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Wall Guard: Crack Detection and Cost Analyzer Using AI

Musale Kajal Jijabhau, Gunjal Monali Rajendra, Bhosale Ashwini Gitaram

Students, Department of Computer Engineering, Samarth College of Engineering and Management, Belhe, Maharashtra, India

Prof. P. P. Pansare

Professor, Department of Computer Engineering, Samarth College of Engineering and Management, Belhe, Maharashtra, India

ABSTRACT: Crack Vision is an innovative AI-powered Android application designed to detect and analyze wall cracks, providing users with real-time, automated repair cost estimates. By integrating advanced object detection models such as YOLOv7 and Mask R-CNN, the application significantly improves the accuracy and efficiency of crack identification. It enables precise measurement of crack dimensions, severity classification, and the early detection of potential structural issues.

The system leverages high-resolution image processing and deep learning techniques to differentiate between structural and non-structural cracks, facilitating more informed decision-making for repair prioritization. This comprehensive approach streamlines the inspection and budgeting process, reducing dependence on manual assessments. Crack Vision serves as a valuable tool for homeowners, contractors, and structural engineers, offering a reliable and scalable solution for wall crack assessment and maintenance planning.

KEYWORDS: Android application, Computer Vision, Object Detection, Machine Learning

I. INTRODUCTION

Crack Vision is a cutting-edge Android application that integrates artificial intelligence (AI) into structural inspection processes, specifically targeting the detection and evaluation of wall cracks. In an age marked by rapid urbanization and infrastructure development, there is a growing demand for faster, more accurate, and cost-efficient solutions for building maintenance and safety assessment. Traditional methods of wall inspection, which primarily rely on manual evaluation and visual observations, are increasingly inadequate due to their labor-intensive nature, high cost, and susceptibility to human error. These limitations often result in delayed detection and inaccurate assessment of structural issues.

To address these challenges, Crack Vision offers an automated, efficient, and highly reliable AI-based solution that revolutionizes the inspection process by delivering real-time crack detection and instant repair cost estimation. This mobile-based application democratizes access to structural assessment tools, making them available not only to professionals such as contractors and civil engineers but also to homeowners and building inspectors.

At the core of Crack Vision are two state-of-the-art object detection models—YOLOv7 (You Only Look Once version 7) and Mask R-CNN (Mask Region-Based Convolutional Neural Network). These deep learning models have been trained on diverse and extensive datasets, enabling accurate recognition and classification of various crack types, including hairline, structural, and stress-induced cracks. YOLOv7 offers real-time detection with minimal computational overhead, while Mask R-CNN enables pixel-level segmentation for detailed crack morphology analysis. Together, these technologies empower Crack Vision to assess crack dimensions, orientation, depth, and severity, thus providing a comprehensive analysis that supports structural integrity evaluations and repair prioritization.

II. LITERATURE SURVEY

Sr. No.	Name of Paper	Publisher	Authors	Year	Findings	Challenges
1	Structural Health Monitoring Using Computer Vision and Machine Learning	Journal of Civil Engineering	Adhikari, B., & Shah, P.	2016	Explores computer vision applications in structural health monitoring (SHM), highlighting the limitations of traditional manual inspections.	Manual inspection is laborintensive and prone to human error, making it unsuitable for frequent inspections.
2	Automated Crack Detection in Concrete Structures Using Deep Learning	IEEE Transactions on Industrial Electronics	Cha, Y. J., Choi, W., & Suh, G.	2017	Demonstrates the effectiveness of CNNs in detecting cracks on concrete surfaces with high accuracy.	CNNs are computationally heavy, limiting their application on mobile devices for real-time inspections.
3	YOLO: Real-Time Object Detection System	IEEE Conference on Computer Vision and Pattern Recognition	Redmon, J., Divvala, S., & Girshick, R.	2016	Introduces YOLO as a fast, real-time object detection model, beneficial for applications needing quick analysis.	YOLO models struggle with small object detection, which may reduce accuracy in detecting fine cracks.
4	Mask R-CNN: Object Instance Segmentation	IEEE Transactions on Pattern Analysis and Machine Intelligence	He, K., Gkioxari, G., & Dollár, P.	2017	Presents Mask R-CNN for pixel-level segmentation, enabling precise crack boundary identification for detailed analysis.	Requires significant computational power, challenging for mobile deployment without optimization.
5	Cost Estimation in Building Maintenance Using Machine Learning	International Journal of Construction Engineering	Sonmez, R., & Tas, M.	2019	Discusses machine learning methods for accurate and contextaware cost estimation in construction projects.	Discusses machine learning methods for accurate and context-aware cost estimation in construction projects.

