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TITLE PAGE

- **Problem Statement ID – 1755**
- **Problem Statement Title-Utilization of images for monitoring of progress of construction activities for building construction projects.**
- **Theme-Smart Automation**
- **PS Category- Software/Hardware**
- **Team ID-28330**
- **Team Name-Griffyndor**

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❖ Proposed Solution:

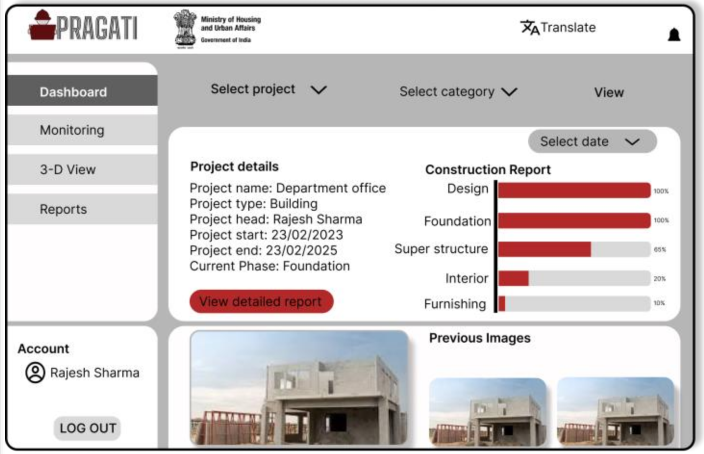
Detailed explanation of the proposed solution

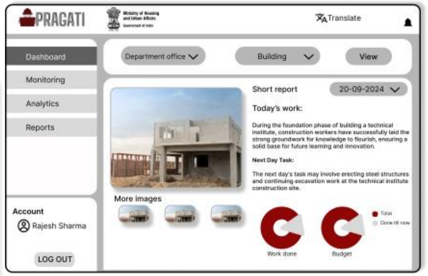
1. **AI-Powered Construction Monitoring:** Utilizing various machine learning models to automatically identify the stage of construction and generate progress index based on images. CCTV enables accurate and real-time tracking of progress without the need for constant on-site supervision.
2. **3D Model Generation with Meshroom:** By integrating Meshroom for 3D image analysis, the system creates detailed 3D models from 2D site images.
3. **Error Detection and Progress Comparison:** The software detects discrepancies between the uploaded images and the selected construction stage. It compares historical and current images to assess incremental progress using change detection algorithm and Semantic Segmentation coded in PyTorch .
4. **Scalability and Customization:** The system is adaptable to various construction components (e.g., foundation, interiors) and can scale for larger projects.
5. **Offline and Online Functionality:** Data and images captured by the mobile device are stored locally when there is no internet connection. Once the device reconnects to the internet, the buffered data is automatically uploaded to the server.

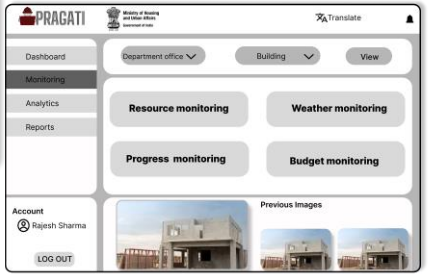
Innovation and uniqueness of the solution

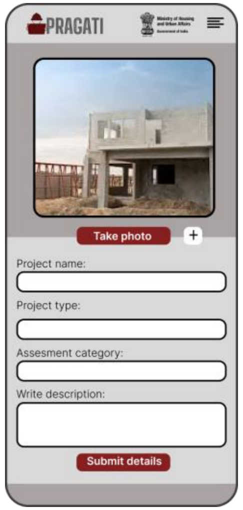
Innovative 3D Analysis: The solution's integration of 3D image analysis through Meshroom, combined with machine learning, offers a groundbreaking approach to accurately track construction progress.

1. **AI-Driven Monitoring:** Tailored machine learning algorithms automate construction stage identification and error detection.
2. **3D Image Analysis:** Meshroom integration provides accurate spatial analysis and progress tracking via 3D models.
3. **Scalable and Sustainable:** The solution reduces site visits, supports large projects, and aligns with environmental goals.









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TECHNICAL APPROACH

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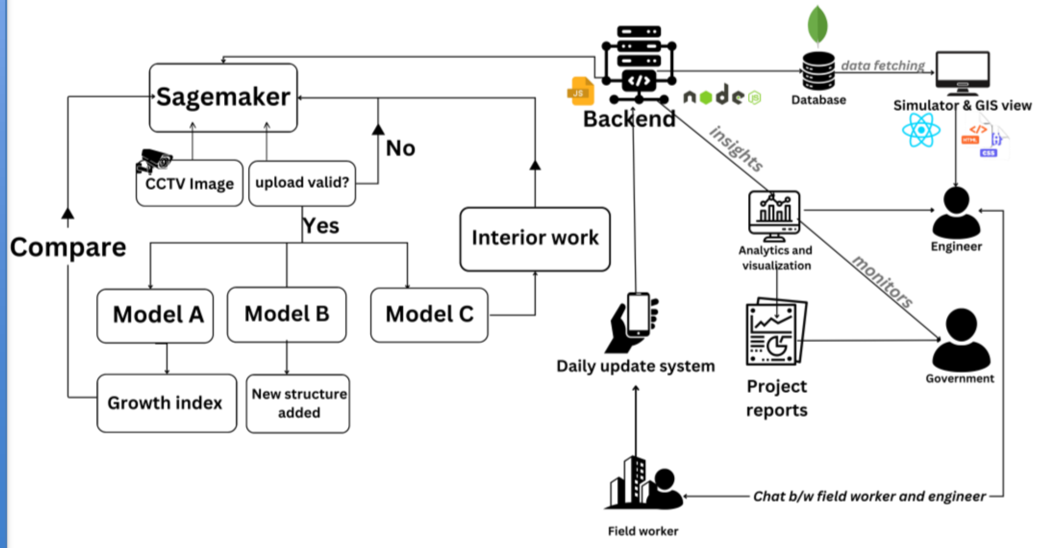
Tech Stack:

1. **Frontend: HTML, CSS, JS, React, Bootstrap -** Designed for the web interface to ensure seamless user interaction and a responsive experience.
2. **App: Flutter, Firebase -** Flutter is used for the mobile app interface, while Firebase handles user authentication, real-time data sync, and cloud storage.
3. **Backend: NodeJS, Flask -** Handles the interfacing between models and Application.
4. **Database: MongoDB, Amazon RDS –** Mongo handles unstructured user uploaded images and site details and logs while RDS handles structured user information, project metadata and construction project history.
5. **Cloud ML: Sage Maker -** Will serve as the core machine learning platform for the project, handling Model Training and Deployment, Image Analysis by leveraging pre-trained model and custom-built models, monitoring and model optimization.
6. **Computer Vision: OpenCV -** Used for image preprocessing and feature extraction, helping to prepare construction site images for analysis. It will handle tasks like resizing, filtering, and detecting key visual patterns before feeding the data into machine learning models.
7. **ML: PyTorch, Hugging Face -** Used for building, training, and fine-tuning deep learning models for image analysis tasks. Provides pre-trained models and tools for natural language processing (NLP) integration, useful for text-related tasks, such as labeling or annotating construction data. ResNet will be leveraged for image recognition tasks, aiding in identifying construction stages from site images.
8. **3D View: Meshroom 3D -** Used for 3D reconstruction, converting 2D site images into 3D models for in-depth analysis. It helps visualize construction progress by generating accurate 3D representations from captured images.
9. **Map Service: QGIS -** Can be used for geospatial analysis, helping to map and visualize construction sites geographically. It can integrate with the project to track progress across multiple locations, providing spatial context for site data and project monitoring.

TECH STACK

Flask
mapbox
Amazon RDS
OpenCV
PyTorch
Amazon SageMaker
MESHROOM
Hugging Face
QGIS



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FEASIBILITY AND VIABILITY

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FEASIBILITY

1. **Data Quality Assessment:** The feasibility of the data hinges on the quality of the images collected from construction sites. High-resolution images with good lighting and clear details are essential for accurate analysis and model generation.
2. **Diversity of Input Data:** Analyzing diverse images of construction stages improves machine learning algorithms' robustness, enabling better generalization across projects and environments.
3. **Availability of Historical Data:** Having access to historical construction images enables progress tracking and enhances the solution's feasibility by providing sufficient data for training machine learning models.

Potential challenges and risks

1. **Data Quality Issues:** Poor-quality images can result in inaccurate analysis and predictions, affecting system reliability. High-quality data collection is essential to avoid this risk.
2. **Scalability Concerns:** As projects grow, high computational demands for image processing and 3D modeling may cause performance issues, requiring efficient architecture and cloud solutions to sustain performance.
3. **User Adoption and Training:** User resistance due to unfamiliarity with technology may hinder adoption. Comprehensive training and support are key to ensuring effective system use.

Strategies for overcoming these challenges

1. **Implement Robust Data Collection Protocols:** Set guidelines for capturing quality images, covering lighting, angles, and resolution. Regular user training can help maintain consistent data quality.
2. **Optimize System Architecture:** Leverage cloud computing and distributed processing for scalability and workload management. Regularly monitor and optimize system performance to handle growing user demand.
3. **Provide Comprehensive Training and Support:** Create user-friendly documentation and training to support adoption. Providing ongoing technical support and feedback channels will help users become comfortable and encourage effective use.

IMPACT AND BENEFITS

Impact

- **Enhanced Decision-Making:** Real-time data on construction progress enables managers to make informed decisions, improving resource allocation and project planning.
- **Increased Efficiency:** Reducing on-site visits allows experts to focus on high-value tasks, speeding up project completion and reducing costs.
- **Greater Transparency and Accountability:** Improved visibility fosters trust among contractors, managers, and agencies, ensuring better compliance and reporting.

Benefits

- **Social:** Enhances collaboration and trust through transparent communication between stakeholders.
- **Economic:** Reduces operational costs and speeds up project completion, boosting profitability.
- **Environmental:** Lowers the carbon footprint from reduced travel and supports sustainable construction practices.

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RESEARCH AND REFERENCES

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- Papers With Code & Hugging Face
- Deep Residual network ResNet
- Data Catalogue
- Image equipment Dataset
- Window Image Dataset
- Excavator Image Dateset
- National Projects Construction Corporation Limited
- Public Private Partnership in india
- UPSCIDC
- QGIS

Project GitHub