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AI for Disaster Reporting: A Review of Technical Barriers and Ethical Imperatives.

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Abstract: With increasing frequency of natural disasters brought about by climate change and high rate of urbanization, there has been an urgency in having efficient and real-time response mechanisms. The given review paper analyzes the disruptive nature of Artificial Intelligence (AI) and new computing capabilities, such as the Internet of Things (IoT), Big Data, and Unmanned Aerial Vehicles (UAVs) in the evolution of disaster reporting and management. We examine how machine learning, deep learning, Natural Language Processing (NLP), and computer vision can be used to provide rapid situational awareness, detect disasters in real-time and assess damage automatically using multi-source data through social media, sensors and remote sensing. This paper examines the use of AI in various disaster stages, such as mitigation, preparedness, response and recovery, with a particular emphasis on improvement of decision making and resource reallocation using specific applications of AI, such as, AI-driven triage and drone-based geohazard surveillance. Moreover, we comment on the combination of high-fidelity Digital Twins and Large Language Models (LLMs) to streamline the evacuation planning and information distribution. Although the impact is huge in the realm of response effectiveness, we recognize severe technical and ethical obstacles, such as the problem of data reliability, misinformation, bias in algorithms, and privacy. The paper ends by providing a road map to future research which focuses on creation of scalable, glorifiable, and integrative AI-based frameworks to enhance disaster resilience globally.

Keywords: Artificial Intelligence, Machine Learning, Deep Learning, NLP, Computer Vision, IoT, Big Data, UAVs, Remote Sensing, Situational Awareness, Damage Assessment, GIS.

1. Introduction

The modernization of the emergency response requires the integration of advanced technological frameworks since the role of the Artificial Intelligence in creating efficient disaster reporting platforms now allows the detection and situational awareness real-time [1]. These systems will allow the extraction of actionable data through machine learning, deep learning, NLP, and computer vision to improve the overall disaster management by extracting social media, sensors, and remote sensing information [2]. The use of drones in the 2024 Noto Peninsula Earthquake illustrates how the unmanned aerial vehicles can be practically applicable in the field of assessing damage and distributing emergency supplies [3]. Likewise, patient prioritization can be enhanced by AI-driven triage systems at the Emergency Departments [4], and 6G-based user localization technologies (based on crowd sensing and 6G network) offer important tracking features during disasters [5].

The predictive capabilities have also improved significantly and now machine learning systems can predict landslide activities in particular areas with high precision [6]. These smart disaster forecast systems comprise environmental, meteorological, and spatial data to construct powerful forecasting structures [7]. These efforts are further reinforced by the increased use of social media and crowdsourcing as it enables real-time communication and sharing of information in the preparedness and response phases [8]. They can be used to identify misinformation and enhance crisis communication using NLP and machine learning [9] and predict disease outbreak using multi-source data and create localized risk scores [10], built-in public health platforms.

The development of these technologies is directed toward Agentic AI systems that are aimed at autonomous and goal-oriented intelligence based on planning frameworks and reinforcement learning [45]. Social networks are now sentiment-analyzed and fake news identified using advanced modelling algorithms, including BERTopic modelling [46], and drone-based sound source localization is offering newer signal processing techniques in the area [47]. The entire spectrum of disaster lifecycle prevention to recovery is now covered by a wide variety of computing tools [48], such as IoT, GIS, Big Data, and VR/AR simulations. Newer frameworks also enable

Human-LLM cooperation to analyze smart building safety capabilities [49], and IoT applications in smart urban planning keep to perfect the utilization of sensors and protocols, such as LoRaWAN [50]. Recent applications consist of autonomous drone systems that rely on fine-tuned models such as YOLOv12n to identify highway incidences in real-time [51], and Digital Twin technology, which integrates 3D city simulations with hydraulic simulations to optimize a route during evacuation of urban floods [52].

2. Literature Review

[1] The development of these technologies is directed to the Agentic AI systems with autonomous, goal-oriented intelligence in the framework of planning and reinforcement learning. Social networks are now being sentiment analyzed and fake news detected using advanced modelling methods like BERTopic modelling, and new approaches to signal processing are being offered through drone-based sound source localization. The entire disaster lifecycle prevention, through to recovery, is now covered with a wide range of computing tools, such as IoT, GIS, Big Data, and VR/AR simulations. New frameworks also enable Human-LLM cooperation to test smart building safe devices, and IoT implementation in smart city planning keeps on improving the use of sensors and protocols such as LoRaWAN. In contemporary practice, help drone systems based on fine-tuned models such as YOLOv12n are used to detect real-time highway accidents, and Digital Twin technology, which uses 3D city models and hydraulic simulations to optimize routes when evacuating the city during floods.

[5] This paper opinions cutting-edge AI and 6G-primarily based consumer localization technologies for emergency and disaster situations, masking 5 main categories: crowd sensing, 6G networks (including joint verbal exchange and sensing, THz communications, reconfigurable wise surfaces, and non-terrestrial networks), unmanned aerial automobiles, RF-based technology (WiFi, Bluetooth, LoRa, UWB, RFID), and non-intrusive load tracking. These technologies employ artificial intelligence techniques like deep studying and federated gaining knowledge of to enhance localization accuracy the use of facts from sensors, cameras, wi-fi get entry to factors, and clever meters. The paper identifies key advantages including greater patient prioritization, reduced wait instances, and optimized resource allocation, whilst highlighting demanding situations consisting of facts fine, algorithmic bias, energy obstacles, and protection/privacy worries. Future guidelines emphasize set of rules refinement, integration with wearable technology, clinician training, and moral framework improvement to make certain equitable implementation in emergency offerings.

[6] This IEEE Access paper (2022) affords a device getting to know-primarily based system for predicting landslide activities someday earlier in Florence, Italy, the use of records from 2013-2019. The researchers compared a couple of ML models (Random Forest, XGBoost, CNN, Autoencoders) and the SIGMA algorithm, locating that XGBoost performed the best performance (MAE: 0.000173, TSS: 0.78) through combining actual-time meteorological facts (rainfall, temperature, humidity, water tiers) with static terrain functions (slope, flowers, soil kind). Using explainable AI (SHAP), they recognized that three-day cumulative rainfall (Day3), maximum temperature, and river water levels had been the most important predictors for quick-time period landslide forecasting. The gadget outperforms present methods and provides actionable early warnings for civil safety government to manage emergency evacuations.

