

CivicEase: A Smart Platform for Reporting and Resolving Civic Issues

Eeshan Mohd Rafiq Shaikh¹, MohammadUmer Amjad Kaji², Shweta Nilesh Pise³, Gayatri Rajaram Kodolkar⁴, Sakshi Rahul Sase⁵, Mrs. Arati V. Patil⁶

^{1,2,3,4,5} Student, Department of Computer Science and Engineering, Ashokrao Mane Group of Institutions, Kolhapur, Maharashtra, India

⁶Assistant Professor, Department of Computer Science and Engineering, Ashokrao Mane Group of Institutions, Kolhapur, Maharashtra, India

Abstract –CivicEase is developed as a smart civic issue management platform that helps citizens report and track urban problems more efficiently using mobile and AI technologies. Built on a cloud-native Firebase backend and a Flutter-based mobile frontend, CivicEase employs YOLOv5 object detection implemented with PyTorch [1], [2] for real-time issue identification, classification, and severity assessment. The platform supports both AI-assisted and manual complaint submission, integrating GPS and Google Street Maps API for precise geo-location reporting. Role-based access control, real-time notifications, and a comprehensive admin dashboard facilitate efficient complaint management and citizen-government interaction. Experimental evaluation highlights detection accuracy influenced by image quality, network latency, and GPS precision challenges in dense urban settings, reflecting practical deployment considerations. CivicEase exemplifies intelligent automation in smart city governance, enhancing infrastructure management through mobile-cloud synergy.

KEY WORDS

Smart City, Civic Issue Reporting, YOLOv5, Deep Learning, Firebase, Real-time Tracking, Cloud Computing, Mobile Application, Intelligent Automation

I. INTRODUCTION

In many cities, traditional complaint systems are still slow, difficult to track, and inefficient for handling civic issues. Traditional complaint handling often suffers from inefficiencies, delayed responses, and limited transparency [5], [6]. CivicEase offers a solution by integrating AI-driven issue detection with cloud-native mobile applications to automate complaint submission, real-time tracking, and resolution. This paper details CivicEase's architecture, AI workflow, and cloud integration, aiming to improve smart

city infrastructure management and enhance citizen-government collaboration.

II. PROBLEM STATEMENT

Manual civic complaint systems are prone to delays, incomplete reporting, and difficulty in prioritization by authorities. Citizens often struggle to provide detailed issue descriptions, while government agencies face challenges in tracking and resolving complaints efficiently. There is a clear need for a platform that automates issue detection, supports real-time tracking, and enables intelligent complaint management to facilitate better urban governance.

III. LITERATURE REVIEW

Smart city frameworks have incorporated IoT and cloud services for infrastructure monitoring [11], while several studies have explored civic complaint management systems using cloud technologies and GIS integration [5], [6]. Prior research on object detection in urban contexts often remains disconnected from citizen-facing applications. Although cloud-native architectures offer scalability, integration of deep learning-based detection, mobile-cloud synchronization, and role-based complaint management in a unified platform remains underdeveloped.

IV. RESEARCH GAP AND NOVELTY

CivicEase fills the gap by combining YOLOv5-based real-time object detection [1], [2] with a Firebase backend [4] and Flutter frontend [9]. The platform uniquely supports both AI-assisted and manual complaint submission, real-time notifications, and a role-based admin dashboard. This integration enables seamless citizen-government communication and intelligent automation in complaint resolution, distinguishing CivicEase from existing solutions.

V. PROPOSED SYSTEM ARCHITECTURE

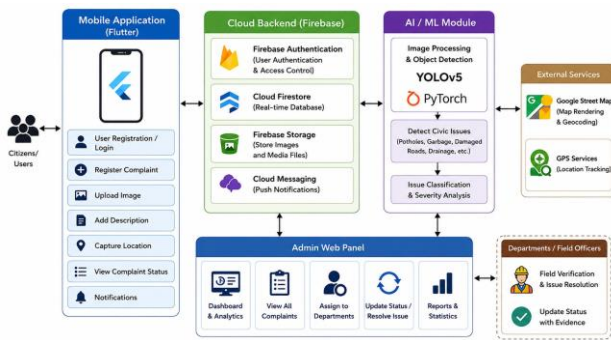


Fig. 1 illustrates the overall system architecture of CivicEase, comprising three main layers:

- **Frontend:** Flutter-based mobile application developed in Dart [9], integrating GPS and Google Street Maps API for accurate geo-location reporting.
- **Backend:** Firebase services including Authentication for secure login, Firestore for complaint data management, Cloud Storage for image handling, and Cloud Messaging for real-time notifications.
- **AI/ML Module:** Python-based YOLOv5 object detection implemented with PyTorch, performing real-time image analysis and automatic issue classification.

