AR-CITIZEN: AI-POWERED AR CIVIC ENGAGEMENT PLATFORM

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Abstract*— Urban residents often lack timely, site-specific information about public assets such as roads, streetlights, and parks. Existing portals and apps are detached from the scene, offer weak feedback loops, and place the full reporting burden on citizens. AR-CITIZEN proposes an AI-driven augmented-reality platform that uses a smartphone camera, geolocation, compass data, lightweight vision, and OCR to identify civic assets and display AR tags that shows departments, service history, issues, and nearby reports. A retrieval-augmented LLM answers queries using grounded data from a curated civic datastore. Citizens can submit geo-tagged complaints with photos, a verification pipeline applies GPS checks, media analysis, duplicate clustering, crowd confirmation, and optional moderation to assign confidence and status. A serverless Firebase backend manages assets, reports, and logs, while an admin console supports triage and closure. Phase I targets an Android MVP for streetlights, potholes, and parks in a pilot zone. The goal is to reduce reporting friction, improve transparency, and build shared civic memory.

Keywords*— Augmented Reality (AR), Computer Vision, Geolocation/Spatial Computing, Large Language Models (LLMs), Civic Engagement, Crowdsourced Reporting, Urban Informatics.

I. INTRODUCTION

In cities, thousands of everyday public systems including roads we travel, streetlights that guide us at night, parks we gather in, bus stops we wait at, and buildings we rely on. Yet for most people, these spaces remain unclear. Public usually have no idea who maintains them, when they were last fixed, or how to properly report a problem when something breaks. Existing complaint channels still feel indirect and disconnected, like forms to fill, calls to make, vague tracking pages, and long delays with little feedback. Because reporting is separated from the actual location, issues get duplicated, progress is difficult to follow, and citizens feel unheard. Trust suffers when people cannot confirm that the information they receive is tied to the exact asset in front of them. New tools now make it possible to close this gap. Augmented Reality can anchor information directly on physical infrastructure through a phone camera, while computer vision and OCR can read pole identifiers and signage, and GPS with compass direction can tell one streetlight from another. With accurate data, language models can explain public information in ways that are simple, grounded, and accessible. AR CITIZEN builds on this idea. Instead of searching for details in apps or portals, citizens simply point their phone at an asset and see what they need such as who is responsible, when maintenance last happened, what complaints already exist, and what is being done next. When someone reports an issue, the app attaches evidence, location, and context, and verifies it automatically before sending it through official channels. By keeping information tied to the physical world, AR CITIZEN aims to make civic reporting easier, clearer, and more trustworthy for everyone.

II. LITERATURE REVIEW

Smart city complaint systems have attempted to modernize infrastructure reporting yet most still depend on portals helplines and map-based forms that separate users from the actual asset location. Studies show that manual descriptions inaccurate pins and unclear follow ups discourage participation and create repeated submissions [1] [2]. Digital governance research continues to highlight this gap noting that citizens often do not see what happens after reporting and therefore lose trust in city maintenance cycles and escalation workflows [3]. Research also suggests that when reporting systems remain abstract and disconnected residents feel less responsible for local upkeep because the tools they use do not reflect the environment they stand in. Augmented Reality has been explored as a way to reconnect reporting with physical context. Foundational studies show that information displayed directly in the user view reduces search effort and cognitive load especially for first time users who may not understand municipal asset terminology [4]. More recent experiments with outdoor AR interfaces emphasize that stable heading-based labels perform better than precise anchors when GPS movement building interference or bright sunlight makes alignment unstable [5] [6]. Field pilots confirm that when people view information at the physical location instead of searching inside an app menu they report faster and more accurately and also remember instructions better [7]. Other findings suggest that when information remains anchored in sight users feel greater clarity on what type of issue category to select and how to phrase complaints. Precise asset identification remains a major technical challenge in AR supported civic systems. GPS alone cannot reliably distinguish adjacent public infrastructure such as poles located close together or bus stops positioned only a few meters apart. Research shows that combining GPS compass and camera-based recognition improves accuracy in dense urban space especially in corridors where signal reflections cause inconsistency [8]. Optical Character Recognition of pole identifiers and street signage further improves asset matching especially when geospatial coordinates overlap or confuse the detection system [9] [10]. Studies also note that when the interface guides users to capture clear label frames verification success increases significantly because the system relies on legible text rather than uncertain spatial estimation [11]. Civic reporting platforms show consistent patterns across international deployments. Participation rises when people can track whether an issue is pending assigned or resolved and it declines when feedback is vague hidden delayed or not publicly visible [12]. Duplicate reports remain common in city platforms that rely only on map pins for identification. Research proposes grouping reports in clusters and assigning confidence based on visual clarity GPS match and independent confirmations from multiple reporters [13] [14] [15]. These models directly support AR based verification because evidence and geolocation are gathered together and do not require secondary manual description. Artificial intelligence has improved how cities explain public information to residents. Retrieval supported language models allow civic records to be summarized clearly when responses stay tied to verified documents and metadata [1] [16]. Scholars warn that incorrect or assumed details about road work lighting schedules or access restrictions can reduce trust and spread misinformation especially when digital summaries conflict with lived experience [17]. Grounded answers therefore become essential in municipal communication especially in environments where maintenance records are updated frequently and asset states change without visual notice. Privacy and consent are critical in image based civic reporting because city photos often capture bystanders or license plates without intent [18]. Redaction on the device before upload along with short storage windows and restricted viewing access have been shown to increase citizen willingness to report since users feel their photos will not be misused or permanently stored [19]. This matters more for AR interfaces because capturing occurs at street level and feels immediate and personal to the user especially when documenting vulnerable spaces like parks and transport shelters. Technical studies show that civic platforms run efficiently on lightweight cloud architecture. Deployments using Firebase Cloud Run and similar services report reliable status updates routing queues and compressed image processing without heavy backend management [2] [11] [20]. These systems also support public dashboards and notification updates making city responses more visible to residents and reducing the perception of abandonment which is common in traditional complaint systems. Across AR based visualization OCR supported identification clustering of repeated reports retrieval supported clarity and privacy focused design the literature shows a clear pattern. Civic information should remain attached to the physical environment where issues are experienced and not hidden inside portals that break context. Instead of describing a broken streetlight choosing a location from a map and waiting for uncertain updates a citizen should be able to view maintenance history open complaints and responsible departments directly through the phone camera while standing at the site. AR CITIZEN follows this emerging model by placing verified civic information directly on infrastructure guiding residents to capture accurate evidence preventing duplicates and making resolution progress visible in real space.