[10] The paper affords an AI-based totally ailment forecasting platform for early outbreak detection and community chance mitigation. It integrates multi-source public fitness statistics consisting of case counts, mobility trends, and environmental factors to generate localized danger rankings. The system uses time-series indicators like SMA, EMA, RSI, and volatility bands blended with a dynamic rules engine for sign assessment. A remarks loop continuously refines thresholds to improve forecasting accuracy. The platform offers real-time signals through an interactive dashboard to guide proactive public health selection-making. Overall, it offers a scalable, explainable, and adaptable solution for disorder surveillance.

[11] Recent research shows that social media and crowdsourcing (SMCS) have become important tools in catastrophe threat control (DRM). A review of 237 research (2008–2023) determined that most studies makes a speciality of catastrophe preparedness and reaction, especially for real-time facts sharing and coordination. Less attention is given to mitigation and long-term restoration. Many studies depend upon single case studies and secondary records, limiting generalizability. Research is also concentrated within the Global North, with confined attention on disaster-inclined areas inside the Global South. Overall, SMCS have strong ability, however gaps remain in inclusiveness, context, and research range.

[12] This paper affords a systematic literature evaluation on the use of cell crowdsensing (MCS) in disaster management, emphasizing information accrued via telephone sensors. It analyzes how extraordinary sensor sorts support catastrophe management categories throughout the mitigation, preparedness, reaction, and healing levels. The look at highlights that maximum existing works consciousness on reaction and recovery, at the same time as mitigation stays underexplored. Findings display that GPS, cameras, and human-as-sensor reporting are the maximum usually used sensing strategies. The overview additionally identifies key challenges which include records reliability, confined real-global validation, and integration with decision-aid structures. Finally, it outlines open research troubles and future instructions for effective MCS-enabled disaster management.

[13] This paper opinions the position of large information analytics in enhancing disaster and humanitarian disaster response. It discusses how huge-scale, heterogeneous information from social media, mobile telephones, sensors, and crowdsourcing can enhance situational awareness and choice-making. The take a look at explains the application of facts-driven techniques throughout all tiers of the crisis lifecycle, including preparedness, response, and healing. It highlights allowing technology consisting of gadget mastering, artificial intelligence, participatory mapping, and crisis analytics structures. The paper also identifies important challenges, together with information extent, privacy issues, facts reliability, and coordination among stakeholders. Finally, it emphasizes the want for integrating human and gadget intelligence for effective disaster control.

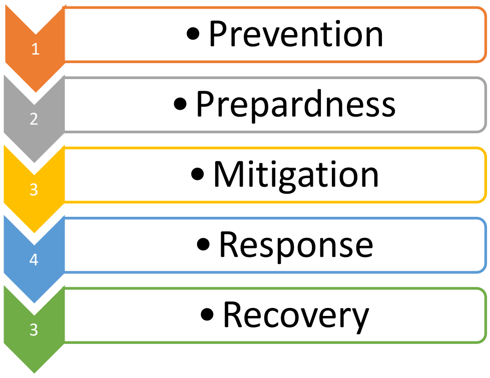

Fig. 3.1: Emergency Management Phases.

[14] social media has come to be an crucial device in catastrophe control due to its potential to enable fast, -way communication at some point of emergencies. It supports disaster preparedness, reaction, and restoration by way of disseminating actual-time records and attractive groups. However, the effective use of social media in catastrophe control is hindered through demanding situations including misinformation, loss of agree with, negative facts excellent, and confined human resources. Existing research in large part consciousness on programs of social media but offer confined perception into those challenges. Therefore, this paper systematically opinions the literature to pick out key demanding situations and suggest techniques to overcome them. The take a look at goals to decorate the effective utilisation of social media in catastrophe control practices.

[15] Natural failures pose severe threats to human existence and infrastructure, with their frequency and intensity increasing due to climate exchange and speedy urbanization. Accurate and well timed submit-disaster constructing harm evaluation is consequently vital for effective emergency response and recuperation making plans. Recent advances in far off sensing technology, which include satellite tv for pc imagery and UAVs, have enabled huge-scale and rapid harm monitoring. At the equal time, gadget studying and deep studying strategies have extensively stepped forward the automation and accuracy of damage detection. This look at affords a decadal bibliometric overview of post-disaster constructing damage assessment studies, highlighting key methodologies, technological traits, and existing studies gaps to support greater resilient disaster management practices.

[17] Natural screw ups regularly motive intense harm to street networks, disrupting emergency response and healing operations. Rapid and correct evaluation of street damage is therefore crucial for ensuring accessibility and prioritizing restoration efforts. Traditional manual inspection strategies are time-eating, labor-intensive, and impractical for large-scale catastrophe-affected areas. Recent advances in excessive-resolution satellite tv for pc imagery and deep getting to know have enabled computerized and scalable infrastructure damage evaluation.

This observe proposes a deep getting to know–primarily based framework that makes use of pre- and publish-disaster satellite pictures to come across and check street harm. By comparing a couple of alternate detection techniques, the paintings aims to improve the reliability and effectiveness of post-disaster street harm evaluation.

[18] The paper reviews the evolution of human-targeted crisis informatics, focusing on how ICT and social media support disaster response. It highlights current demanding situations such as records overload, statistics reliability, and restricted coordination among citizens and emergency offerings. The observe identifies destiny traits together with professionalized citizen–authority collaboration, explainable and multimodal AI for content evaluation, and disruption-tolerant communication networks. It also emphasizes the growing position of IoT, mobile apps, and decentralized infrastructures in disaster communique. Finally, the paper envisions the usage of virtual twins and virtual reality to educate multi-corporation coordination for complicated and hybrid catastrophe situations.

[49] The have a look at evaluates smart building functions for fireplace, electric, and lifestyles protection the use of a fast Human-LLM collaborative framework. It applies systematic evaluation strategies, PRISMA screening, and bibliometric mapping to analyze present literature. The framework combines human knowledge with AI-assisted synthesis to accelerate studies evaluation. It identifies key safety technologies and highlights studies trends and gaps. The look at also discusses limitations consisting of LLM bias and transparency issues. Overall, it supports improved selection-making and destiny research in clever constructing safety structures.