VI. METHODOLOGY

6.1 YOLOv5 Architecture

YOLOv5 is a single-stage object detector optimized for speed and accuracy [1], [2]. It uses a CSPDarknet backbone for efficient feature extraction, a PANet neck to aggregate multi-scale features, and a YOLO head that predicts bounding boxes, object classes, and confidence scores simultaneously. This architecture enables real-time inference suitable for mobile-cloud deployment [8].

6.2 Object Detection Workflow

Users capture images of civic issues through the app, which are preprocessed and transmitted to the backend AI module. YOLOv5 processes these images to detect objects such as potholes, garbage accumulations, and damaged streetlights. The model outputs bounding boxes around detected issues, along with confidence scores indicating detection certainty.

6.3 Image Preprocessing Pipeline

Images are resized to 640×640 pixels and normalized to standardize pixel values. Augmentation techniques such as

brightness and contrast adjustment are applied to enhance robustness against varying lighting and weather conditions. This preprocessing improves detection accuracy across diverse environments.

6.4 Issue Classification and Severity Assessment

Detected objects are classified into predefined civic issue categories. Severity is estimated based on bounding box dimensions and confidence scores, assisting in prioritizing complaints. The AI module generates structured complaint data including issue type, severity level, and geo-location.

6.5 Auto-Generated Complaint Reports

The system auto-populates complaint reports with AI detection results and user inputs. Users can review and modify reports before submission. These reports are stored in Firebase Firestore, linked with associated images stored in Cloud Storage.

6.6 Real-Time Inference and Firebase Integration

Real-time inference is achieved by processing images on a backend server running the YOLOv5 model. Firebase Authentication manages role-based user access and real-time synchronization capabilities [4], Firestore synchronizes complaint data across devices, Cloud Messaging delivers notifications, and Cloud Functions trigger status updates. The admin dashboard interfaces with these services for complaint monitoring and management.

VII. YOLOv5 OBJECT DETECTION WORKFLOW

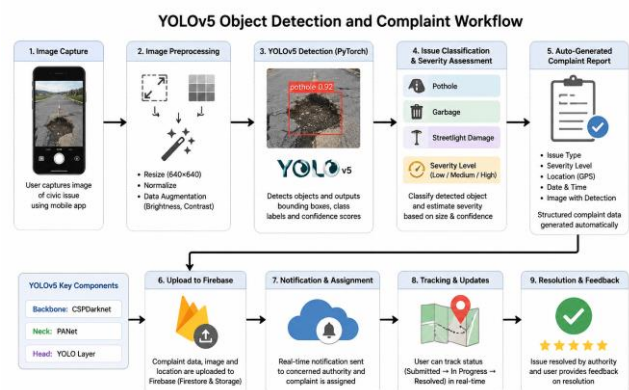


Fig. 2. YOLOv5 Object Detection and Complaint Workflow

Fig. 2 depicts the detailed AI workflow: image capture → preprocessing → backend transmission → YOLOv5 detection → bounding box and confidence score generation → classification and severity assessment → auto-generated complaint report → Firebase storage and synchronization → real-time user updates.

VIII. FIREBASE CLOUD WORKFLOW

Firestore handles authentication, data storage, and notifications to ensure seamless user experience [4]. Complaint data is synchronized in real-time across all user devices. Cloud Functions automate notification triggers upon complaint status changes, enabling timely communication between citizens and administrators.

IX. ADMIN DASHBOARD AND COMPLAINT MANAGEMENT

The admin dashboard provides a comprehensive interface for complaint oversight. Features include:

- **Complaint Management:** View, filter, and update complaints by status, severity, and location.
- **Priority Assignment:** Assign priority levels based on AI-assessed severity and manual inputs.
- **Verification Workflow:** Validate complaints through role-based verification before escalation.
- **Analytics:** Generate reports on complaint trends, resolution times, and user engagement.
- **Real-Time Status Updates:** Monitor complaint progress with live synchronization and notification delivery.