III. PROPOSED SYSTEM

Crack Vision is a revolutionary Android application designed to automate wall crack detection and repair cost estimation using artificial intelligence (AI). Unlike traditional manual inspections, the app analyzes wall images to accurately identify cracks, classify their severity, and provide reliable cost estimates.

By streamlining the inspection process, Crack Vision offers a fast, consistent, and user-friendly solution. It benefits homeowners assessing property damage, contractors providing repair quotes, and inspectors evaluating structural integrity—all through a single, intelligent mobile platform.

Features:

Crack Vision is equipped with several powerful features that make it a comprehensive solution for wall crack detection and repair cost estimation:

AI-Powered Crack Detection: Crack Vision uses cutting-edge machine learning algorithms such as YOLOv7 and Mask R-CNN to automatically detect and classify cracks in walls. These state-of-the-art algorithms enable the app to accurately identify cracks of varying sizes and types, including hairline cracks that might be easily overlooked by the human eye.

Cost Estimation: Once cracks are detected, Crack Vision calculates a reliable repair cost based on several factors, including crack severity, the materials required, labor costs, and regional pricing standards. The AI-powered system analyzes the dimensions and characteristics of each crack to generate an accurate estimate, providing users with a detailed breakdown of costs.

Invoice Generation: Crack Vision goes a step further by automatically generating a comprehensive repair bill once a crack is detected and analyzed. This feature allows users to quickly understand the financial aspects of the repair, from materials to labor, and provides a document that can be shared with contractors or used for insurance claims.

Real-Time Reporting: Users receive instant feedback on detected cracks and their severity. The app's realtime reporting allows homeowners and contractors to assess the situation promptly, make informed decisions, and plan repairs efficiently.

Multilingual Support: Crack Vision supports multiple languages, ensuring that users from different regions and linguistic backgrounds can benefit from the app's functionality.

User Accounts and History Tracking: The application allows users to create accounts where they can track previous inspections, monitor the progression of wall cracks over time, and receive reminders for follow-up inspections.

Benefits

Crack Vision offers a range of benefits that make it a valuable tool for a wide variety of users, from homeowners to professional contractors:

Accurate Detection: Crack Vision's AI-powered algorithms ensure consistent, reliable, and accurate detection of cracks in walls. The application can identify cracks that may be missed during manual inspection, including those in hard-to-reach areas or those of minimal width.

Cost Efficiency: By eliminating the need for professional consultations and repeated inspections, Crack Vision helps users save time and money. The automatic generation of cost estimates and invoices further streamlines the budgeting process, making it easier to plan repairs and manage costs.

User-Friendly Interface: Designed with both homeowners and professionals in mind, Crack Vision offers a simple, intuitive interface. The app's easy navigation makes it accessible to individuals with no technical background, while still providing enough detail and customization options for professionals who need precise information.