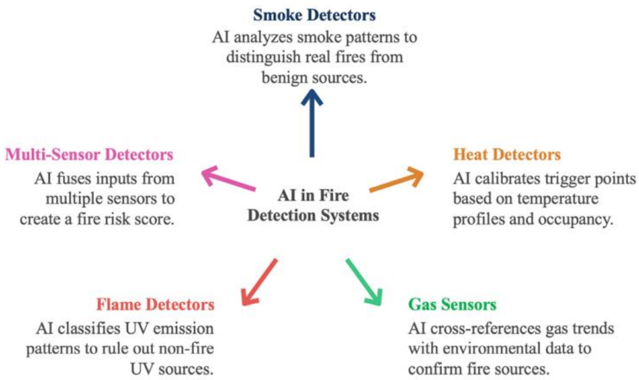

Fig. 3.2: AI in Fire Detection System: Roles if AI across different sensor modalities [49].

[50] The look at gives a comprehensive evaluation of IoT applications in clever urban planning, focusing on real-world implementations from 2022–2024. It analyzes urban sensor technology, verbal exchange protocols which includes LoRaWAN, BLE, Wi-Fi, and Zigbee, and their technical change-offs. The paper evaluates performance metrics including electricity intake, accuracy, and conversation variety. It highlights the integration of AI and large statistics analytics for predictive and independent city services. Key challenges consist of energy control, scalability, cybersecurity, and sustainability. Overall, the look at emphasizes the vital position of electronics engineering in growing efficient, resilient, and sustainable clever towns.

[51] This independent drone device makes use of a DJI Matrice 30T and docking station for fast, unmanned dispatch to highway incidents based totally on authority-supplied GPS coordinates. Real-time video is analyzed by means of a first-rate-tuned YOLOv12n version to come across collisions and fires with high precision. A hybrid vision-language pipeline, featuring LLaVA-OneVision-Qwen2 and GPT-4o mini, then interprets visual information into precise herbal language descriptions and based summaries. These summaries provide responders with vital contextual awareness, which includes incident severity and advocated movements. Field checking out demonstrates that this quit-to-quit AI answer considerably complements situational attention and decreases emergency response times to underneath 3 minutes.

[52] This observe explores the combination of Digital Twin (DT) generation with three-D metropolis modeling and IoT to decorate city flood evacuation systems. By combining real-time sensor statistics, hydraulic simulations, and agent-primarily based modeling, the device creates a excessive-constancy digital replica of the city to are expecting inundation and optimize rescue routes. The studies highlights the shift from static catastrophe management to dynamic, data-driven selection-making that bills for infrastructure

interdependencies. Key blessings include advanced situational consciousness and the capability to simulate various "what-if" situations for emergency responders. However, huge demanding situations continue to be regarding excessive computational costs, information integration from multi-supply sensors, and the want for robust actual-time connectivity. Ultimately, the paper offers a roadmap for future studies to shut the distance between theoretical modelling and practical, on-the-fly evacuation making plans.

Table 3.1: Comparative Review of AI Techniques in Disaster Management

Authors	Techniques	Strengths	Limitations	Outcomes
Jose Giner Perez de Lucia et al., (2026) [1]	**Machine getting to know, deep studying, NLP, computer vision, social media analytics, faraway sensing, crowdsourcing, large statistics analytics, IoT, GIS.**	The AI-primarily based disaster reporting platform allows real-time detection, improves situational attention, helps quicker choice-making, and enhances coordination amongst stakeholders.	The effectiveness of AI-based disaster reporting structures is confined by information reliability issues, incorrect information, privateness issues, and uneven statistics availability.	The observe suggests that AI-based totally catastrophe reporting structures enhance timely information extraction, situational consciousness, and help greater powerful disaster response.
Jinping Liu et al., (2023) [2]	**Machine learning, deep getting to know, natural language processing, laptop imaginative and prescient, social media analytics, far flung sensing.**	The key electricity of the proposed technique is its capability to integrate AI techniques with multi-source statistics to allow accurate, actual-time catastrophe information extraction and decision help.	The approach is confined by statistics first-rate problems, misinformation in social media content, and challenges in real-international deployment at scale.	The observe demonstrates that AI-pushed evaluation substantially complements timely catastrophe reporting, situational awareness, and reaction effectiveness.
Mikio Ishiwatari, (2024) [3]	**AI-primarily based 3D modeling, orthophoto technology, virtual floor modeling, drone-based logistics transport, cell base station communique relays, and aerial infrastructure inspection.**	The key strength of the study is its actual-international case evaluation of drone applications during the 2024 Noto Peninsula Earthquake, demonstrating practical effectiveness in catastrophe reaction.	The fundamental issue is that drone operations faced regulatory, coordination, and technical demanding situations together with limited flight time and climate constraints.	The look at concludes that powerful integration of drones into catastrophe control can significantly beautify emergency reaction, improve coordination, and reduce disaster impact.
Adebayo Da'Costa et al., (2025) [4]	**Machine gaining knowledge of algorithms, neural networks, choice tree fashions, real-time analytics, natural language processing (NLP), wearable tool facts integration, and predictive modeling.**	The principal energy of the study is its complete and balanced evaluation of AI-pushed triage systems, highlighting each realistic advantages and implementation challenges in emergency care.	This narrative assessment lacks systematic rigor, excludes non-English literature, and can be tormented by book bias favoring superb AI effects.	AI-pushed triage improves patient prioritization and decreases wait instances, but faces challenges with information excellent, algorithmic bias, and clinician trust.
Ali Alnoman et al., (2024) [5]	**CNN, LSTM, GAN, federated gaining knowledge of, deep studying, reinforcement gaining knowledge of, NLP, THz, RIS,**	Improved patient prioritization, decreased wait times, greater accuracy, optimized resource allocation, actual-time response, decreased	Data excellent issues, algorithmic bias, clinician agree with deficit, privacy and protection issues, strength limitations, limited education facts,	Enhanced patient prioritization, decreased wait instances, stepped forward localization accuracy, and optimized useful