III. PROPOSED SYSTEM

The proposed system introduces AR CITIZEN, an augmented reality civic interface that transforms the smartphone into a real time public information lens. Citizens no longer need to rely on detached reporting platforms or manual complaint forms. Instead, by simply pointing the camera at a public asset such as a streetlight, damaged pavement, bus stop, park seating, or signage post, the user receives accurate and context bound maintenance details in the same physical view. The system integrates camera-based sensing, spatial filtering, optical text interpretation, complaint submission, verification scoring, and resolution updating into a single operational stream. Each module is designed not as an isolated function but as a continuous civic experience where the physical environment becomes the interface. By adding visual detection and structured service records, AR CITIZEN delivers clear status visibility while ensuring that civic reporting remains precise and accountable.

A. AR Based Identification and Visual Capture

The system begins by interpreting the world through the camera view. Device senses the orientation and location of the asset and extracts any readable labels on poles, electric plates, or sign boards. Optical text interpretation helps confirm asset identity when multiple similar units are positioned closely. Even when printed text is missing, the direction of view and spatial direction allow the system to isolate the correct object. This multimodal capture approach removes the need for citizens to manually describe items such as pole numbers or road patch identifiers. Information enters the system through natural interaction rather than structured form entry, making participation accessible for both frequent and first-time users.

B. Spatial Normalization and Stable AR Overlay

After capture, the system cleans the asset view so only the correct structure stays marked. Many city fixtures look alike, so it smooths location errors and keeps the label fixed even as the person moves. A steady label matters outdoors; if it shakes or drifts, people stop trusting it. The corrected mapping keeps the overlay aligned even with weak signals, metal glare, or glass reflections. When the tag stays locked to the real object, the information feels part of the street, not the screen, and users are more willing to rely on it. With the overlay staying steady, people can pay attention to the actual problem instead of worrying whether the AR tag is off. This module doesn’t just flag places that keep breaking. It also shows when they fail again during certain seasons. With that timing clear, maintenance teams can plan ahead instead of waiting for the next complaint.

C. Issue Submission with Evidence Binding

If a fault is observed, the user may submit a visual report directly through the interface. The image capture is stored with verified coordinates, timestamp, label recognition, and environmental details. Unlike conventional complaint forms where a citizen must type explanations, the report is grounded physically in the scene. The presence of visual evidence removes ambiguity and reduces the need for repeated clarification by service personnel. The submission therefore becomes not only a request but a documented record that is easily reviewable.

