



(RESEARCH ARTICLE)



## Smart City Vision: A Geo-tagged AI System of Automated Road damage detection and civic workflow management

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### Abstract

The municipal grievance systems have been found to have some difficulties in delayed response, manual verification and non-transparency which have impeded proper management of the infrastructure. Conventional channels are dependent on written descriptions and manual inspection, which make them ineffective and unstable in terms of decision-making. In order to eliminate these constraints, this study presents a Smart City Civic Intelligence and Resolution Management Platform that combines artificial intelligence with web-based processes. Constructed on the basis of Django, the system enables citizens to report complaints with an option to upload the images, which are processed with the help of YOLOv8 to identify the damage which is evident and is then used to classify the severity and estimate the cost of repair. Performance on testing shows that the prototype has acceptable levels of accuracy with inference time of between 1-3 seconds on each image, which illustrates that the system can help revolutionize the municipal complaint management system. The paper sets the stage of scalable smart city governance and the future goals encompass regression-based cost forecast, GIS amalgamation, and implementation of a mobile application.

**Keywords:** Smart City; Civic Intelligence; YOLOv8; Damage Detection; Geo-Tagging; Django; Municipal Complaint Management; AI-based Infrastructure Monitoring

### 1. Introduction

The problems of urban infrastructures like potholes, drainage leakage, broken streetlights, and cracks on roads pose a great challenge to the safety and quality of life of the population. Most of such systems only store textual descriptions and rely solely on manual verification though there are numerous municipalities that offer online forms to file complaints. There are a number of issues with such traditional systems: Delayed response times, lack of consistency in the assessments of severity, lack of transparency, none of the automated prioritization, inadequate inter-departmental coordination.

Recent developments in Artificial Intelligence, particularly the computer vision architectures such as YOLO (You Only Look Once) give a chance to make visual damage detection automated. Simultaneously, the metadata of the geo-tagged images may allow tracking the location accurately. This project suggests a common platform comprising of: Submission of complaints by the citizens, AI-based image analysis, Geo-location extraction, Cost estimation, Role based resolution workflow.

The system fills the gap in between citizen reporting and smart municipal response.

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## 2. Literature Survey

Civic complaint management has been facilitated by a number of digital platforms that have been introduced over the last ten years. Majorities of the current systems are centralized web-based applications whereby the citizen is able to file complaints via online forms. These systems enable authorities to monitor issues using computerized systems unlike in paper records. Although platforms of this kind enhance access and record maintenance, they rely on manual verification and subjective evaluation of complaints to a large extent.

Conversely, great advances have been realized in computer vision of road damages. Research has indicated that deep learning networks especially convolutional neural networks (CNNs) and object detection systems such as YOLO can detect road cracks, potholes, and distress on the surface with fair degree of performance. Research in this direction has also been made possible by the use of datasets like the Road Damage Dataset (RDD) that are publicly available. Nevertheless, the majority of such works are limited solely to training of models, accuracy and performance of detection. They are seldom applied to practical governance processes in the real world and they are not interlaced with civic management systems.

The other shortcoming that has been witnessed in literature is absence of structured role-based workflow integration. Most of the systems are either citizen reporting interfaces only, or are more focused on the analytics at the back of the system, without integrating all the stakeholders, including the citizens, administrators, and field officers, into a single lifecycle. Consequently, the process of resolving the complaint is not cohesive.

Hence, although efforts are underway to enhance the individual capabilities like computer vision, geo-tagging and online system of complaints, a distinct research gap exists in the field of creating a more comprehensive end-to-end civic intelligence system. The combined damage detection in images, geo-location extraction, automated cost estimation, and structured role-based workflow management platform has not been studied broadly based on real-life applications.

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## 3. Existed and Proposed System

### 3.1. Existing System

Most of the current cities have civic complaint management that is conducted manually in a semi-digital fashion. Citizens report problems like a pothole, drainage problem or broken streetlights visiting the municipal offices, filling paperwork or calling the phones.