	MIMO, beamforming, ToA, AoA, RSSI, SLAM, WiFi, Bluetooth, UWB, LoRa, RFID, 5G, 6G, GPS, UAV, NILM, facet computing, IoT.	clinician burden, adaptability in emergencies, privacy renovation, fee-powerful, and strong overall performance.	high computational requirements, infrastructure dependency, and regulatory gaps.	resource allocation, no matter challenges with bias, privacy, and infrastructure limitations.
Enrico Collini et al., (2022) [6]	**The strategies used in this look at include Random Forest (RF), XGBoost, Convolutional Neural Network (CNN), Autoencoder (AE), SIGMA rainfall threshold version, and SHAP-based Explainable AI.**	Strong brief-term (1-day ahead) prediction accuracy the usage of XGBoost combined with explainable AI for clear characteristic interpretation and reliable early warning.	The version relies upon heavily on fantastic actual-time statistics and is demonstrated handiest for a particular region, so its overall performance might also range in other geographical areas.	The study developed an correct 1-day beforehand landslide prediction version, in which XGBoost outperformed other strategies and enabled reliable early warning with clean feature interpretation the use of SHAP.
Cem Kozcuer et al., (2024) [7]	**Machine learning algorithms with data preprocessing, feature selection, model optimization, and comparative performance evaluation methods.**	High prediction accuracy and improved reliability through the integration of advanced machine learning techniques with real-time and spatial data.	The model’s performance depends on the availability and quality of large, real-time datasets and may not generalize well to different regions without retraining.	The study achieved improved disaster prediction accuracy and demonstrated the effectiveness of AI-based models for reliable early warning and better disaster management.
Nadejda Komend antova et al., (2025) [8]	**Natural Language Processing (NLP), Machine Learning, Deep Learning, Sentiment Analysis, Named Entity Recognition (NER), Topic Modeling, Clustering, Real-time Monitoring.**	Enhances actual-time detection and mitigation of incorrect information, enhancing disaster reaction, public believe, and decision-making.	Limited by way of records pleasant, evolving misinformation processes, algorithmic bias, privateness concerns, and demanding situations in know-how context and cultural nuances.	Improved accuracy of records, quicker response to misinformation, more suitable public agree with, and higher selection-making throughout screw ups.
Bortiorkor N.T. Alabi et al., (2026) [9]	**Machine Learning, Deep Learning, Natural Language Processing (NLP), Sentiment Analysis, Topic Modeling, Social Network Analysis, Data Mining, Big Data Analytics.**	Provides rapid statistics processing, improves situational consciousness, and complements powerful choice-making for the duration of disasters.	Dependent on statistics reliability, liable to misinformation and bias, and confined in shooting nearby context and vulnerable populations.	Improved catastrophe communique, better coordination among stakeholders, and more informed and well timed response movements.
Balaji Chode, (2023) [10]	**SMA, EMA, RSI, Volatility Bands, Threshold-Based Triggers, Dynamic Rules Engine, Risk Scoring, Feedback Loop.**	Real-time multi-source statistics integration with explainable signs, scalable structure, dynamic comments, and localized threat scoring for early outbreak detection.	Dependent on records exceptional and actual-time availability, requires careful threshold calibration, and may generate false positives or delayed signals in low-surveillance areas.	Early and localized outbreak detection with stepped forward forecasting accuracy, enabling timely signals and proactive public health choice-making.
Anne B. Nielsen	**Content Analysis**	The key electricity of	The look at is limited	Identification of key

et al., (2024) [11]	**Technique, Research Design Classification, Temporal Comparative Analysis, Geographical Analysis Technique, Social Network Analysis (SNA), Disaster Phase Mapping (UNDRR Framework).**	the observe lies in its comprehensive evaluation of social media and crowdsourcing traits, gaps, and practical applications in disaster chance control.	by using variability in information first-class and the dearth of standardized frameworks for integrating social media and crowdsourced facts into formal disaster control structures.	research trends, gaps, and inequalities within the use of social media and crowdsourcing across catastrophe threat management phases, techniques, and geographical regions.
Didem Cicek et al., (2023) [12]	**Mobile crowdsensing, GPS-based localization, camera-based totally sensing, accelerometer-based totally sensing, gyroscope-based sensing, Bluetooth-based totally sensing, crowd-as-reporter sensing, information fusion, participatory sensing, opportunistic sensing.**	The key electricity of the have a look at is its effective integration of sensor-based records and superior analytics to beautify real-time disaster monitoring and response accuracy.	The principal challenge is the dependency on sensor availability and infrastructure, which can also limit overall performance in aid-restrained or far off catastrophe-inclined regions.	Improved situational awareness, better hazard detection, green evacuation and mapping, better rescue coordination, effective aid allocation, dependable information trade, and improved selection-making.
Junaid Qadir et al., (2016) [13]	**Big records analytics, disaster analytics, crowdsourcing, participatory sensing, cell telephone information evaluation (CDRs), social media analytics, disaster mapping, visual analytics, gadget learning, synthetic intelligence, natural language processing, pc vision, records fusion, cloud computing, micro tasking.**	The key power of the study is its comprehensive framework for leveraging social media information to decorate actual-time catastrophe detection and disaster communique.	The major trouble is the reliance on social media information, which may be noisy, biased, and unreliable all through disaster situations.	It highlights the usage of statistics from social media, mobile telephones, sensors, and crowdsourcing to support actual-time decision-making. The take a look at also discusses permitting technology and key challenges in disaster management.
Krisanthi Seneviratne et al., (2024) [14]	**Systematic literature evaluation, PRISMA 2020 framework, qualitative content evaluation, bibliometric analysis the use of VOSviewer.**	The key electricity of the look at is its comprehensive and sustainability-focused framework that integrates advanced technology to improve catastrophe resilience and lengthy-time period threat discount.	The principal dilemma is the shortage of huge-scale actual-world validation and sensible implementation in diverse disaster scenarios.	The have a look at identifies foremost challenges in the use of social media for catastrophe control and proposes sensible techniques to improve its effective use.

