

Urban Intel Platform – A Smart Response System for Emergency Services

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Abstract:

The process of rapid urbanization and growing populations' densities increases the complexity of emergency management. Traditional mechanisms of reporting emergencies are mainly limited by telecommunication tools, leading to inefficient reactions, wrong geolocation information, and incompleteness of the situation's description. Those factors negatively affect situational awareness and the quality of emergency management. To solve these problems, this paper proposes Urban Intel, an intelligent emergency response system that can provide assistance for real-time incident reporting, automatic disaster classification, and efficient emergency dispatching. The presented system allows citizens to report emergencies, providing structured information with the descriptions, urgency level, multimedia content, and geolocation data through web interfaces. It uses the AI-based image classification module to identify the category of a disaster such as fire, flood, accident, and destruction. Also, geospatial intelligence can be used to route incident to an appropriate emergency organization depending on the category and location of the incident. Real-time communication between citizens, responders, and administrators also provides advantages for the efficiency of the process. Through integration of web technologies, machine learning algorithms, cloud computing, and geospatial services, Urban Intel offers a scalable and intelligent emergency management solution.

Keywords - Emergency Response, Smart Cities, Artificial Intelligence, Disaster Management, Geospatial Intelligence, Incident Classification, Emergency Dispatching.

I. INTRODUCTION

The growing complexity of modern cities has created challenges for emergency response organizations. Rapid population growth, urban congestion, and more frequent disasters have raised the need for efficient emergency management systems that can provide timely and accurate responses. Traditional emergency reporting methods mainly rely on voice communication through emergency call centers, which often face issues like communication delays, incomplete incident details, inaccurate location reporting, and difficulties in prioritizing multiple emergencies happening at once. These problems can greatly impact response effectiveness and public safety. Recent developments in information technology, geospatial intelligence, cloud computing, and artificial intelligence provide chances to change traditional emergency response methods into smart, data-driven systems. Smart city initiatives focus on using digital technologies to improve public services, situational awareness, and emergency readiness. In this context, intelligent emergency management platforms can be vital by allowing real-time communication between citizens and emergency agencies while supporting automated decision-making.

Urban Intel is proposed as a web-based platform for intelligent emergency response that addresses the problems of traditional reporting systems. It lets citizens submit structured emergency reports that include incident descriptions,

urgency levels, multimedia proof, and precise geolocation information. To improve operational efficiency, the system uses a machine learning classification mechanism that automatically identifies disaster types from uploaded images. This feature reduces the need for manual assessments and allows incidents to be sent to the best-suited emergency service providers. Besides incident reporting and classification, Urban Intel uses geospatial intelligence to locate the nearest relevant emergency agencies and help with effective dispatching. The platform also enables real-time monitoring, incident tracking, and analytical reporting, allowing administrators and responders to keep track of the situation throughout the emergency lifecycle. The main goal of this research is to create and assess an intelligent emergency response framework that combines artificial intelligence, geospatial technologies, and real-time communication to improve emergency reporting and response coordination. By bringing these technologies together into a single platform, Urban Intel contributes to building resilient, responsive, and data-driven smart city infrastructures.

II. RELATED WORK

Recent research has shown the increasing role of smart technologies in emergency management and disaster response systems. Various studies have looked into how real-time communication, location information, artificial intelligence, social media analysis, and Internet of Things (IoT) technologies can improve emergency response effectiveness. Rosyidah et al. proposed an emergency response app that uses Socket.io and WebRTC technologies for fast communication and location-aware emergency services. Their findings emphasized the need for real-time information sharing between citizens and emergency responders. Inspired by this, Urban Intel uses real-time communication tools to ensure quick transmission of emergency reports and updates.

Bodkhe et al. introduced the Track-Me-Down Emergency Location Service Provider, highlighting the importance of accurate geolocation during emergencies. Their work showed that precise location sharing significantly enhances emergency response coordination. Urban Intel applies similar ideas by incorporating automatic geolocation tagging and location-aware incident routing. Research on Mobile Crowdsensing (MCS) for disaster management has pointed out the value of information generated by citizens in emergencies. However, past studies also noted challenges related to misinformation, inconsistent reports, and data validation. To tackle these issues, Urban Intel uses structured reporting forms, urgency classification, and multimedia validation methods to increase information reliability.