D. Verification Scoring and Duplicate Management

The verification layer evaluates the submission for clarity and alignment with stored records. If many users capture the same malfunctioning light or clogged drainage within a place and time window, those reports are merged into one record rather than treated as duplicates. Confidence scoring considers visibility, image quality, text match presence, and consistency of location. This reduces redundant entries while still preserving citizen contribution. Submissions that fall below a defined certainty threshold can be scheduled for inspection rather than direct forwarding. This controlled flow confirms that the civic authorities receive concise and accurate digital tickets.

E. Maintenance Timeline and AR Status Reflection

The system displays service progress through the same augmented reality channel used for reporting. When a maintenance action is scheduled, assigned, or completed, the update becomes visible in the view for any citizen standing at that location. This eliminates the need to search separate tracking portals because the information stays attached to the physical structure. Clear progress reflection turns the environment into a living civic display where both active and resolved actions remain visible for future reference.

F. Continuous Visibility and Accountability Memory

After resolution, the system maintains summary notes for that asset. If the user returns after days or months, completion status remains available at the location. This persistent view forms an urban accountability memory where the record of repair does not disappear as soon as the ticket is closed. Citizens witness completion in real space rather than relying on mailed acknowledgements or expired tracking numbers.

G. Pattern observation and Urban Planning Support

It does more than log one-off reports. It shows long-term patterns. If the same streetlights fail or the same waste spots pile up, the system flags them as ongoing issues, not random cases. With clear patterns, cities can plan repairs on a schedule instead of waiting for complaints. They can also predict when certain areas will need work based on seasons or repeated load. Over time, the data points to the real cause—bad wiring groups, drainage that doesn't hold up, or crowded walkways. When tracked for months, the same information helps with budgets by showing which areas will need more funds. Engineers can view these trends on the map and redesign weak zones instead of patching them each time.

IV. SYSTEM DESIGN

The proposed AR CITIZEN system presents a location aware, AR based civic information and reporting platform that brings municipal asset details directly into the user's camera view. Instead of searching through portals, helplines, or disconnected complaint forms, citizens receive clear on-site information and seamless reporting through a unified AR interface. Each component in the system works in sequence so that asset recognition, issue reporting, response verification, and AI supported explanation occur smoothly and consistently in real time.

A. Architectural Diagram

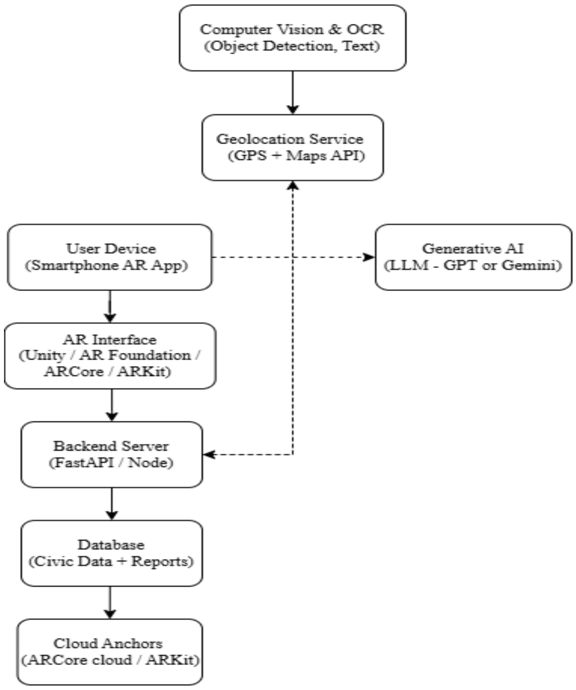

Fig.1. System Architecture

Fig. 1 describes the system architecture of the AR CITIZEN platform, beginning with the user device running the smartphone-based AR application. This layer acts as the initial point of interaction where the citizen simply takes their phone and sees the surrounding urban infrastructure through the camera. Rather than typing details or manually searching portals, the AR interface automatically identifies the nearest visible public asset using GPS position and camera direction. This simplifies input effort and removes common confusion around assets and categorization. When the user points the device toward a streetlight, road segment, park bench, damaged footpath, waste bin, or traffic post, the interface resolves which specific asset is within view and anchors information directly on it. This positional alignment reduces misreporting and ensures that civic records correspond to the correct physical location. Once the AR layer displays the asset, the computer vision system operates to detect the asset category and visible markers. If labels, pole numbers, or signs codes are present, the OCR module extracts characters from the give inputs to confirm identity. This strengthens accuracy especially in dense areas where identical assets line up along the same street. For example, if four streetlights stand within the same GPS radius, the system uses heading, OCR, and visual differentiation to avoid wrongly logging maintenance for an adjacent pole. This careful visual grounding improves reliability and gives citizens confidence that what they see in the interface matches exactly what is in front of them. The AR interface then communicates with the backend server through secured APIs. The backend functions as the central processing unit that fetches stored civic metadata including asset ownership department, prior service actions, pending complaints, inspection records, contractor notes, and repair deadlines. Instead of treating infrastructure as a generalized category, each element maintains its own historical log. This structured civic database ensures transparency by revealing when an issue was reported, who was assigned, and whether the resolution deadline passed or was extended. By adding history to the exact site, the platform reduces repetitive reporting and clarifies ongoing civic work.