Sultan Al Shafian et al., (2024) [15]	**Remote sensing, satellite imagery, UAV-primarily based information series, device studying, deep getting to know, convolutional neural networks (CNNs), synthetic aperture radar (SAR), LiDAR, bibliometric evaluation the use of VOSviewer.**	Strength is the internal power and resolution that helps us conquer challenges and face problems with braveness.	A hindrance is a weakness or constraint that restricts performance or development.	More correct and timely constructing damage evaluation, higher use of faraway sensing and gadget getting to know techniques, improved disaster reaction making plans, and clean identification of research trends and gaps.
Jiancheng Gu et al., (2024) [16]	**Visual interpretation, Threshold-based photo processing, Texture and function-based algorithms, Object-based totally alternate detection, Machine mastering methods (SVM, RF, KNN), Convolutional Neural Networks (CNN), Siamese neural networks, U-Net based totally segmentation, YOLO-based item detection**	The look at's power lies in its comprehensive review of superior remote sensing and AI-based totally methods for rapid and correct publish-catastrophe constructing harm detection.	The main hindrance is that the accuracy of harm detection closely depends at the excellent, decision, and availability of pre- and publish-catastrophe far flung sensing snap shots.	The look at indicates that data-pushed faraway sensing methods allow fast and correct identification of submit-catastrophe constructing damage. Advanced deep learning strategies enhance reliability and assist well timed catastrophe reaction.
Jungeun Cha et al., (2025) [17]	**Overlay-based segmentation, Difference photo–based exchange detection, Siamese neural community architecture, U-Net–primarily based semantic segmentation, Deep gaining knowledge of–based totally trade detection, Pre- and submit-disaster satellite tv for pc photo evaluation.**	The look at's electricity lies in its systematic comparison of 3 trade detection fashions and the established order of a strong benchmark for deep learning-based road harm assessment using satellite imagery.	The most important predicament is the low detection don't forget for the 'damaged road' elegance because of excessive elegance imbalance inside the dataset, which restricts accurate harm identification.	The examine finds that the distinction-primarily based deep gaining knowledge of version achieves the maximum accurate and strong avenue damage detection.
Marc-André Kaufhold, (2024) [18]	**Social media analytics, human-computer interplay (HCI) design, visual analytics, explainable artificial intelligence (XAI), multimodal AI, huge language models**	The have a look at's energy lies in its integration of advanced deep studying techniques to beautify conversation network overall performance and reliability in next-era systems.	The predominant difficulty is the excessive computational complexity and resource necessities, which may restriction real-time implementation in big-	The study outlines a future roadmap for human-focused crisis informatics, enabling greater effective collaboration among residents and emergency offerings thru AI-pushed

	(LLMs), few-shot learning, information augmentation, internet of things (IoT).		scale network environments.	analytics, resilient conversation networks, and immersive training technologies.
Lazima Faiah Bari et al, (2023) [19]	**Machine Learning, Artificial Neural Networks (ANN), Deep Learning, GIS, Remote Sensing, Satellite Imaging, Drone Technology.**	Enhances early catastrophe prediction, improves aid allocation, helps actual-time decision-making, and strengthens emergency fitness response and recovery making plans.	Dependent on big and tremendous datasets, can also produce misguided predictions, faces validation demanding situations, and requires technical infrastructure and public acceptance.	Improved disaster forecasting, better emergency health management, optimized resource distribution, and decreased health and financial affects of catastrophic occasions.
Leonardo Grando et al., (2025) [20]	**Unmanned Aerial Vehicles (UAVs), Remote Sensing, Thermal Imaging, Photogrammetry, GIS Mapping, Deep Learning, Computer Vision, and Image Processing.**	Provides high-resolution actual-time facts, permits fast disaster evaluation, improves situational consciousness, and supports efficient emergency response in inaccessible areas.	Limited battery life, weather dependency, regulatory regulations, excessive operational costs, and challenges in statistics processing and real-time transmission.	Enhanced catastrophe tracking and damage evaluation with faster response, improved decision-making, and greater green resource deployment.
Robiah Al Wardah et al., (2025) [21]	**Decision Tree, Random Forest, Staggered Rule-Based Method, Critical Path Method (CPM), Proximity Analysis, Zonal Statistics.**	Strong rule-primarily based and constraint-conscious framework that allows obvious, adaptable, and operationally possible drone–sensor venture making plans for more than one geohazards.	Limited flexibility due to rule-primarily based common sense, reliance on expected records, and lower adaptability to new sensors or complex multi-hazard eventualities.	Developed an operational system that gives automatic drone–sensor recommendations for efficient geohazard task making plans.
Justin Diehr et al., (2025) [22]	**Machine Learning (Random Forest, Support Vector Machine, Neural Networks), Deep Learning (CNN, RNN), GIS-based totally Spatial Analysis, Remote Sensing, Big Data Analytics, and Predictive Modeling.**	High predictive accuracy and actual-time spatial analysis functionality, permitting proactive disaster resilience thru AI-pushed GIS integration.	Requires massive splendid datasets, excessive computational resources, and might lack transparency because of complex AI models.	Enhanced proactive disaster resilience through correct threat prediction, stepped forward spatial decision-making, and AI-powered early warning and mitigation strategies.
Rym Ayadi et al., (2025) [23]	**Climate Modeling, Statistical Downscaling, Extreme Climate Indices Analysis, Trend Analysis (Mann–Kendall Test), Sen's Slope Estimator, and Spatial Analysis using GIS.**	Comprehensive weather trend evaluation the use of sturdy statistical methods and spatial analysis, enhancing reliability of weather alternate effect evaluation.	Limited by way of dependence on historic weather records, uncertainties in weather models, and ability spatial decision constraints affecting local-scale accuracy.	Identified huge climate trends and intense occasion patterns, helping progressed weather risk evaluation and model making plans.
Afraa Attiah et al., (2025) [24]	**Desktop-based Virtual Reality, Fully Immersive**	Provides intensive, technology-enhanced training that improves	Limited by high implementation costs, technical challenges,	Disaster medicine training was improved through improved