Firmansyah et al. studied the use of image text extraction and ChatGPT-assisted geolocation for disaster response. Their findings revealed that artificial intelligence can enhance location inference and situational understanding when traditional location data is missing. This research supports the integration of AI capabilities in future versions of Urban Intel. Recent studies on Artificial Intelligence in Disaster Management and Disaster Risk Management have highlighted the effectiveness of machine learning, predictive analytics, and automated classification systems in emergency operations. These methods allow for quicker incident identification, better resource allocation, and improved situational awareness. Urban Intel builds on these concepts with AI-powered image classification that automatically sorts incidents like fires, floods, accidents, and structural damage.

Moreover, new research on the Internet of Emergency Services (IoES) and IoT-enabled disaster management systems shows the potential of connected sensors, smart devices, and real-time monitoring systems to enhance emergency coordination. These advancements lay the groundwork for Urban Intel's future growth through IoT integration, predictive analytics, and smart decision-support features. While existing studies address specific areas of emergency management, few offer a unified framework that combines citizen reporting, AI classification, location intelligence, real-time communication, and agency coordination on a single platform. Urban Intel seeks to fill this gap by integrating these elements into a complete emergency response ecosystem.

Authors	Year	Methodology / Technology	Major Contribution	Limitation
A. D. Rosyidah et al.	2024	Socket.io and WebRTC	Developed a real-time emergency response application with location-based communication services.	Lacks AI-driven incident classification and automated dispatch mechanisms.
H. Bodkhe et al.	2025	GPS-Based Emergency Location Service	Improved emergency response through accurate user location tracking and sharing.	Focused primarily on location services without intelligent prioritization.
D. Cicek and B. Kantarci	2023	Mobile Crowdsensing (MCS)	Utilized crowdsourced information for disaster management and situational awareness.	Challenges related to data reliability, scalability, and misinformation.
H. B. Firmansyah et al.	2024	ChatGPT and Image-Based Geolocation	Enhanced disaster response by extracting location information from images and social media content.	Limited integration with emergency agency coordination systems.
J. P. J. Peixoto et al.	2024	Geospatial Analytics and Smart City Infrastructure	Optimized placement of emergency detection units using urban infrastructure data.	Focused on infrastructure planning rather than real-time incident management.

Table 1. Literature Review

III. RESEARCH GAP AND MOTIVATION

Existing emergency response systems typically specialize in a particular disaster management function, such as location monitoring, social media analytics, crowdsourcing information acquisition, or delivering emergency alerts. Although these systems have improved specific aspects of emergency management, there is a lack of development of a comprehensive intelligent framework to consolidate real-time citizen reporting, artificial intelligence (AI), geospatial intelligence, media content processing, and automated emergency agency dispatching. Conventional methods of reporting emergencies through voice, for example, lead to problems such as inconsistent reporting, inaccurate location, late reporting, and misallocations of emergency personnel. Some research has been conducted using IoT devices, Geographic Information System (GIS) tools, artificial intelligence, mobile sensing, and social-media based disaster intelligence for emergency response.

Many existing emergency management systems have, however, treated each of these capabilities individually rather than using them in a well-integrated, intelligent way in a large-scale platform and do not effectively support real-time emergency decision-making. In addition, some emergency management systems still rely on manually checking, and classifying the incident reports, which can delay a response significantly. Moreover, in many cases, emergency agencies have a poorly integrated communication structure and share data across agency boundaries, relying on manual data transmittal, which slows responses. The multimedia contents of incident reports, furthermore, many of emergency management systems only weakly support for analyzing media contents to understand the level of the severity or the conditions on-site. Most incident management systems have no specific methods for intelligent incident sorting.