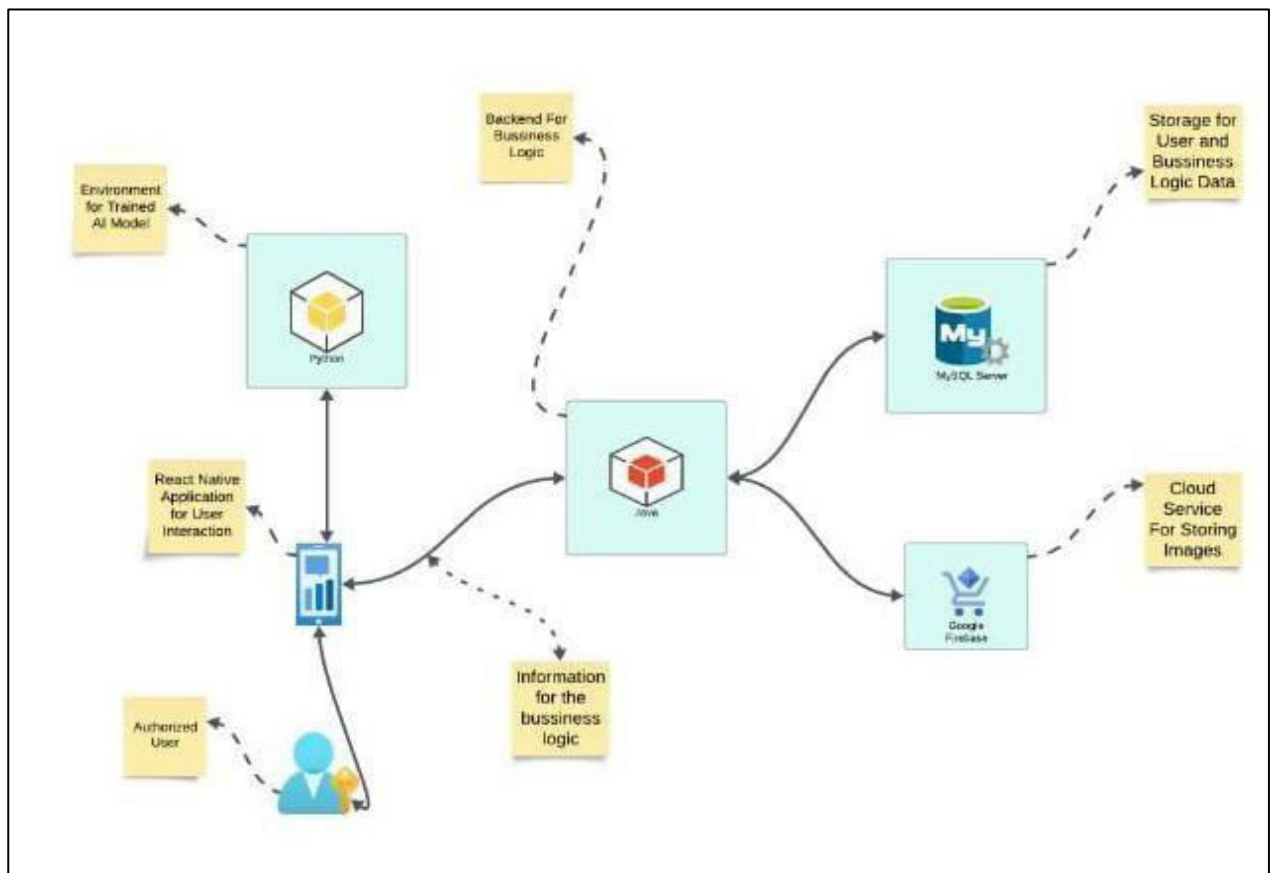
Faster Response Times: With Crack Vision's real-time crack detection and cost estimation, users can make quicker decisions regarding repairs. This feature is especially useful in emergency situations where fast action is necessary to prevent further damage.

Proactive Maintenance: Regular use of Crack Vision can help users track the condition of their walls over time, allowing them to spot emerging cracks early. This can prevent small issues from escalating into larger, more expensive repairs and promote long-term maintenance of building structures

Improved Accuracy in Cost Estimation: The application provides users with an accurate, data-driven estimate of repair costs, reducing the likelihood of inflated or inaccurate pricing often encountered with traditional manual evaluations

Convenience and Accessibility: The app's mobile nature means that users can assess wall cracks anytime, anywhere. Whether they're at home or on a job site, they can quickly evaluate the condition of their walls and access the necessary information with ease.

IV. SYSTEM ARCHITECTURE



V. SCOPE

Enhanced AI Capabilities: Extend the AI capabilities to detect a broader range of structural issues beyond wall cracks, such as moisture damage, foundational shifts, and material degradation. This enhancement would make Crack Vision a comprehensive structural analysis tool, providing users with more insights and accurate diagnostics for a variety of issues.

AR Integration for Visualization and Planning:

Integrate Augmented Reality (AR) to allow users to visualize the repair process on their device screens. This feature would overlay potential repair solutions directly onto the user's wall, helping users understand the extent of repairs and expected outcomes. It could also suggest the estimated time frame and steps for each repair phase, enhancing user understanding and planning.

Real-Time Collaboration and Expert Consultation:

Enable in-app communication and collaboration between users and repair professionals, such as contractors or engineers. This feature would allow users to share real-time images, receive expert assessments, and discuss repair options instantly, improving consultation efficiency and providing users with immediate access to expert advice.