	VR, Augmented Reality, e-learning platforms, mobile-based simulation, high-fidelity mannequins and tele-simulation.	triage accuracy, engagement and decision-making in disaster medical education.	variable evaluation methods and lack of long-term effectiveness evaluation.	triage performance, knowledge acquisition, and technology-supported decision making, although results varied across studies.
Afraa Attiah et al., (2025) [25]	**Desktop-Based Virtual Reality, Fully Immersive VR, 360° Simulation, Augmented Reality, E-Learning Modules, Mobile-Based Simulation Apps, High-Fidelity Mannequins, Video-Based Training, and Tele-Simulation.**	Improves disaster preparedness and triage competency thru immersive, interactive, and generation-more desirable education processes.	Limited by means of excessive expenses, technical complexity, inconsistent assessment strategies, and insufficient evidence on long-term skill retention.	Simulation era, specifically immersive triage schooling, improves catastrophe medicine knowledge and accuracy however calls for greater rigorous, final results-aligned studies and integration.
Maria Tsourma et al., (2021) [26]	**The EarthPress framework uses deep getting to know, YAKE entity extraction, photograph segmentation, BERT sentiment analysis, and Transformer-based models (PEGASUS, BART, T5) for automated catastrophe reporting.**	Strengths consist of immersive, low-hazard schooling, improved triage accuracy, real-time information integration, automatic information generation, and powerful misinformation filtering for improved catastrophe reaction and reporting.	Key barriers encompass inconsistent assessment practices, a loss of long-time period metrics, restrained curricular integration, and inadequate realism in schooling environments.	Simulation generation improves catastrophe remedy knowledge and triage accuracy, whilst AI frameworks automate personalised, confirmed information generation from actual-time Earth statement statistics.
Vasileios Linardos et al., (2022) [27]	**Techniques include ML strategies like SVM, Naïve Bayes, and Random Forest, plus DL architectures inclusive of CNN, LSTM, GANs, and Transformers for prediction and assessment.**	The documents highlight powerful immersive schooling, advanced triage accuracy, real-time data integration, automated information generation, and sturdy incorrect information filtering to decorate disaster preparedness and response.	Limitations include inconsistent evaluation, confined curricular integration, high labor costs, negative image sign-to-noise ratios, and difficulty acquiring categorised disaster information.	Improved triage accuracy, more desirable learner understanding, automatic customized catastrophe reporting, and green gadget studying-based hazard prediction and damage assessment.
Amir Khorram-Manesh et al., (2025) [28]	**Virtual truth, mixed truth, serious video games, and AI-pushed simulations beautify situational consciousness, decision-making, and proactive mindsets in disaster medicine.**	Immersive simulations and AI tools decorate triage accuracy, situational consciousness, and real-time information integration, whilst presenting secure, repeatable training environments.	High prices, restrained curricular integration, inconsistent assessment techniques, facts shortage, and a loss of long-time period studies on ability retention.	Improved triage accuracy, better learner knowledge, automatic personalised catastrophe reporting, and efficient device learning-based chance prediction and harm assessment.
Rashid Mustafa et al., (2025) [29]	**The DEAPP device makes use of a cross-layer structure (Android, Spring**	The DEAPP machine presents steady, actual-time reporting, move-layer architectural	Potential safety vulnerabilities, high development charges, restrained long-term	DEAPP guarantees real-time hazard visualization, stable records transmission,

	Boot, MySQL), HTTPS RESTful APIs, Redis caching, Role-Based Access Control, and GPS-assisted reporting.	balance, high-overall performance facts caching, and correct GPS-primarily based hazard visualization for responders.	effectiveness statistics, inconsistent evaluation standards, and facts scarcity for version training.	progressed situational focus, and streamlined coordination between customers and emergency response groups.
Tommaso Destefanis et al., (2025) [30]	**Techniques encompass SAR and optical imagery fusion, 3-d LiDAR/DEM integration, and AI fashions like CNNs, Random Forests, and SVMs.**	The integration of Earth observation, AI models, and 3-D statistics affords excessive-precision flood mapping, speedy damage assessment, and stronger forecasting.	High costs, constrained curricular integration, inconsistent assessment strategies, facts scarcity, and a loss of long-time period research on skill retention.	Precision flood mapping, fast damage assessment, stepped forward forecasting, and automatic, actual-time reporting for enhanced catastrophe reaction and choice-making.
Mohammed Hlal et al., (2025) [31]	**Techniques include Digital Twins, Remote Sensing, IoT integration, and hydrodynamic modeling (1D/2D) for real-time urban flood monitoring and early warning.**	Digital twins provide real-time visualization, excessive-accuracy predictive modeling, seamless IoT integration, and better choice-making for city flood chance control.	High prices, lack of standardized assessment frameworks, statistics privacy issues, integration challenges with legacy systems, and dependency on real-time connectivity.	Enhanced city resilience through real-time monitoring, accurate flood predictions, quicker emergency reaction, and facts-pushed selection-making for disaster risk discount.
Pirhossein Kolivand et al., (2025) [32]	**Machine mastering, large statistics analytics, predictive modeling, Internet of Things (IoT), generative AI, and Geographic Information Systems (GIS).**	AI complements catastrophe governance by improving policy mechanisms, health gadget resilience, statistics control, and providing records-driven selection help for emergencies.	Limitations include excessive implementation fees, lack of standardized evaluation frameworks, statistics privateness dangers, dependency on actual-time connectivity, and significant gaps in long-time period effectiveness information.	AI improves catastrophe governance thru improved policy mechanisms, resilient fitness structures, optimized resource allocation, and records-pushed decision guide for emergencies.
Yingwen Yu et al., (2025) [33]	**Building Information Modeling (BIM), Geographic Information Systems (GIS), photogrammetry, laser scanning, and Virtual/Augmented Reality.**	Digital technologies allow non-detrimental evaluation, precise structural tracking, more advantageous 3D visualization, and integrated information control for architectural heritage upkeep.	High costs, records complexity, lack of standardized renovation, speedy software obsolescence, and restricted integration of numerous virtual equipment throughout areas.	Digital tools provide excessive-fidelity documentation, non-unfavorable structural evaluation, superior hazard visualization, and progressed longitudinal tracking for historical past web page maintenance.
Zhaohui Chen et al., (2025) [34]	**Large Vision Language Models (LVLMs), multi-agent coordination, Retrieval-Augmented Generation (RAG), photo interpretation, and automatic map annotation.**	Disaster automates damage assessment, reporting, and aid allocation, substantially lowering human response time at the same time as enhancing coordination via specialised multi-agent structures.	Downstream mistakes propagation, necessity for human validation, constrained photograph resolution for first-rate damage, ability algorithmic bias, and excessive computational fees.	Disaster automates harm reports, coordinates emergency alerts, optimizes resource allocation, and generates restoration plans, substantially accelerating publish-disaster reaction and resilience.
Han Zhang et al., (2025) [35]	**IoT sensor networks, Edge**	The system gives sub-450ms latency, ninety	High initial infrastructure costs,	The machine can provide real-time