This proposed work presents the intelligent emergency management framework of the "Urban Intel" that will seamlessly integrate with all three core emergency management requirements: AI based on incident categorization, location information, media contents processing, automatic sorting, and automatic nearest agency dispatching. The framework developed combines technologies such as AI, mobile communication, geospatial data, rich media and automated dispatch systems to enhance situation awareness, reduce response times, improve cross-agency coordination, and make a faster, more informed decision, as part of a broader and scalable smart city ecosystem.

IV. PROPOSED FRAMEWORK

Urban Intel is envisioned to be a smart emergency response framework designed for collaboration among citizens, emergency responders and system administrators. The framework consists of 5 major modules: (i) Citizen Reporting Module, (ii) AI Classification Engine, (iii) Geospatial Intelligence Module, (iv) Agency Management Module, and (v) Administrative Analytics Module. These modules work synergistically to deliver a intelligent ecosystem for real-time reporting, assessment, dispatching, and monitoring of incidents. The process begins when a citizen initiates an emergency report via the platform.

The report can contain a text-based description of the event, its urgency level, location data in lat/long, as well as supporting media such as images and/or videos. With these parameters standardized across reports, detailed yet unambiguous data may be delivered to emergency agencies for evaluation of an event. Following submission of the report, any media in the report is fed into the AI Classification Engine for automatic incident detection and categorization of the event. For example, the AI model can identify images of a burning house or a car accident to predict the emergency category and send this label along with the report. The identified incident is sent to the Geospatial Intelligence Module for routing.

This module leverages incident information such as type of incident, its location and severity to identify the most appropriate service provider by applying a nearest agency policy in relation to location or other smart routing algorithms. Finally, incident notification and delivery is performed by the Agency Management Module to the intended service agency through a user-interactive display and real-time dashboards which will contain details of the event, progress status of any associated ongoing response, and ongoing updates to be delivered by on-field personnel and the framework to support situation awareness. Performance evaluation metrics for ongoing and past incidents can be generated using the Administrative Analytics Module. This includes time taken for various stages of response, identification of repeated incident occurrences at different locations, and usage patterns of various modules within the system, allowing for performance improvement and continuous adaptation of the framework. Urban Intel, the described framework for intelligent urban emergency response integrates Artificial Intelligence, Geospatial Technology, cloud platforms and Real-Time communication systems within a unique architecture to provide a fully scalable and integrated solution for modern city emergency management to aid emergency preparedness and responses effectively and to foster smarter cities with technology.

V. METHODOLOGY

Our methodology in Urban Intel, involves emergency information collection, automatic intelligent incident classification, geographical relevance discovery, and emergency routing and prioritization. The proposed methodology blends citizen reporting, artificial intelligence, geospatial tools, and automated decision making to optimize the process of emergency management. Our approach to tackle this problem follows the next steps:

5.1 Data Collection

The most common sources of emergency information to be exploited in the Urban Intel system is represented by those reported by the citizens. Citizens have been able to submit emergency incidents through a web-based platform for the purpose of Urban Intel project by describing type, urgency level and the location where the emergency occurred. They are also encouraged to upload an image or video related to the emergency to add evidence that can support the automatic classification. All the submitted emergency reports have associated some basic information such as time, GPS coordinates of the device reporting, and the citizen ID of the reporter. These data are essential for the whole processing system.

5.2 Incident Classification

Every emergency submitted to the system and containing images or videos is sent to a classification module that is powered by an AI algorithm (based on machine learning). It exploits images that contain some evidence about the nature of the incident and predicts one class for the event among a predefined set of classes including road accident, house fire, crime, flood, building collapse, medical emergency. This information would be then added to the report and then sent to the relevant agency, reducing human intervention to classification tasks.

5.3 Location Intelligence

The geographical information for each submitted incident is acquired directly by the GPS module integrated in user's devices or estimated through other available means. Each submitted report of an incident requires to define the geographical location, this information is captured with GPS coordinates. This geographical feature is then exploited by Geospatial Intelligence Module, in order to determine the location on the map and identify nearest available emergency agency, able to address specific categories of incidents. Location-aware search is performed to efficiently map each incident type and its location to the appropriate emergency provider. Route finding to dispatch location can be mapped as well.

