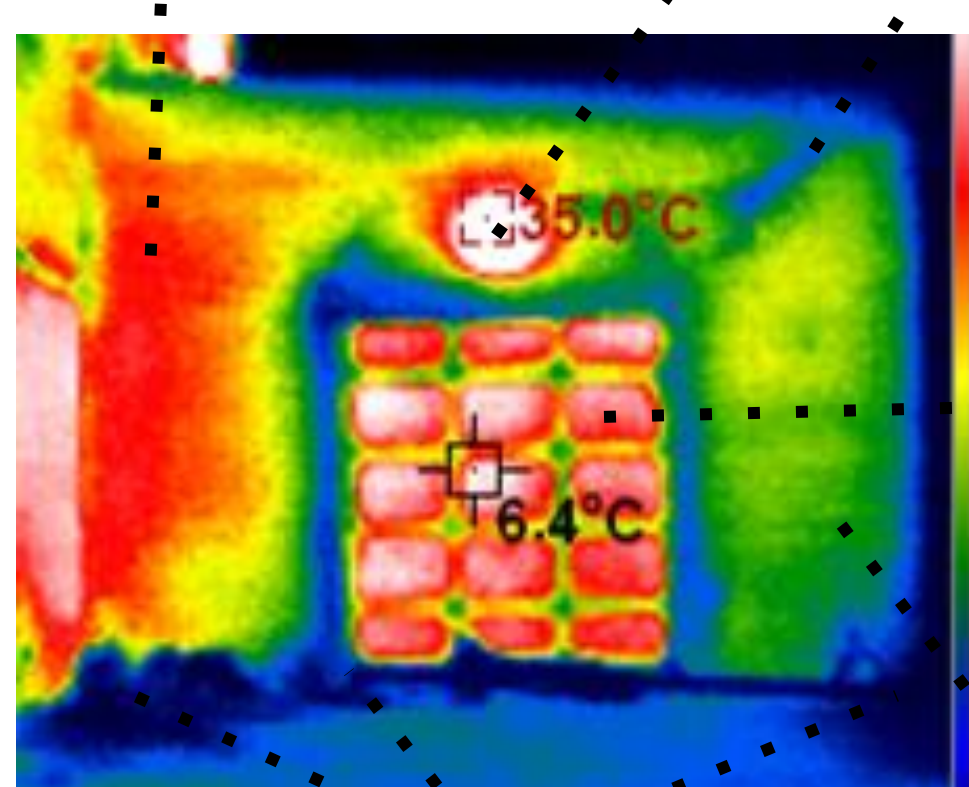
METHODS:

- Categorize **materials, emissivity values, paints, and sources of heat** to minimize errors ($e=0.95$)
- Categorize **pathologies**
- Use **HTI Thermal Imaging Camera (HT-18)** for thermal and regular images of the building (**LCD resolution: 320x240; thermal sensitivity: 0.07°C**)
- **Map pathologies in AutoCAD and SketchUp**
- **Level of detail** for recording heritage structures⁷: classified as **"Initial"** or **"Reconnaissance"**
- Photographs taken on **February 23rd 2022, 9am** (cloudy, 31.9°F, 46% of relative humidity)

Considerations for the AI model:



- Brick (0.93)
- No paint
- heater
- Light bulb
- Crack



- Glass (0.94)
- No paint
- No heater
- Brick (0.93)
- No paint
- No heater
- Humidity (capillarity)

Figure 1: East Façade IRT Image – Method

RESULTS:

