TITLE PAGE

- **Problem Statement ID –** 1725
- **Problem Statement Title -**Utilization of images for monitoring of progress of construction activities for building construction projects.
- **Theme-** Smart Automation
- **PS Category-** Software
- **Team ID-**
- **Team Name:** The outliers

THE OUTLIERS

IDEA TITLE

SMART INDIA HACKATHON 2024

Solution Overview: The proposed solution is a machine learning-based software for monitoring construction progress through image analysis.
It detects and analyzes key construction elements (foundations, super-structures, facades, interiors) using algorithms like YOLOv8 (object detection and segmentation).

Problem Solved:

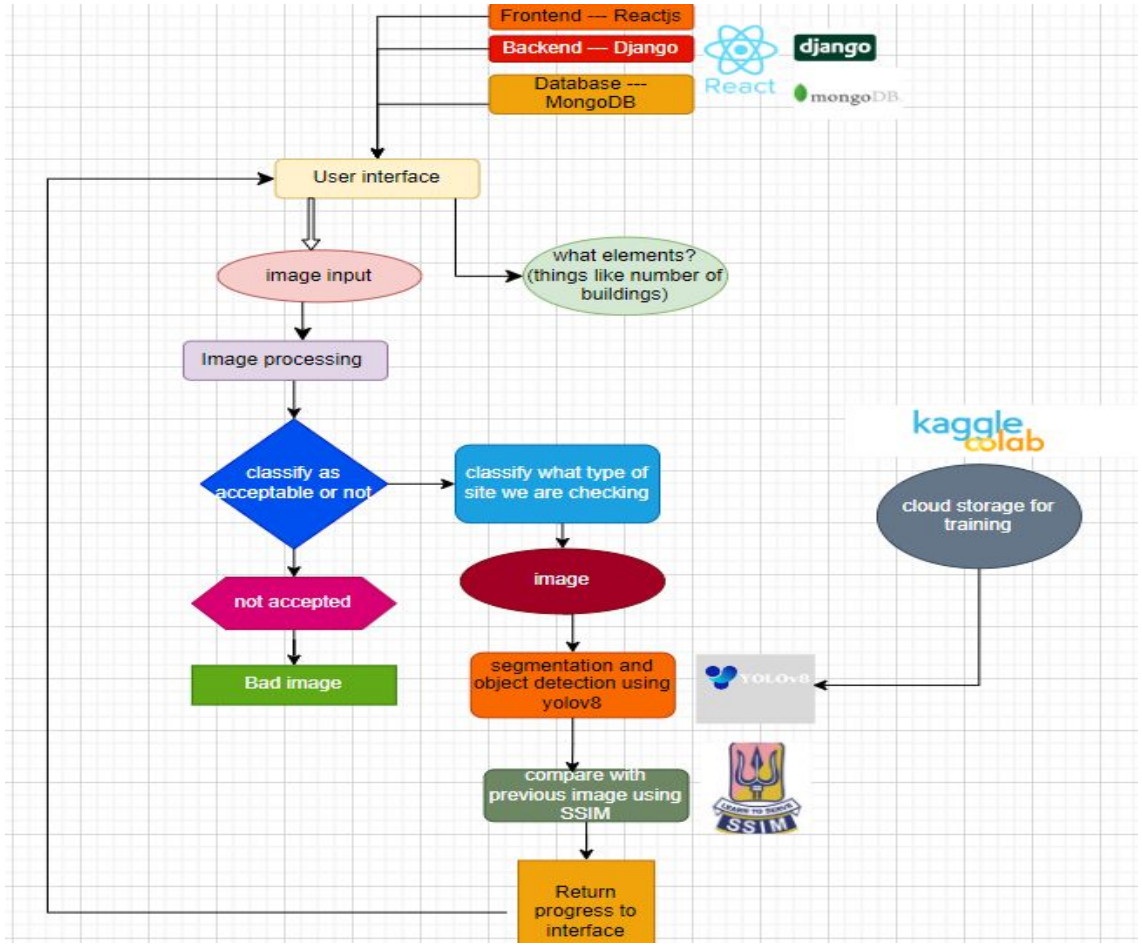
Remote Monitoring: Reduces the need for physical site visits by providing real-time updates.
Error Detection: Ensures accurate monitoring by flagging incorrect data.
Automation: Saves labor hours and minimizes human error.
Timely Interventions: Provides instant feedback to minimize delays.