5.4 Emergency Prioritization Strategy

Our framework incorporates a severity-based prioritization mechanism in order to address efficiently urgent situations. Incidents are prioritized by considering user-defined urgency level (e.g., Low, Medium, High) and also by AI prediction of a severity score derived from the nature of the incident, its context (extracted information) and spatial context. Then, a combined score is derived following a severity fusion logic and used to classify incident severity into different levels. Critical high severity emergencies get routed and handled first.

VI. SYSTEM IMPLEMENTATION

Urban Intel is designed as a web-based application, leveraging advancements in artificial intelligence, geospatial intelligence, cloud computing and real-time communication for building an emergency response system. The framework for the urban Intel is modeled as having a modular design where we can see components of front-end (user interfaces), back-end (application servers, API), database (storage), artificial intelligence (incident identification), and analytics (data analysis). Front-end provides interfaces for citizens to report events using structured forms including details about incident type, urgency level, location, and evidence such as multimedia files. The focus is on minimizing effort on part of the citizen while ensuring that important data are available for the agencies.

Citizens can also view the current status and get updates about their submitted incidents and actions taken by the responders. Backend is the interface for managing all user operations, handling requests from the front-end to perform actions, distributing tasks across various components, handling authorization, and manages interaction between components. Incident data are stored in a cloud-based data repository, facilitating simultaneous access by various parties, synchronization and scalability. The framework supports different user roles, such as citizen, emergency

agency personnel, administrators, system operators etc. With their respective access privileges. The artificial intelligence block works by a pre-trained image classification model.

The model is designed to analyze uploaded images of the incident to predict the incident type from a set of predetermined categories. Supported categories currently are fire incident, flood incident, road accident, medical emergency, criminal act, structural damages, etc. The classification result is stored with the incident along with the report information. Geospatial intelligence block utilize the position information obtained from the submitted incident and employs location-based queries and efficient routing logic to identify and allocate nearest relevant emergency service provider for the reported incident, thus reducing manual assignment and dispatching time. Emergency response personnel are provided with an interactive dashboard that shows the list of incoming and ongoing incident with all the information like description, location, urgency and response status. They can update the incident's status and progress or assign to different available personnel. The administrative dashboard of the application has features for overview of ongoing incidents, evaluating response times of different agencies, identifying potential hazard zones based on current and past incident records and analyzing various trends over time.