There are always limitations to the systems in terms of simple complaint submission and simple tracking even in locations where mobile applications or web portals are present. These conventional strategies have a number of disadvantages: Delays in responding, the complaints are checked manually thus slows down prioritization and resolution and lack of transparency.

When citizens file a complaint, they seldom know what becomes of it, which causes them frustration and other disengagements. Human personnel can perform subjective decision-making; this can lead to bias or resource wastage based on severity and urgency. Low location accuracy: Most systems are based on manual address input rather than accurate geo-tagging, and thus it is more difficult to find and fix problems in a short time. Little accountability: Municipal authorities have very little accountability because no clear dashboards or audit trails allow them to monitor their performance. Thus, current systems fail to deliver the speed, precision and confidence needed by the contemporary urban governance. People feel alienated to the process of resolving, and the municipal employees are overwhelmed with ineffective work flows.

### 3.2. Proposed System

The proposed Smart City Civic Intelligence and Resolution Management Platform help to solve these challenges, through the development of centralized, intelligent and citizen-based solution. The system combines AI-based image analysis, geo-tagging, and automated processes to simplify the complaint management process, instead of manually verifying the complaints.

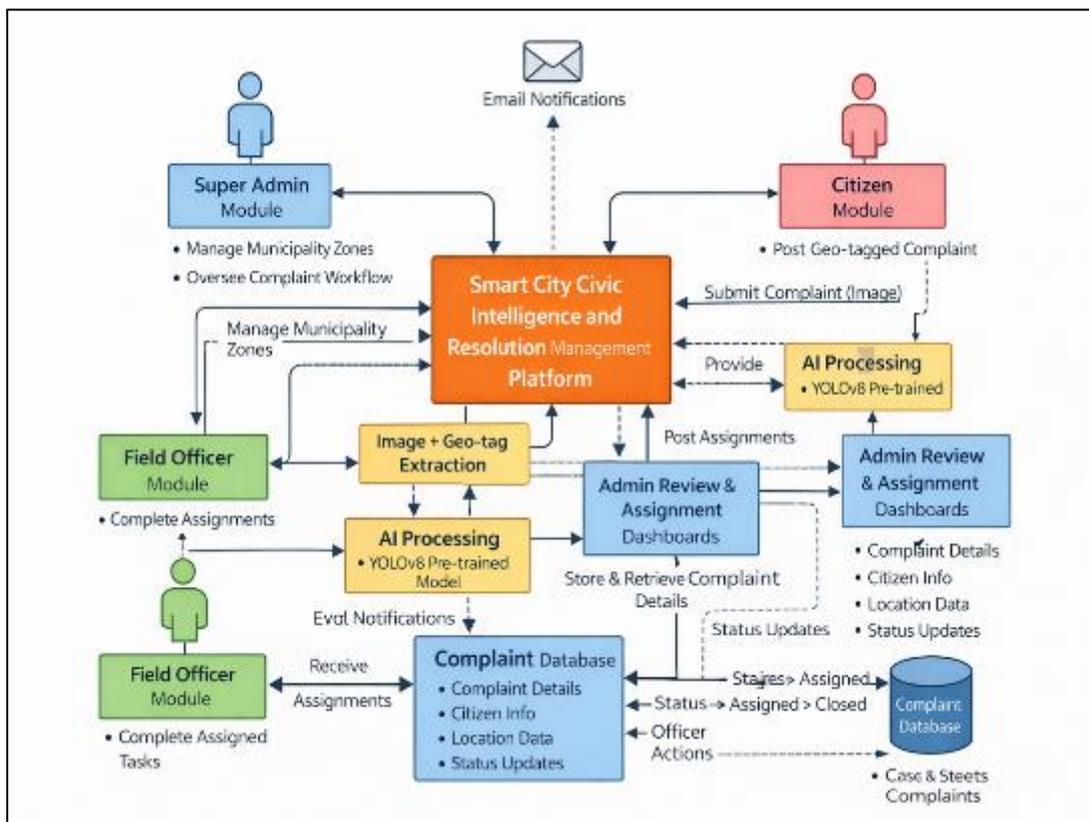
The complaints are submitted by the residents on a web-based interface, where they also attach geo-tagged pictures, which automatically pick up the location of the problem. The system executes the analysis of uploaded images with the help of YOLOv8 and, depending on the type of damage, classifies it by severity, and predicts the cost of its repair. This guarantees priorities that are objective and lessening delays. The real-time location of their complaints can be