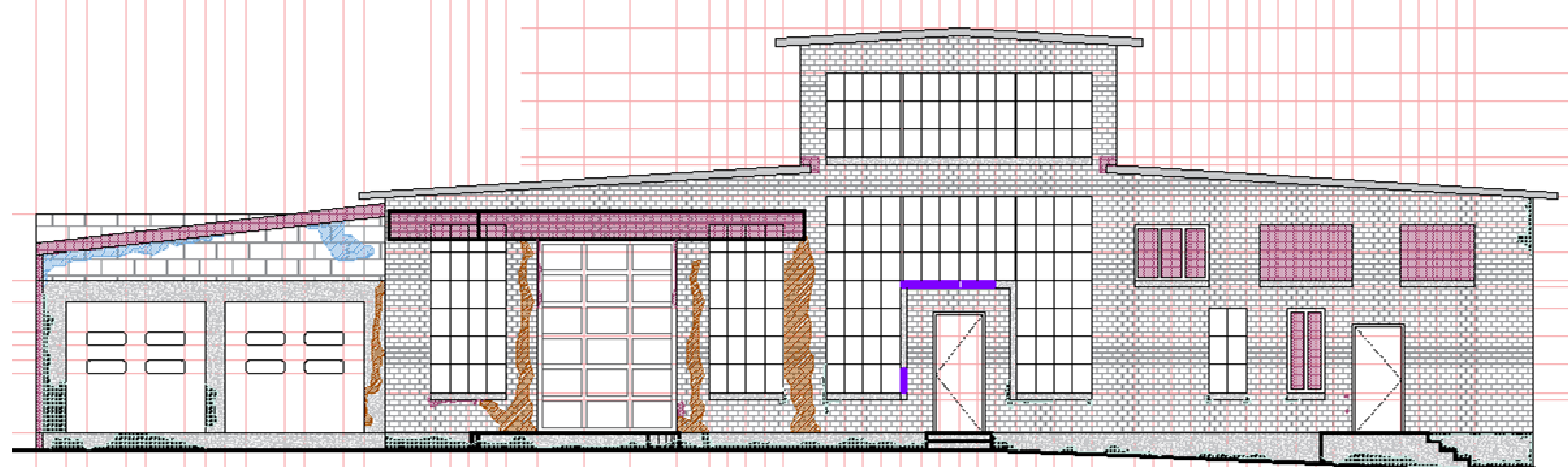
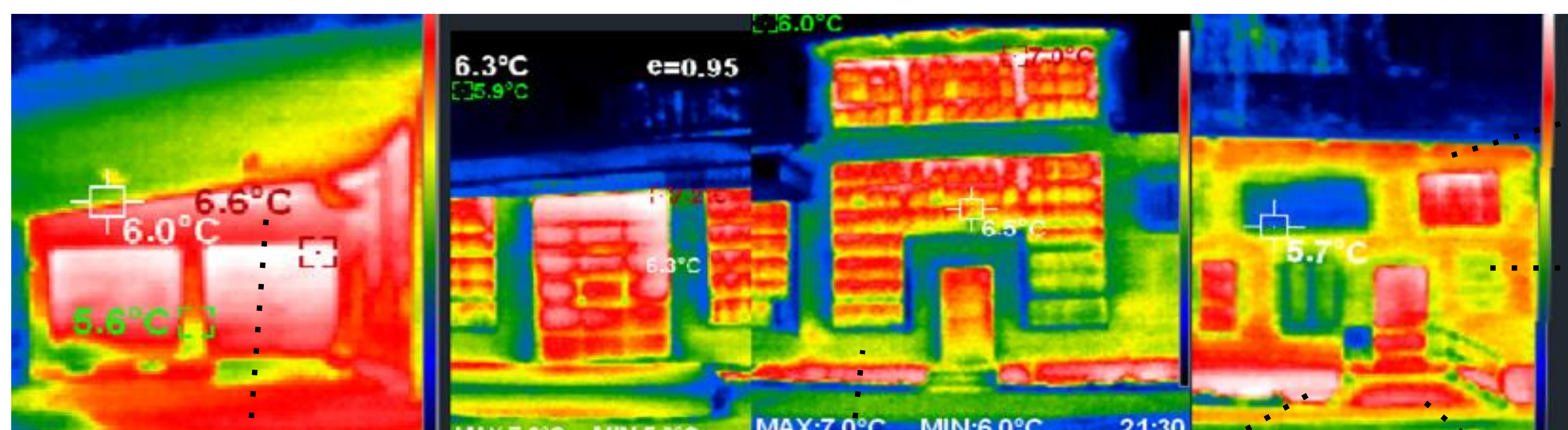