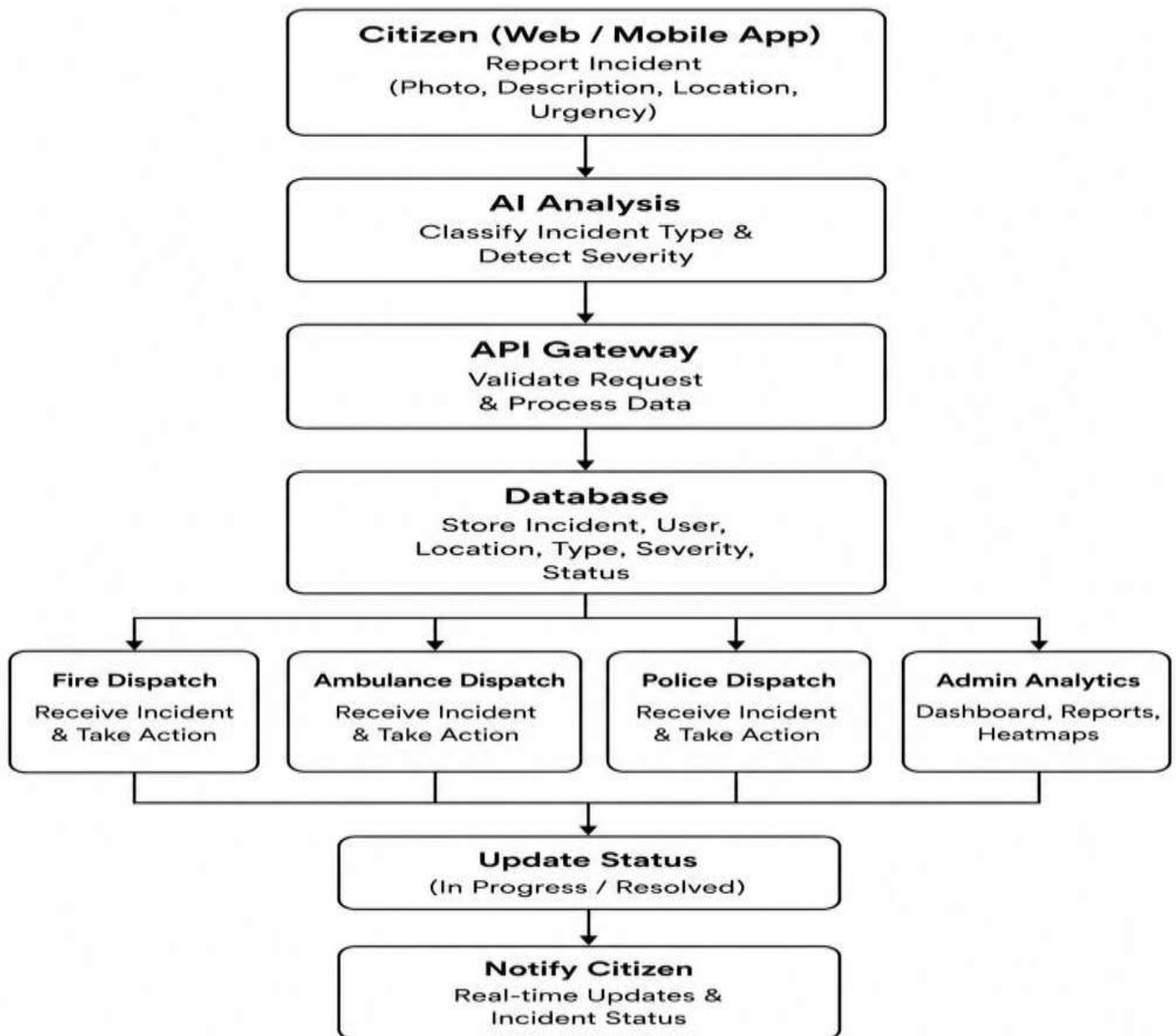


Fig 1. Working Flow

VI. RESULTS AND ANALYSIS

The performance of Urban Intel was investigated with various tests, including functional, performance, and AI classification evaluation, across incident classification accuracy, emergency routing accuracy, response latency, and system reliability. Firstly, functional testing of Urban Intel identified and resolved initial issues with module interactions before the experimental tests. The classification component of Urban Intel used the incident classified dataset of images, covering various emergency events as described by disasters as a reference set to assess how many of the emergency categories the AI could classify at a particular classification accuracy, precision, or recall level [6]. Experimental evidence supported successful and reasonably accurate automatic incident classification, with an overall accuracy of approximately 92%, weighted F1-score 0.92 and Macro F1-score 0.91.

The classifier had relatively good precision and recall for disaster types such as fire, flood, accident, medical emergencies, crime related cases etc.. The test result suggested that Urban Intel's classification system reliably can serve automatic classifying emergency events for emergency decision. Then we investigated latency of our triage system by measuring classification of incident event as 1.4s on average with the 95th percentile less than 3s. This should be satisfied with emergency situation requiring high rapidity for decision making. Thirdly, we demonstrated the effectiveness of geo-smart based routing by testing to how efficiently it could identify suitable emergency agency to response the incident (depending on both type and location of incident).

We have validated that using such mechanism for dispatching can minimize manual effort, also enable dispatch of incidents to right responders. Overall we had also concluded through functional test that the Urban Intel framework is also a perfectly usable and integrate system, i.e., module for incident notification, incident reports, location information and classification were properly connected and functioned as it designed. Administrative analytical panel gave useful indications about incident distribution, frequent locations and response patterns of emergency agency.

