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Project Outline

EN3350 - Software Design Competition

Last Modified: Jul 13, 2025

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1. Overview

1.1. Background

Power utilities perform routine thermal inspections of distribution transformers to detect anomalies like overheating, insulation degradation, and load imbalances. Currently, these inspections rely on manual comparison of thermal images, making them time-consuming, subjective, and error-prone. There is a strong need to automate and digitize this workflow while ensuring traceability, efficiency, and adaptability.

1.2. Your Challenge

Design and develop a complete software solution that allows users to:

1. Record and manage transformers and their associated image data
2. Automatically detect temperature anomalies in new images using computer vision
3. Allow users to manually validate or correct detected anomalies
4. Generate a maintenance record sheet with marked anomalies and editable fields

This project will be executed in **four phases**, and your solution must support the flow of data and insights across all of them.

1.3. Required Features (Phase-wise)

Phase 1 – Transformer and Baseline Image Management

- FR1.1: Build an admin interface to add transformer records (ID, location, capacity).
- FR1.2: Enable uploading of thermal images (baseline and maintenance) tagged to transformers.
- FR1.3: Categorize baseline images by environmental conditions (sunny, cloudy, rainy).

Phase 2 – Automated Anomaly Detection

- FR2.1: Implement an AI-based comparison engine to detect anomalies in new images.
- FR2.2: Display side-by-side comparison of new and baseline images.
- FR2.3: Automatically highlight potential hotspots and deviations based on thresholds.

Phase 3 – Interactive Annotation & Feedback

- FR3.1: Allow engineers to manually adjust detected anomalies or annotate new ones.
- FR3.2: Save annotated images with metadata (user, timestamp).
- FR3.3: Feed annotations back into the model pipeline for improved accuracy (retraining or correction tagging).

Phase 4 – Maintenance Record Sheet Generation

- FR4.1: Generate a transformer-specific digital maintenance form with the thermal diagram pre-marked.

- FR4.2: Allow manual input of other required fields.
- FR4.3: Save completed records in the system under the relevant transformer.

1.4. What You'll Be Judged On

This is not just about completing the system—it's also a competition. You'll be assessed on:

Area	Criteria
Functionality	Completion of all required features
Scalability	Modular and well-structured architecture
Efficiency	Speed of image uploads, model inference, and overall responsiveness
ML Integration	Accuracy and robustness of anomaly detection (fine-tuning or integration)
Creativity	Innovative annotation tools or workflow improvements
Quality	Test coverage and coding best practices

1.5. Resources Provided

- Sample dataset of thermal images and baseline records
- Sample diagrams and formats of handwritten maintenance sheets.

1.6. Final Deliverables

- Working web-based system with all four phases integrated
- Test coverage report
- Deployment instructions and README
- GitHub repository with source code

2. Tech Stack

2.1. Technologies

- Maintenace recorded keeper
    - Front-end: React
        - Utilize React for the front end. It provides a responsive and interactive user interface for the questionnaire application.
    - Back-end: Java with Spring framework
        - Java, with the Spring framework, offers a scalable back-end solution.

        - Spring facilitates the development of RESTful APIs for communication between the front-end and back-end components of the questionnaire application.
        - Database interactions, user authentication, and API endpoints can be efficiently managed using Java with Spring.
- Target platform: Web browser
    - The tool will target web browsers as the primary platform.

2.2. Development Guidelines

- Development: Use a GitHub public repository to maintain the source code.
- Follow software engineering best practices and design principles in the development work.

3. Phase 1 – Transformer and Baseline Image Management

3.1. Overview

In this phase, your team will lay the foundation of the system by implementing essential functionalities to manage transformer records and their associated baseline thermal images. This includes setting up the core data models, admin interfaces for data entry, and image uploading mechanisms. The primary goal is to create a structured and searchable repository of transformers and their thermal imaging data under various environmental conditions.

3.2. Scope

You are required to implement the following functional requirements for Phase 1:

FR1.1: Admin Interface for Transformer Management

- Add new transformer records
- View and edit existing transformer records
- Delete transformer entries if necessary

FR1.2: Thermal Image Upload and Tagging

- Allow uploading of thermal images to specific transformer entries
- Images must be tagged as either:
    - **Baseline**: Used as the reference image for future comparisons
    - **Maintenance**: New images used for periodic inspections
- Each image must be associated with metadata such as:
    - Upload date/time
    - Image type (Baseline / Maintenance)
    - Uploader (admin user ID or name)

FR1.3: Categorization by Environmental Conditions

- While uploading a baseline image, the user must tag it with the observed environmental condition:
  - Sunny
  - Cloudy
  - Rainy
- Environmental condition should be selectable via a dropdown during image upload.

Additional Technical Requirements:

- Image storage should support efficient retrieval and viewing
- Transformer and image metadata should be stored in a relational database
- Admin interface should be accessible via a web browser
- Follow a modular architecture that supports easy extension in future phases

3.3. Resources Provided

The following resources will be provided to assist with implementation:

- **User Interface Designs**: Figma/PNG/HTML mockups for all required Phase 1 screens (admin panel, image upload, etc.)

3.4. Deliverables

- A working web-based system with the following:
  - Admin dashboard for managing transformers
  - Image upload interface with appropriate tagging options
  - Database schema and seed data for initial testing
- Clean and readable source code hosted in a **GitHub public repository**
- A short **demo video (2–3 minutes)** showing the working features of Phase 1
- A **README.md** file with:
  - Setup instructions
  - List of implemented features
  - Any known limitations or issues
- Test data (minimum of 5 transformers with baseline images) included in the repository

3.5. Evaluation Rubric

Criterion	Weight
Completeness of all required features (FR1.1–FR1.3)	35%
Clarity and intuitiveness of the admin interface	15%
Clean structure, modularity, and adherence to best practices	15%

Proper tagging, storage, and retrieval of images and metadata	15%
Clear README and usage instructions	10%
Any additional thoughtful features	10% (bonus)*

*Bonus marks can push the total above 100 for exceptionally creative or technically impressive additions, but the core score will be capped at 100 for ranking purposes.