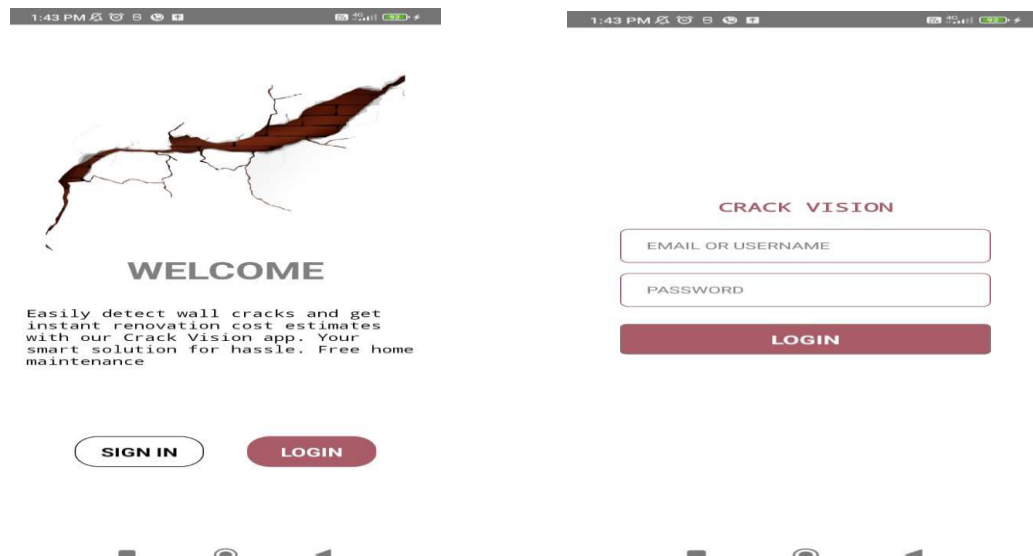
Global Adaptation with Localization:

Adapt the app for international markets by incorporating localized databases for repair costs, material types, and labor rates, reflecting country-specific data. Additionally, add multilingual support to make Crack Vision accessible to non-English speaking users, promoting wider adoption and usability in diverse regions.

Preventive Maintenance Alerts and Historical Tracking:

Implement a feature that tracks the condition of walls over time and provides preventive maintenance alerts when minor cracks are detected. Users could monitor crack progression, enabling timely intervention to prevent further damage. This feature would also store historical data, allowing users to access past assessments and invoices for better tracking and planning.

VI.RESULT



1:46 PM

SIGN IN

USERNAME

EMAIL

CONTACT

SET PASSWORD **Show**

CONFIRM PASSWORD **Show**

SIGN IN

1:44 PM

Crack Vision

An AI-driven solution to detect cracks on your wall.

User ID : 602

Email ID : monali@gmail.com

Wall Repair

Ceiling Repair

Floor Repair

Painting

Menu

10:24

Wall Detection

User ID : 700

User email : sahil

+ Capture Image

Submit

10:26

Invoice

Walls	X 2	₹ 60
Wall 1		
crack_1: 12.17 cm		₹ 41
Wall 2		
crack_1: 4.6 cm		₹ 15
Cement Required	(3 KG)	₹ 180
Discount		- ₹ 50
Labour Charges		Free
		₹ 246

Detected Crack Masks

Download Invoice

VI. CONCLUSION

In conclusion, Crack Vision is an innovative leap forward in the structural inspection landscape, delivering an advanced yet accessible solution to the critical issue of wall crack detection and assessment. By merging cutting-edge AI with practical functionality, the app redefines how building maintenance is approached, particularly for non-specialists and professionals seeking fast, precise, and cost-effective inspection options. With YOLOv7 and Mask R-CNN at its core, Crack Vision achieves exceptional accuracy in detecting cracks, categorizing them based on severity, and assessing their potential impact on a structure's integrity. This realtime, automated analysis minimizes reliance on manual inspection methods, reducing human error, speeding up assessment times, and saving on inspection costs.

Beyond mere crack detection, Crack Vision's intelligent cost estimation module is a game-changer. By accounting for material costs, labor, and repair complexity, it offers users a realistic, data-driven budget for repairs, streamlining what has traditionally been a multi-step, fragmented process. This functionality is invaluable to property owners, contractors, and inspectors alike, as it allows them to transition seamlessly from problem identification to budgeting and repair planning. Additionally, the app's comprehensive digital reporting feature allows users to document wall conditions over time, creating a valuable record for historical tracking and enabling more informed decisions about structural upkeep.

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