Analysis of Historical incident data showed that such functionality might be helpful to aid planning of emergency agency. However, it is of importance to mention that during the whole of the testing of system, all the emergency reports delivered to agency's dispatchers through the urban Intel system not simply automatically reported to emergency agency's existing information system, but these were confirmed to the dispatchers as part of the standard reporting and notification flow in their work, allowing human intervention if necessary and without compromising established practices and workflow. Future work can enhance the prediction of incidents and establish of best practice for using such automated system.

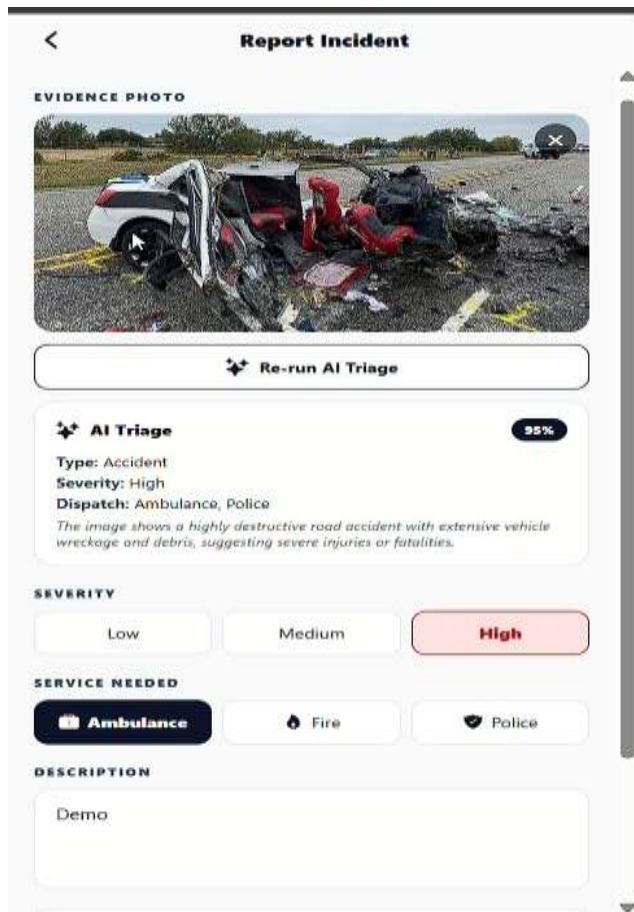


Fig 2. Incident Filling By Citizen

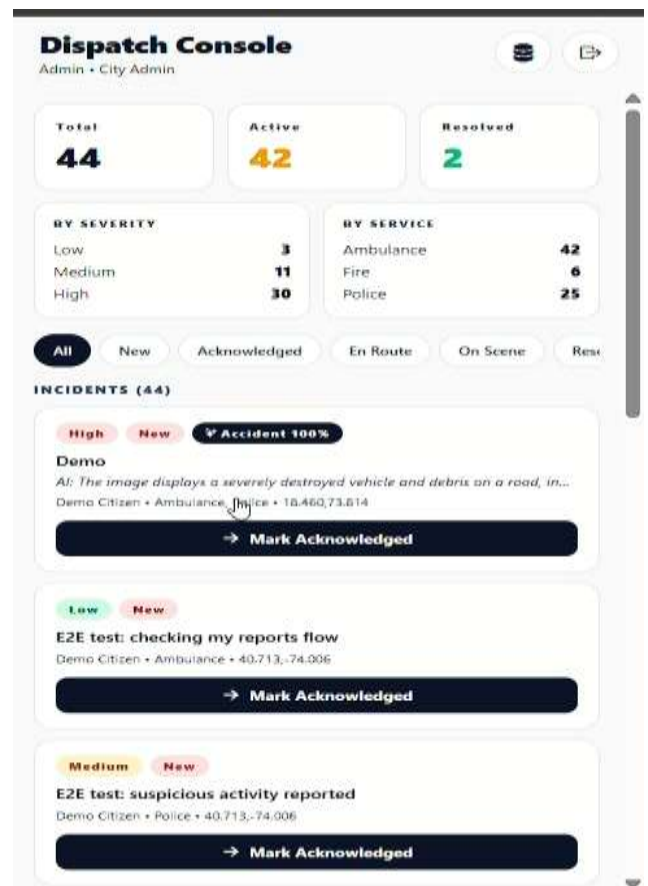


Fig 3. Dispatch Console

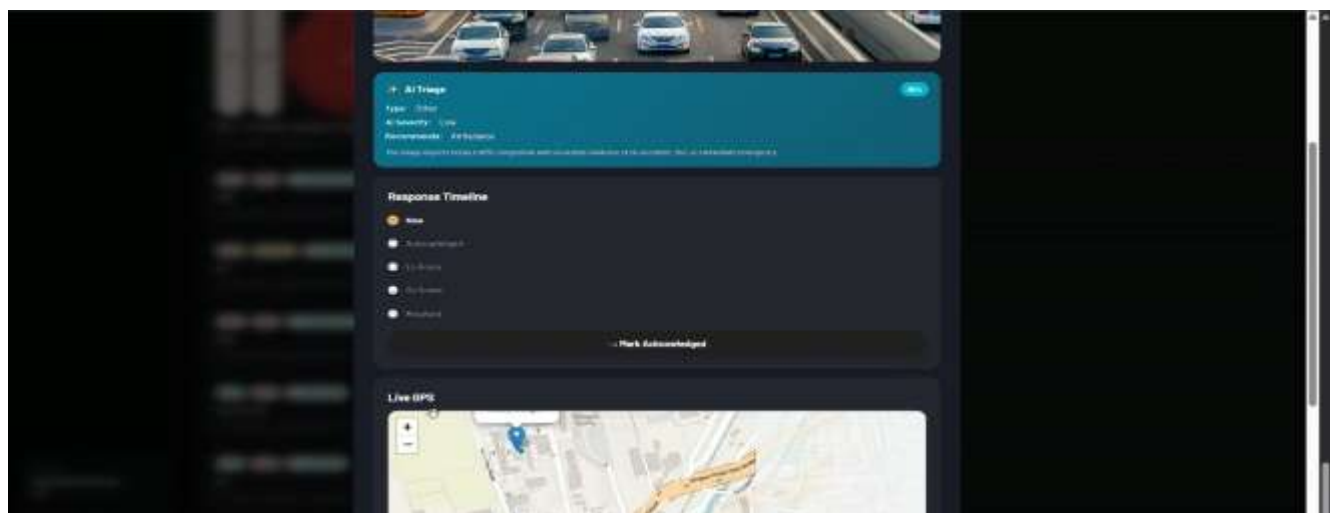


Fig 4. Response Acknowledgment By Dispatch

<i>Features</i>	<i>Traditional Emergency Systems</i>	<i>Existing Smart Emergency Systems</i>	<i>Urban Intel</i>
Citizen Incident Reporting	Yes	Yes	Yes
AI-Based Incident Classification	No	Partial	Yes
Geospatial Intelligence	No	Yes	Yes
Automated Agency Dispatching	No	Partial	Yes
Multi-Agency Coordination	Limited	Partial	Yes

Table 2. Comparative Analysis Of Emergency Response Systems

VIII. PERFORMANCE EVALUATION

The proposed Urban Intel framework is validated with common classification performance measures: Accuracy, Precision, Recall and F1-Score:

1. Accuracy: The number of correct predictions divided by total number of cases .

$$\text{Accuracy} = (TP + TN) / (TP + TN + FP + FN)$$

2. Precision: The number of true positives divided by all false positive cases and true positives.

$$\text{Precision} = TP / (TP + FP)$$

A large precision indicates low false alarm rate .

3. Recall: The number of true positives divided by all real cases which should have been predicted.

$$\text{Recall} = TP / (TP + FN)$$

Higher recall indicate system has better emergency situation recognition capability .