monitored by citizens. Municipality Admins look into and delegate duties to Field Officers. Field Officers check on progress and declare problems solved. Super Admins monitor the whole process via the use of monitoring dashboards. Dashboards and visualization instruments allow seeing the trends in complaints, their response time, and resources utilized so that citizens and administrators could see the process. The system is created to support a variety of municipalities, a high number of complaints and further expansion to the cloud to ensure increased adoption.

The proposed system will make civic grievance management a smart, efficient, and trustworthy process by incorporating automation, transparency, and citizen involvement in the program. It acts as an intermediary between people living in the city and the municipal governments, thus making sure that any problem is solved in a timely manner, justly, and in a fully responsible manner.

#### 4. Methodology

The offered system is built on a monolithic Django framework that is selected due to its ease of deployment and ease of integration with AI elements. The internet workflow starts with registering users and role-based log-in, in which the citizens, administrators, and field officers are granted their privileges. Complaints are also allowed on the site where the citizens post pictures and a brief description. When an image has been uploaded, it is automatically read by the system and GPS metadata is read using the Exif Read library making sure it is geo-tagged correctly without any need to enter location information.



**Figure 1** Proposed System Architecture

The model that is then run on the uploaded image is the YOLOv8 that detects the presence of objects to identify present damage through the presence of potholes or cracks. Depending on the severity of the detections, the severity is classified as minor, moderate or severe basis on the number and nature of detections. The classification assists to prioritize complaints and more efficiently distribute resources. It estimates the cost of a repair based on the severity using a simple rule-based cost estimation algorithm, which provides a transparent and prototype-friendly method that does not use the complex regression models.

After AI analysis, the complaint is added to a workflow. The administrators examine the output of AI and delegate tasks to field officers, who check the problem and set the status of the resolution. The citizens can monitor the development

of their complaints live and this makes them accountable and minimizes the element of uncertainty. The platform includes visualization tools created in Matplotlib to facilitate decision-making by creating dashboards that show severity distribution, trends of complaints, and timeline of resolutions. Such insights will help the administrators to recognize repetitive problems, workload regulation, and performance assessment.

## 5. Experiments and Results

In a bid to assess the performance of the proposed Smart City Civic Intelligence Platform, several experiments were done with the aim of assessing AI detection performance, geo-tag accuracy, workflow efficiency, and system response time.

### 5.1. Experimental Setup

The system was tested on standard development environment: Windows OS with 8 GB RAM, Python 3.x, Django 4.2, MySQL (local server), YOLOv8 pretrained weights. Test images included: Road potholes, Surface cracks, Unbroken lanes (without damages), Images having GPS metadata inside them. Images without GPS metadata. This arrangement enabled testing of both the functional and edge-case.

### 5.2. AI-Based Damage Detection Evaluation

Images uploaded were detected with visible infrastructure damage using the YOLOv8 model. Each image was fed into the system and it provided back detections of bounding boxes and confidence scores. The severity classification was calculated on the basis of: Number of detected regions, size of bounding boxes and confidence threshold.

#### 5.2.1. Observations

Huge and visible potholes were observed with maximum confidence. Small surface cracks were sensed moderately with regard to the lighting and clearness. Images of clean roads were rightly rated as low severity. Minimal false positives were achieved with confidentially adjusted confidence threshold.