Figure 2: South Façade Damage Map – Pathologies in AutoCAD

- Intervention
- Stain (leakage)
- Stain (rust)
- Humidity (capillary rising)
- Lack



- Concrete block
- Light color
- No heater

- Brick
- No paint
- No heater

- Concrete
- Paint
- Heater

- Concrete
- No paint
- Heater

- Brick
- No paint
- Heater
- Brick
- Paint
- Heater

Figure 3: South Façade Infrared Thermal Images – Compilation



Figure 4: South Façade Photographs – Compilation

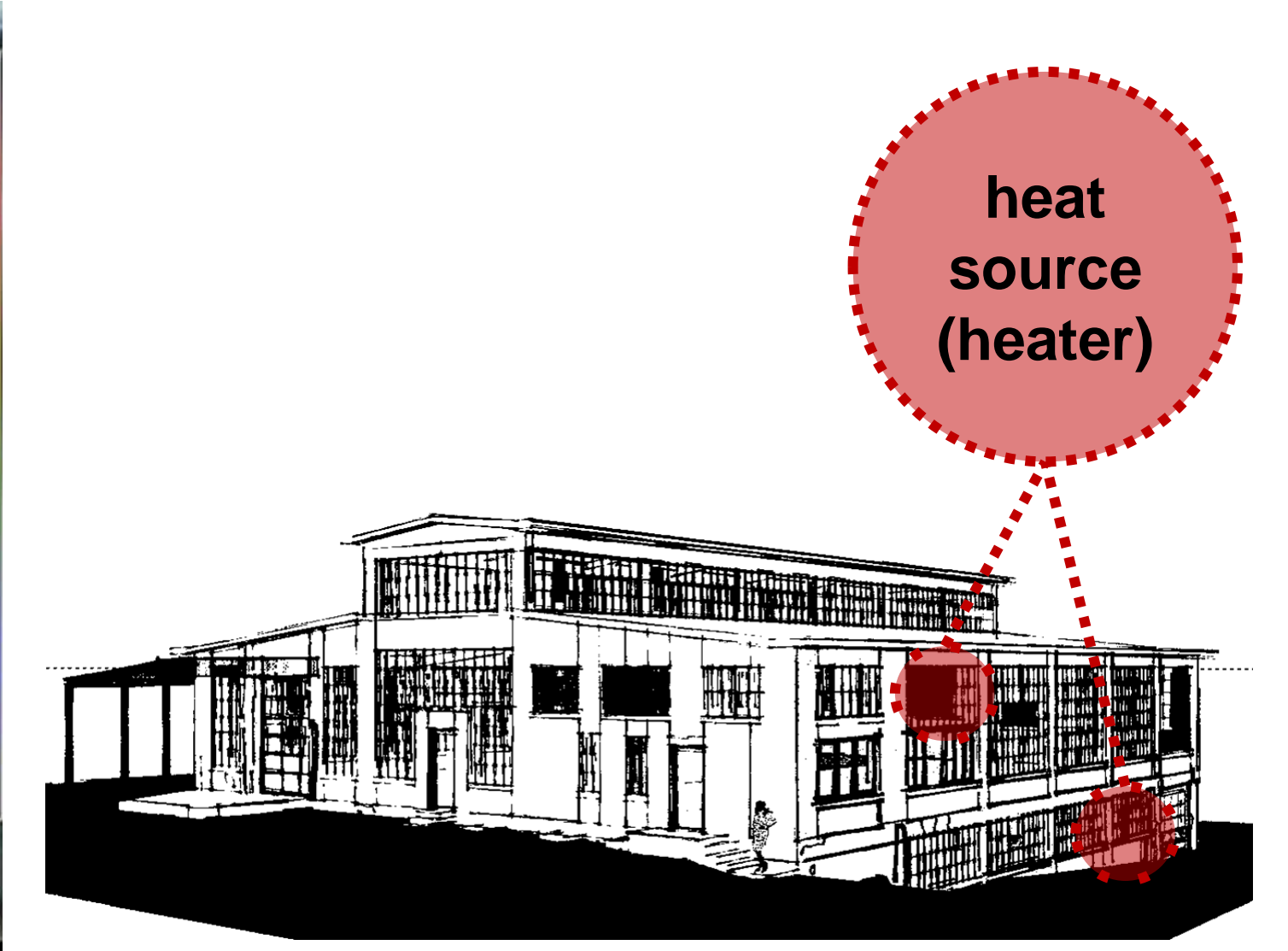


Figure 6: Heat Sources in the building

AI MODEL OUTCOME:

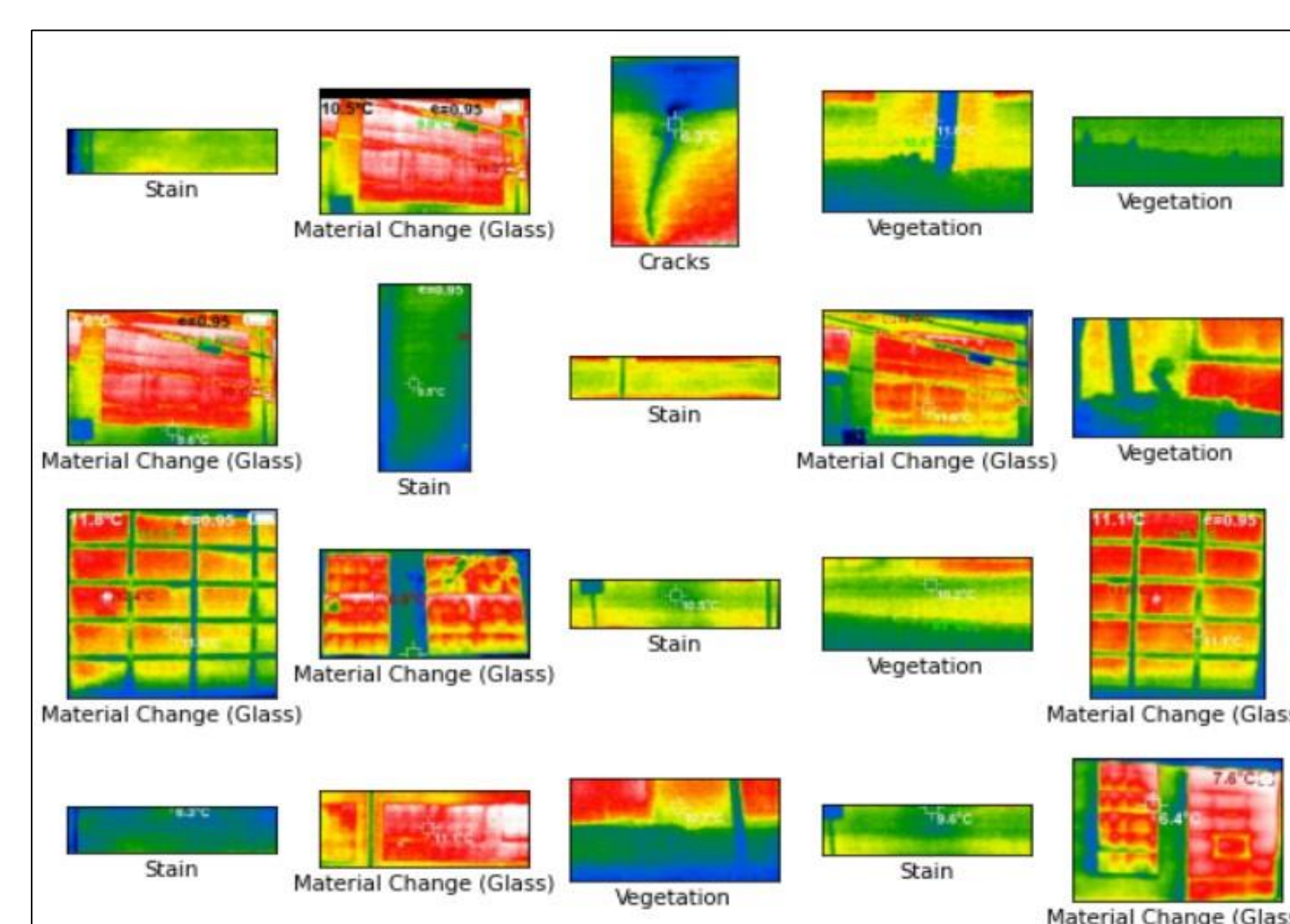


Figure 7: Training the Image Recognition Model

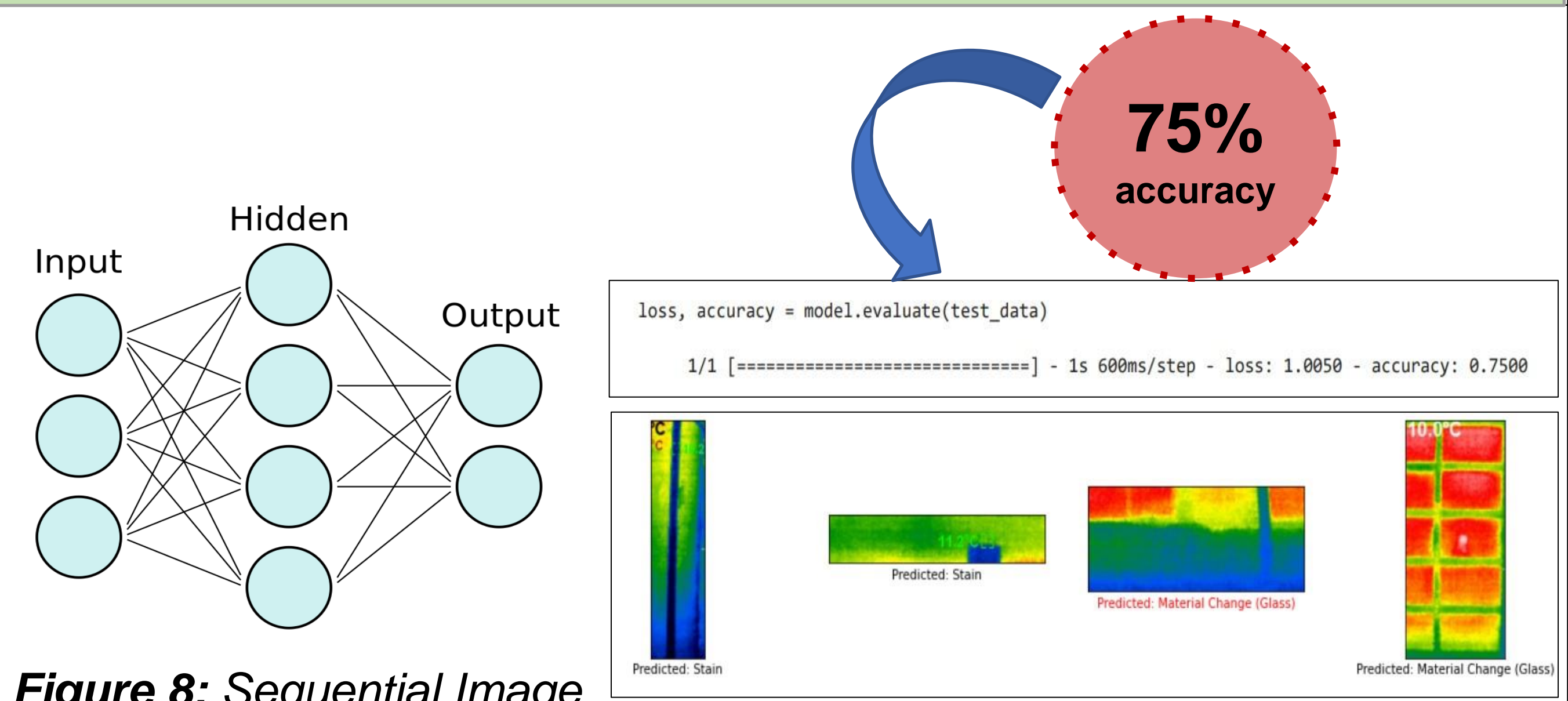


Figure 8: Sequential Image Recognition Model

Figure 9: Image Recognition Model Results

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