4. F1-Score : The F1-Score is used to measure the accuracy of a set . F1-Score is the harmonic mean of the precision and recall .

$$\text{F1-Score} = 2 (\text{Precision} * \text{Recall}) / (\text{Precision} + \text{Recall})$$

Where

:

TP: True Positives TN: True Negatives FP: False Positives FN: False Negatives

<i>Class</i>	<i>Accuracy</i>	<i>Precision</i>	<i>Recall</i>	<i>F1</i>
<i>Fire</i>	95.2%	0.952	0.952	0.952
<i>Accident</i>	92.9%	0.929	0.929	0.929
<i>Flood</i>	95.2%	0.909	1.000	0.952
<i>Medical</i>	80.0%	0.800	0.800	0.800
<i>Crime</i>	90.9%	0.833	1.000	0.909

Table 3. Evaluation Metrics

IX. LIMITATIONS AND FUTURE WORK

Limitations Urban Intel, despite its strengths, has a few inherent limitations that open avenues for future improvements. It is currently largely dependent on citizen-reported incidents and uploaded multimedia content, and as such relies heavily on user engagement and the availability of network access. Areas with poor connectivity or incomplete reporting might be overlooked and emergency assessment compromised. Current classification module It is still under development, but demonstrates potential for image-based classification.

Its effectiveness is reliant on the quality and diversity of the training data sets, and only applies to the predefined emergency classes. Further training will be required as new incident classes emerge, and in changed environments. Classification through only images cannot account for many variables in a complex emergency situation. The future work The development is planned to proceed with advanced artificial intelligence methods, including the use of multimodal data, for example integrating images, video, and textual streams into complex image processing, incident understanding, automatic report generation and decision support technologies.

Artificial Intelligence will be utilised to process large volumes of data; this will also be facilitated by machine learning with large language models to generate a more comprehensible incident report and for emergency decision support.

Image classification combined with natural language processing, image segmentation, video analysis will assist greatly to get more context. We anticipate predictive analytics approach can predict a high probability of occurring an event with reference to the historical information related to emergency data in a particular area. To overcome the issue of reliance on Manual Incident Reporting, integration with smart systems like IOT devices(CCTV networks, Fire and security alarm,environmental monitoring system, sensors) will be sought.

Further upgrades will be focused to leverage high performance network standards like 5G and edge computing solutions. Some advanced enhancements will be considered to support multicounty system, multilingualism, accessibilities for diverse range of users and data integrity using distributed technologies like blockchain

X. CONCLUSION

As cities grow increasingly vulnerable to a wide array of emergencies and disasters, the need for intelligent and autonomous systems becomes ever more apparent in assisting emergency management operations. Existing methods of emergency management are characterized by, amongst others: untimely reports, insufficient situational data, unoptimal resource deployment and insufficient collaboration across agencies. To mitigate these shortcomings, we have designed and built Urban Intel, an intelligent emergency management system capable of consolidating citizen reports, automated classification, geospatial intel and real-time agency coordination. We provide an end to end framework for citizen

reports with multimedia evidence and geolocation capabilities to improve data accuracy, speed of detection and accuracy of information.

Using AI, incidents are automatically classified to help with faster emergency decision-making. We enable rapid dissemination of information by incorporating intelligent routing of incident information based on real-time geolocal information to best equip and route agencies. Through communication facilities, information on ongoing emergency events are centralized for the relevant parties. Through experimental study, we show that the presented architecture effectively categorizes the incident types and is efficient to aid agencies by quickly disseminating relevant incident information in time for proactive agency allocation to respond to the incident. With Urban Intel and the cloud, we can provide an environment suitable for intelligent and timely responses in cities which are equipped with smart infrastructure.

The work in this paper contributes to creating an emergency management system by synergizing artificial intelligence, cloud computing and geo-spatial information that has great potential to assist in both existing and potential futures of intelligent, adaptive and resilient cities against various forms of disasters and emergencies.

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