Role-based access control ensures secure operations, with distinct privileges for general users, admins, and government officials.

X. RESULTS AND DISCUSSION

Metric	Value	Implementation Observations
Detection Accuracy	87.5%	Image quality and lighting significantly affect detection.
Precision	85.3%	Higher precision observed in well-focused, clear images.
Recall	83.7%	Lower recall in low-contrast or occluded scenarios.
F1-Score	84.5%	Balanced performance reflecting practical conditions.
mAP (0.5:0.95)	80.2%	Comparable

		with YOLOv5 benchmarks under realistic deployment settings [2]
Complaint Processing Efficiency	+40%	Faster complaint handling compared to manual systems.
Real-time Tracking Latency	~1.2 s	Latency influenced by network speed and Firebase sync delays.

Practical deployment underscored challenges including:

- **Image Quality:** Poor lighting and motion blur reduced detection accuracy.
- **Mobile Performance:** Optimization was necessary to maintain UI responsiveness during AI-assisted reporting.
- **Firestore Synchronization:** Occasional delays in data sync affected real-time updates.
- **GPS Precision:** Urban canyons and dense buildings caused geo-location inaccuracies.
- **Notification Delays:** Poor network conditions led to delayed real-time notifications.

These observations reflect the complexities of deploying AI-powered civic platforms in real-world urban environments.

XI. COMPARATIVE ANALYSIS

Feature	CivicEase (Proposed)	Traditional Systems	Other AI Platforms
AI-Powered Issue Detection	Yes (YOLOv5)	No	Partial
Real-time Complaint Tracking	Yes	Limited	Limited
Cloud-Native Architecture	Firestore-based	On-premises	Varies
Role-Based Access Control	Implemented	Often missing	Varies
Geo-location Reporting	GPS + Google Street Maps	Manual	Partial
Admin Dashboard	Comprehensive	Basic	Varies

XII. RESEARCH CONTRIBUTIONS

Developed a mobile-cloud integrated platform combining Flutter frontend with Firebase backend and YOLOv5-powered AI detection.

- Enabled real-time, automated civic issue detection, classification, and severity assessment.
- Implemented role-based complaint management enhancing smart governance and citizen engagement.
- Conducted practical evaluation of deployment challenges and system performance in urban environments.

XIII. ADVANTAGES OF PROPOSED SYSTEM

- Accelerates complaint reporting and resolution through AI automation.
- Enhances transparency and accountability in civic issue management.
- Scalable cloud infrastructure ensures real-time synchronization and notifications.
- User-friendly mobile interface supports both manual and AI-assisted reporting.

XIV. CHALLENGES AND LIMITATIONS

- Detection accuracy is sensitive to image quality and environmental factors.
- Network latency and Firebase synchronization delays impact real-time responsiveness.
- GPS inaccuracies occasionally affect geo-location precision, especially in dense urban areas.
- Mobile resource constraints require optimization to maintain smooth user experience.

XV. FUTURE SCOPE

- Integration of additional AI models for multi-modal issue detection (e.g., audio, sensor data).
- Enhanced severity prediction using temporal data and historical complaint trends.
- Offline reporting capabilities with deferred synchronization.
- Expansion to support multi-lingual interfaces and wider citizen accessibility.
- Incorporation of predictive analytics for proactive infrastructure maintenance.

XVI. CONCLUSION

CivicEase demonstrates a practical application of AI [8] and cloud technologies [10], [12] for smart city civic issue management. By integrating YOLOv5 for real-time issue detection with a robust Firebase backend and Flutter frontend, the platform offers a scalable and user-friendly cloud-native solution [10], [12]. During implementation and testing, several practical challenges related to image quality, internet connectivity, and GPS precision were observed. Deployment experiences reveal realistic challenges such as image quality limitations, network latency, and GPS precision issues, underscoring the importance of mobile-cloud synergy and thoughtful optimization. CivicEase's intelligent automation and comprehensive complaint management contribute meaningfully to enhancing urban governance and citizen engagement.

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