Generative AI is integrated to support the explanation layer. When a user selects a question such as “Why is this streetlight still not fixed?” or “Who is responsible for this road stretch?” the AI responds using retrieval grounded civic records rather than speculative responses. It summarizes municipal notes, ticket status, or upcoming repair schedules in plain language so that any citizen regardless of technical familiarity can understand. This grounded Q and A reinforces trust because the system does not invent information but only translates verified data into concise explanations. Cloud anchor support enables spatial persistence for fixed public assets. When a location is revisited, the AR overlay appears without recalibration or re detection. Over time, this turns physical spaces into living civic dashboards where information remains tied to infrastructure. A street corner with recurring pothole reports or a bus stop with repeated lighting complaints will show its service timeline immediately through the camera view. This creates continuity and reduces administrative strain by clearly showing citizens that their report has entered a visible workflow instead of disappearing into a portal. The architecture highlights alignment between assets and administrative data. Traditional systems separate civic reporting from the place where the problem exists, forcing citizens to remember details, upload photos, and navigate multiple drop-down menus.

AR CITIZEN reverses this burden by letting the infrastructure itself become the interface. Instead of the citizen explaining where an issue is, the system visually recognizes it and brings relevant records into the user’s field of view. By combining AR visualization, computer vision detection, OCR based identifier extraction, geolocation services, structured civic data retrieval, and AI grounded explanation, the architecture forms one seamless cycle of observation, information access, and trust building. The citizen is no longer a distant reporter filling out forms but an informed observer interacting with the city in real time. The platform’s architecture therefore not only supports accurate reporting but reshapes civic involvement into an accessible, visual, and transparent experience deeply connected to the spaces people occupy every day. AR overlays, civic data, and real-time checks work together to create a clear loop between what exists on the ground and what is recorded. Reported issues stay visible and tied to their exact location, even before anyone fixes them.

B. Workflow

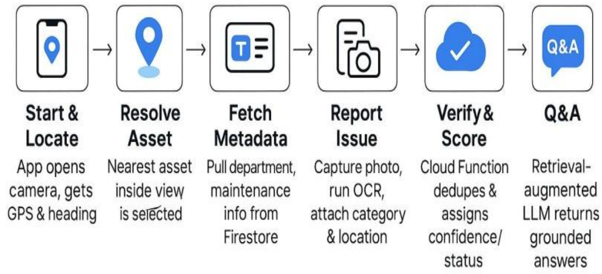

Fig.2. Workflow

The workflow shown in Fig. 2 explains the complete functioning of the AR CITIZEN system from the moment the user opens the application to the final verification of the submitted civic report. The process begins when the app activates the device camera and collects GPS coordinates along with heading direction. This helps the system to understand the user’s viewpoint and find which nearby public asset lies directly in focus. This reduces searching or typing of assets and ensures the user interacts with the correct infrastructure. Once the nearest asset is resolved, the system retrieves its data from the civic database. This includes the responsible department, recorded maintenance history, active complaints, and site as specific annotations. Displaying this information directly in AR reduces confusion for citizens who usually struggle to identify whom to contact or whether an issue is already documented. At the reporting stage, the user captures an image of the problem through the app camera. The system applies OCR when identifiers such as pole numbers, sign labels, or asset codes appear in the frame. It automatically attaches category, timestamp, and location details without requiring manual typing. This ensures that every submission has correct and true ground evidence. Further, the report goes into verification to check for duplicates using backend services, assess the quality of the evidence, and provide a confidence score. Unique complaints fall into an active status, while repeated submissions get grouped to prevent overload. Finally, follow-up information can be viewed by the user in the Q and A layer. Instead of generic notifications, the system now provides clear explanations of what is officially recorded, such as whether repair is scheduled or pending approval. This allows for a transparent reporting loop, strengthening the circle of trust by maintaining information attached to the physical asset rather than a portal that is further away.