Innovation:

Custom Monitoring: Tracks specific construction tasks (e.g., window installation).
Error Validation: Flags incorrect image inputs, ensuring accuracy.
Real-Time Progress: Uses image comparison algorithms like SSIM to track incremental progress.
Scalability: Can extend to other construction types in the future.

TECHNICAL APPROACH

Technologies Used:



YOLOv8 (Object Detection): Detects construction elements (walls, machinery) in site images, helping track progress in specific stages. Segments images into areas like walls, windows, or machinery for detailed analysis.
Transfer Learning: Fine-tunes pre-trained models with construction-specific images.
OpenCV: Preprocesses images (resizing, feature extraction) to improve quality before analysis.
Pillow: Basic image manipulation (cropping, resizing) for initial transformations.
PyTorch/TensorFlow: Builds and trains deep learning models for detection and segmentation.
Keras: Simplifies building neural networks for image tasks.
Scikit-learn: Validates correct images and categories using classifiers.
Databases (MongoDB): It will be great for handling unstructured data like image metadata, progress reports, and other details. Its flexibility will allow for easy scaling as your project grows.
Django: Web frameworks for the user interface to upload images and view progress.
Docker & Kubernetes: Containerize models and scale deployment.
Google Collab: Provides cloud computing and storage for model training and deployment.
Image Difference (SSIM): Compares old and new images to assess progress.
React: Creates responsive and dynamic user interfaces.

FEASIBILITY AND VIABILITY

Analysis of the feasibility of the idea

- **Established Technologies**: Uses proven tools like YOLOv8 and OpenCV for reliable image detection.
- **Transfer Learning**: Fine-tunes pre-trained models with construction-specific images, reducing training time.
- **Cloud Scalability**: The use of **cloud platforms (AWS, GCP, Azure)** for storage and model deployment allows the software to scale efficiently with the size of the project and volume of data, ensuring real time performance.

Potential challenges

- Ensuring the models generalize well to different construction sites with varying conditions.
- Handling the diversity of construction stages and components accurately in a single framework.
- Detecting and raising errors for incorrect categories or mismatches may require extensive validation mechanisms.

Overcoming challenges

- **Model Generalization**: Use diverse training data, data augmentation, and continuous fine-tuning to improve robustness across sites.
- **Multi-Stage Analysis**: Develop specialized models for each construction stage and implement a hierarchical decision system.
- **Error Handling**: Use classification models for validation, user feedback for corrections, and ensemble methods for stronger error detection.

IMPACT AND BENEFITS

Potential impact on the target audience

Target audience: ULBs, state agencies, central agencies and construction companies.

Impacts: Automates progress tracking, real time insights, cost saving, increased transparency and better resource management.

Benefits of the solution

- Automating progress tracking and inspections minimizes the need for frequent on-site visits, reducing manual labor expenses.
- Early detection of issues prevents costly rework or corrections later in the project lifecycle.
- Clear progress tracking improves stakeholder confidence, attracting more clients and investment.
- As construction teams adopt digital tools, it encourages upskilling in tech-related areas, enhancing job prospects.
- Fewer on-site inspections reduce travel, decreasing emissions and fuel consumption.

RESEARCH AND REFERENCES

Links and references

Automated progress monitoring of construction projects using Machine learning and image processing approach: Automated progress monitoring of construction projects using Machine learning and image processing approach (researchgate.net)

AI for Construction Progress Monitoring:
https://www.desapex.com/blog-posts/revolutionizing-construction-progress-monitoring-and-as-built-verification-with-bim

YOLOv8:
https://github.com/ultralytics/ultralytics
OpenCV: https://opencv.org/
TensorFlow: https://www.tensorflow.org/
PyTorch: https://pytorch.org/