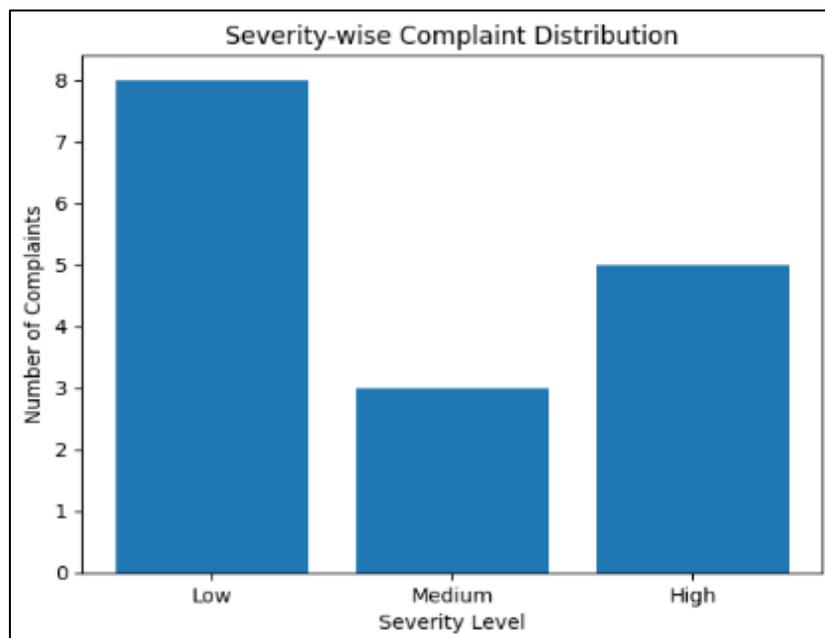


Figure 2 Distribution of Complaints Across Severity Levels

### 5.3. GPS Extraction Validation

In order to prove geo-tag functionality: Pictures that contained EXIF GPS were uploaded. Exif Read was used to extract the values of latitude and longitude. The generated coordinates were checked manually. Proper retrieval of valid EXIF-images. Secure manipulation of non-gps tagged images. None of the system crash or wrong coordinate parsing had been noticed. This guarantees good geo-location mapping in tracking complaints.

#### 5.4. Cost Estimation Analysis

There was cost estimation based on rule-based formula:

$$\text{damage\_size} = (\text{width} + \text{height}) / 2$$

$$\text{total\_cost} += \text{damage\_size} \times \text{cost\_factor}$$

The verification of the calculated values was done by hand.

The cost was proportional to size of damages detected. Several discoveries led to cost estimation accumulation. When no damage had been found, base cost was charged. Despite the fact that the rule based approach was not trained using regression models, it produced the same and interpretable estimates that could be used in prioritization.

#### 5.5. Workflow Efficiency Testing

End-to-end workflow testing included: Filing complaint by citizens, AI processing, Admin review, Officer assignment, Status update to closure.

The phases of the complaint cycle that were successfully passed through include:

The phases of the complaint cycle that were successfully passed through include:

Pending → Assigned → Closed

Repeated tests did not find any inconsistencies in databases.