	computing (Raspberry Pi/ESP32), Cloud platforms (AWS/Firebase), MQTT over TLS, and LoRa conversation.	five% detection accuracy, 99.1% reliability, and scalable assist for 12,000 gadgets thru multi-layered communication protocols.	vulnerability to cyberattacks, potential sensor inaccuracies, battery lifestyles constraints, and performance degradation in severe weather conditions.	alerts beneath 450ms, achieves 95% detection accuracy, and guarantees 99.1% reliability throughout diverse emergency situations.
M. Umadevi et al., (2025) [36]	**Massive Machine-Type Communications (mMTC), Temporal Convolutional Networks (TCNs), Federated Learning, Blockchain era, and light-weight edge-based totally anomaly detection.**	The framework offers excessive prediction accuracy, more suitable information privacy via federated learning, stable blockchain-subsidized updates, and occasional-latency facet-based anomaly detection.	Scalability bottlenecks in blockchain, high computational overhead for aspect gadgets, capacity statistics heterogeneity troubles, and risks of poisoning attacks.	The framework achieves excessive prediction accuracy, reduces latency, guarantees information privacy via federated studying, and presents steady, scalable catastrophe monitoring.
Kiran Saleem et al., (2025) [37]	**Massive Machine-Type Communications (mMTC), Temporal Convolutional Networks (TCNs), Federated Learning, Blockchain generation, and light-weight area-based anomaly detection.**	High prediction accuracy, low latency, stronger facts privacy through federated mastering, and steady, decentralized model updates via blockchain integration.	High computational overhead for area gadgets, scalability bottlenecks in blockchain, ability data heterogeneity, and dangers of poisoning assaults.	The framework achieves high prediction accuracy, reduces latency, ensures records privacy thru federated learning, and affords stable, scalable disaster monitoring.
Johannes Bhanye et al., (2025) [38]	**Machine Learning, Deep Learning, Geospatial AI, AIoT, Neural Networks, Support Vector Machines, Random Forests, and Decision Support Systems.**	AI complements predictive precision, speeds choice-making, and improves operational agility, fostering robust city structures able to withstanding excessive hydrological occasions.	Key barriers include records fine constraints, model opacity, algorithmic bias, virtual inequalities, restricted institutional readiness, and terrible transferability across unique geographies.	AI enhances predictive precision and speeds choice-making, yet its fulfillment is context-structured, requiring justice-oriented governance and network-led, ethical integration.
Tan Yigitcanlar et al., (2020) [39]	**Machine mastering, deep mastering, rule-primarily based structures, and neural networks for city catastrophe safeguarding.**	AI structures offer superior computational competencies for processing good sized records, enhancing predictive precision, disaster control, and healthcare monitoring.	AI pitfalls include biased choice-making, job marketplace instability, statistics privateness concerns, cybersecurity risks, racial discrimination, and ability socioeconomic inequality.	AI improves disaster forecasting and response, yet its fulfilment calls for addressing moral risks, statistics biases, and making sure inclusive city governance.
Ángel Lloret et al., (2025) [40]	**Artificial Intelligence, Internet of Things (IoT) sensors, actual-time Dashboards, and records-driven Digital Transformation techniques.**	The framework offers scalable, computerized, and replicable assessment, integrating numerous facts assets with AI to enhance public service high-quality and sustainability.	Critical obstacles consist of a particular local cognizance , constrained training data , potential oversimplification from composite rankings , and complex GDPR compliance.	Critical obstacles consist of a particular local cognizance , constrained training data , potential oversimplification from composite rankings , and complex GDPR compliance.

Peiyan Lu et al., (2025) [41]	**Techniques encompass Machine Learning, Deep Learning, and Large Language Models carried out to reveal gasoline, hearth, water, roof, and dust hazards.**	AI improves coal mine safety through imparting high-precision, actual-time risk predictions, allowing quicker emergency responses and smarter data-pushed choice-making.	AI barriers encompass fragmented information, bad version transferability, high computational costs, lack of standardized protocols, and opacity in complex decision-making.	AI gives you excessive-precision, real-time hazard predictions for coal mine failures, drastically enhancing protection management, emergency reaction instances, and choice-making accuracy.
Rashid Mustafa et al., (2025) [42]	**The framework employs move-layer cellular sensing, real-time facts aggregation, spatial visualization, and stable cryptographic protocols for catastrophe reporting and monitoring.**	The framework gives excessive-pace statistics transmission, enhanced protection through cryptographic protocols, real-time visualization, and progressed power efficiency for cell sensing.	Limitations consist of capability records privateness breaches, high energy consumption in cellular gadgets, restricted community coverage in remote areas, and architectural complexity.	The framework permits real-time catastrophe reporting and visualization, improving emergency response efficiency thru stable, power-efficient facts transmission and cellular sensing.
Zhenyu Lei et al., (2025) [43]	**Fine-tuning, spark off studying, retrieval-augmented era (RAG), chain-of-idea reasoning, multimodal fusion, energetic gaining knowledge of, ensemble techniques, and hybrid architectures (CNN, BiLSTM, GNN integration).**	Provides a comprehensive and systematic review of LLM applications throughout all four disaster management stages with a clean taxonomy and resource compilation.	Overreliance on standard LLMs, dataset imbalance and bias, excessive computational cost, hallucination risks in generation, constrained consciousness past response section, and absence of unified assessment standards.	Provides a based taxonomy, compiles key datasets and sources, identifies research gaps and demanding situations, and guides destiny improvement of dependable and green LLM-pushed disaster management structures.
Sarandis Mitropoulos et al., [44]	**Fine-tuning, prompt engineering, retrieval-augmented technology (RAG), transfer mastering, multimodal getting to know, energetic mastering, and hybrid deep getting to know models (CNN, LSTM, GNN integration).**	Integrates advanced LLM techniques with a established taxonomy and comprehensive dataset evaluation to provide clean course for destiny catastrophe management research.	Limited real-world validation, statistics excellent and bias issues, excessive computational requirements, risk of hallucinated outputs, and inadequate insurance of all disaster management stages.	Enhances understanding of LLM packages in disaster control, identifies research gaps, and presents steerage for developing more accurate, dependable, and scalable disaster response systems.
Deepak Bhaskar Acharya et al., (2025) [45]	**Planning and reasoning frameworks (ReAct, Chain-of-Thought), device-use integration, memory augmentation, multi-agent collaboration, reinforcement gaining knowledge of, self-mirrored image mechanisms,**	Provides a complete framework for autonomous aim-pushed AI by using integrating planning, reasoning, reminiscence, and multi-agent collaboration mechanisms.	High computational and resource prices, scalability challenges in complicated environments, reliability and safety concerns, constrained real-international evaluation, and difficulty in lengthy-time period self reliant reasoning.	Advances information of agentic AI systems by using outlining architectures, techniques, and challenges, and provides a roadmap for growing more self reliant, dependable, and purpose-oriented smart agents.