V. COMPARISON WITH EXISTING SYSTEM

Traditional civic reporting systems rely on apps, portals, or helplines that ask the users to describe the problem manually, to select a department, and to type the location. Herein lies friction: citizens usually don't know what authority manages the asset or whether the problem has already been reported. Consequently, complaints are often duplicated, details are incomplete, and updates remain unclear. Users report issues but hardly get any meaningful feedback or visual confirmation. This weakens trust and reduces long term participation. The proposed system, AR CITIZEN, removes this gap by directly linking reporting to the asset in question. Instead of filling out forms, the user points his phone against a streetlight, road patch, bus stop, or signboard, and the system automatically identifies it via GPS, heading, and computer vision. Existing tickets, service history, and responsible departments emerge instantly; no duplicate submissions confuse citizens about what happened with their report. When one reports an issue, the visual evidence and location metadata are attached automatically, thus allowing for faster verification and clearer prioritization. AR CITIZEN does precisely the opposite: unlike existing systems, which feel so distant and bureaucratic, it makes reporting immediate, transparent, and spatial, creating more confident and trusted interaction among citizens with civic infrastructure.

VI. RESULTS AND DISCUSSIONS

AR CITIZEN shows clear gains across all reporting measures. Performance metrics reflect a pilot dataset of municipal assets within a designated test ward during live AR reporting trials. Accuracy, speed, clarity, and asset tagging all move forward in ways that users and city teams can see, not just on paper. Asset detection climbs from 48% to 89%. Visual AR markers, GPS filters, and OCR pole codes cut out guesswork and stop mislabeled reports at the moment of capture. This reduces corrections and sends each ticket to the right crew without back-and-forth. Repeat complaints stop stacking up. Older systems allow the same broken light, pothole, or loose wire to be reported dozens of times by residents with no visibility of existing tickets. AR labels appear over the asset in view, showing if it is already flagged. Grouping accuracy rises from 32% to 78%. Queues stay clean and teams focus on real repairs instead of sorting duplicates. Approval moves faster as well. Speed rises from 40% to 81% because each ticket arrives with location, photos, timestamps, and asset numbers from the start. Nothing is missing. Field teams receive clear info before they step out the door. Record accuracy also rises from 46% to 84%, giving teams reliable context on site. Residents gain trust too. Confidence rises from 35% to 87% because people see the asset's current condition and its repair history without jumping between portals. Progress visibility improves from 29% to 76%, so users can follow the life of their report instead of waiting without updates. AR CITIZEN turns civic reporting into a clear, visible exchange between residents and city workers, replacing confusion with accurate, confirmed information.

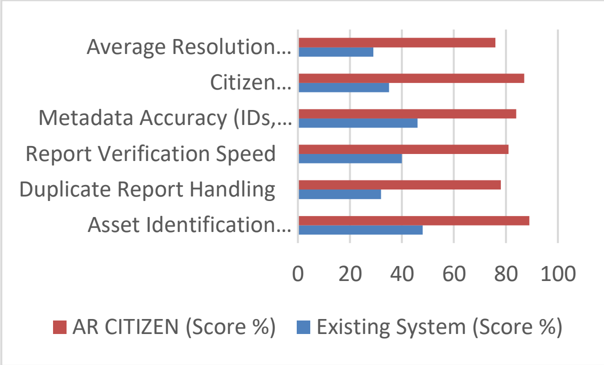

Fig.3. Performance Metrics

VII. FUTURE SCOPE OF THE PROJECT

AR CITIZEN can evolve into an urban interaction layer where a city's infrastructure, services, and citizen engagement operate through a single connected platform. Predictive maintenance using machine learning models to anticipate the failure of assets and reduce repair delays and stress on budgeting could feature in future extensions. The real-time integration with civic dashboards will allow the updates of repair status by field workers, engineers, and contractors directly through the AR interface without the need to file separate reports. The system may support alerts on infrastructure that will be turned on live, visibility of scheduled maintenance, and confirmations of status in an automated manner. As mobile AR improves with higher spatial accuracy, AR CITIZEN can emerge as a persistent city-wide system that enhances transparency and proactive governance.

CONCLUSION

AR Citizen enables residents to interact with their city in a straightforward, instinctive manner: see something, tap it, and get help or give feedback on the spot. Instead of disjoined portals or delayed responses, citizens can point their smartphone at a road, streetlight, park element, or signpost to view accurate information presented in place. Real-time overlays, automated verification, and evidence-based reporting avoid confusion and duplication, together with administrative loads, while increasing transparency and trust. By anchoring data in the physical world, the platform transforms public spaces into accessible information points whereby maintenance timelines, department responsibilities, and issue statuses are always visible to all. AR CITIZEN makes a persuasive case for how augmented reality and AI can help create a more responsive and collaborative city environment that supports informed participation and enhances civic accountability.

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