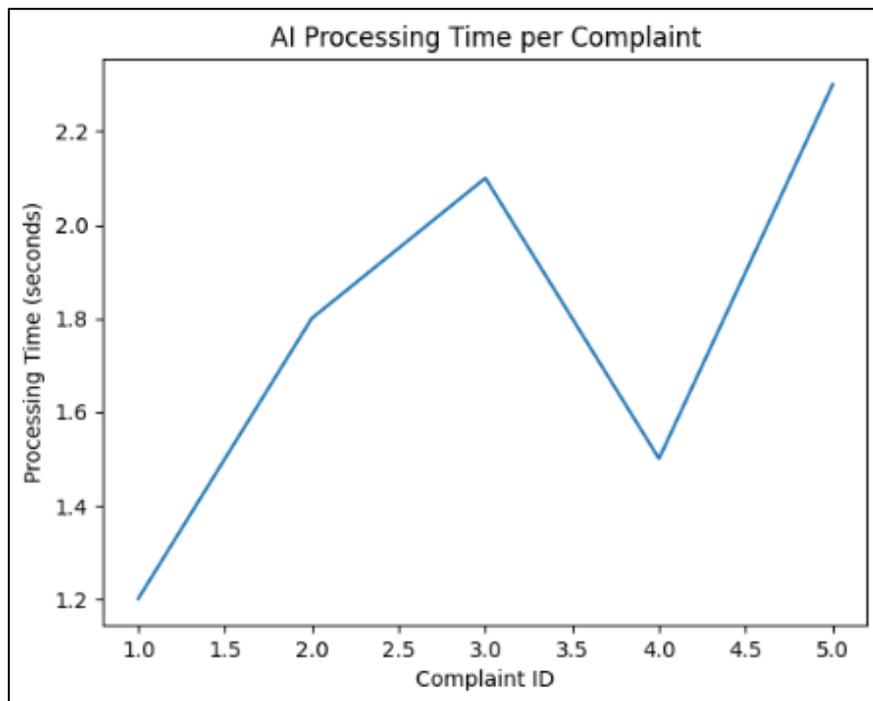


Figure 3 AI Processing Time Analysis per Complaint

## 6. Comparative Analysis

To see the contribution of the proposed system better, the proposed system was compared with the traditional municipal complaint systems.

**Table 1** Comparison Between Traditional Complaint System and Proposed AI-Based Civic Management System

Feature	Traditional System	Proposed System
Complaint Input	Text-based only	Image + Geo-tag
Damage Assessment	Manual	AI-based
Cost Estimation	Manual	Automated (Rule-based)
Location Accuracy	Address-based	EXIF GPS
Status Transparency	Limited	Real-time
Analytics Dashboard	Minimal	Graphical Reports
Prioritization	Manual	Severity-based

The proposed system improves: Automation, Accuracy, Transparency, Decision-making efficiency. The proposed platform incorporates AI-based intelligence into the complaint lifecycle, unlike the traditional systems that use manual inspection.

### *Future Scope*

Although the existing system has been modelled as a working prototype, there are a number of areas that can be improved to increase the level of scalability and intelligence.

Train custom YOLO models using larger datasets. Implement crack detection by segmentation. Use regression cost prediction models. Integrate Google Maps or OpenStreetMap APIs. Create live complaint clusters heatmaps. Implement system on cloud (AWS/Azure). Use containerization (Docker) for scalable deployment. Add distributed database architecture. Feedback and rating system of complaints. Reopen function of complaints. Multi-language support. Cluster to identify high-risk regions (e.g. DBSCAN). Expect the trends in the deterioration of infrastructure.

These would make the platform more than an experiment and a full-scale smart city governance solution.

## 7. Conclusion

The platform of Smart City Civic Intelligence and Resolution Management illustrates the ways artificial intelligence may be successfully incorporated into the system of municipal governance. The project achieved: Damage detection by automated image, tracking of complaints using geo tags, estimation of repair cost that is based on rules, transparent workflow management, administrative analytics boards.

Infrastructure damage detection using YOLOv8 has a great chance to decrease the use of manual inspection. Roles can be used to optimize the workflow, and GPS metadata extraction can be used to increase the accuracy of location.

Despite the fact that the present implementation is done on a prototype level with tests being conducted in a controlled setup, the system provides a solid base to smart city management of civic issues. The proposed solution is able to fill the gap between citizen reporting and AI-assisted municipal response.

## Compliance with ethical standards

### *Disclosure of conflict of interest*

No conflict of interest to be disclosed.

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