	and retrieval-augmented era (RAG).			
Prema Nedungadi et al., (2025) [46]	**PRISMA overview, BERTopic modeling, BERT transformers, CNN, BiLSTM, DGNN, multitask mastering, sentiment evaluation, faux information detection, federated mastering.**	Combines superior AI strategies and scalable methodologies with ethical safeguards to decorate personalization, misinformation detection, and real-time social media evaluation.	Algorithmic bias, privateness concerns, high computational fees, limited go-platform adaptability, language useful resource shortage, and challenges in actual-time big-scale deployment.	Improves content material personalization, misinformation detection, and real-time opinion analysis at the same time as promoting scalable, ethical, and consumer-shielding AI frameworks for social media.
Sergio F. Chevtchenko et al., (2025) [47]	**TDOA, DOA estimation, beamforming, GCC-PHAT, triangulation, microphone arrays, Kalman filtering, particle filtering, CNN-based localization, deep learning strategies.**	Integrates traditional signal processing and present day device learning techniques to decorate localization accuracy and robustness in dynamic drone environments.	Sensitive to environmental noise and wind interference, limited accuracy in complex terrains, high computational requirements, synchronization problems, and real-time processing demanding situations.	Enhances drone-based totally sound supply localization accuracy and robustness, enabling powerful surveillance, search-and-rescue, natural world tracking, and environmental consciousness applications.
Ali Daud et al., (2025) [48]	**Artificial Intelligence, Machine Learning, IoT, GIS, Big Data analytics, drones, blockchain, 5G communique, cloud computing, VR/AR simulations, sensor networks.**	Provides a comprehensive assessment of emerging computing equipment throughout all emergency management stages, highlighting sensible applications and actual-international deployment capability.	Faces demanding situations including battery and sensor reliability, AI prematurity, privateness and protection risks, interoperability problems, communique failures, and regulatory complexities.	Demonstrates how emerging computing gear transform emergency management through enhancing decision-making, coordination, preparedness, reaction efficiency, and normal network resilience.
ANDRÉS LEIVA-ARAOS et al., (2025) [49]	**Rapid Human-LLM framework, PRISMA screening, systematic review, bibliometric evaluation, keyword co-occurrence mapping, research mapping, AI-assisted synthesis, clever constructing assessment.**	Integrates human know-how with LLM assistance to accelerate literature assessment, improve studies mapping accuracy, and beautify evaluation of clever building safety functions.	Potential LLM bias, dependence on prompt high-quality, restrained transparency in AI-assisted synthesis, and viable omission of nuanced area-precise safety insights.	Accelerates literature synthesis, identifies key smart building protection functions, maps research gaps, and helps improved hearth, electrical, and life safety choice-making frameworks.
AHMED A. ZAKARIAi et al., (2025) [50]	**Sensor overall performance contrast, protocol evaluation, AI integration, big statistics analytics, smart metropolis framework modeling.**	Provides a holistic, implementation-centered evaluation integrating sensor specifications, verbal exchange technology, investment tendencies, and real-world IoT deployments for clever cities.	Faces demanding situations related to electricity management, network scalability, cybersecurity dangers, interoperability constraints, and sustainability issues in big-scale IoT deployments.	Demonstrates how IoT-pushed sensor networks, verbal exchange protocols, and AI integration enhance city efficiency, sustainability, resilience, and facts-driven smart city selection-making.

HASSAN EESAAR et al., (2025) [51]	**Autonomous drone navigation, route making plans, YOLOv12n item detection, LLaVA-OneVision-Qwen2 scene interpretation, GPT-4o mini summarization, and statistics augmentation (Flip, Rotate, Shear).**	The system offers fast, self sustaining aerial deployment that drastically reduces emergency response instances from over 10 minutes to beneath three.	Relies on preliminary incident coordinates, restrained to urban highways, operational constraints like battery existence, connectivity problems, and 90-2d deployment latency.	The autonomous drone gadget achieves high-precision incident detection, reduces emergency reaction instances to below three minutes, and provides actionable summaries.
ARY SETIJADI PRIHATMANTO et al., (2025) [52]	**3-D metropolis modeling, CityGML, hydraulic simulations, agent-primarily based modeling, IoT sensors, far off sensing, LiDAR, AI, device studying, GIS, and crowdsourcing.**	High-fidelity 3-D visualization, actual-time IoT tracking, and multi-situation simulations permit proactive, information-driven selection-making for optimized city flood evacuation and protection.	High computational requirements, information integration difficulties, real-time simulation gaps, sensor connectivity troubles, and a loss of specific "on-the-fly" evacuation making plans.	Digital dual cities beautify flood evacuation with the aid of supplying excessive-constancy simulations, actual-time monitoring, and optimized routing to improve urban disaster preparedness.

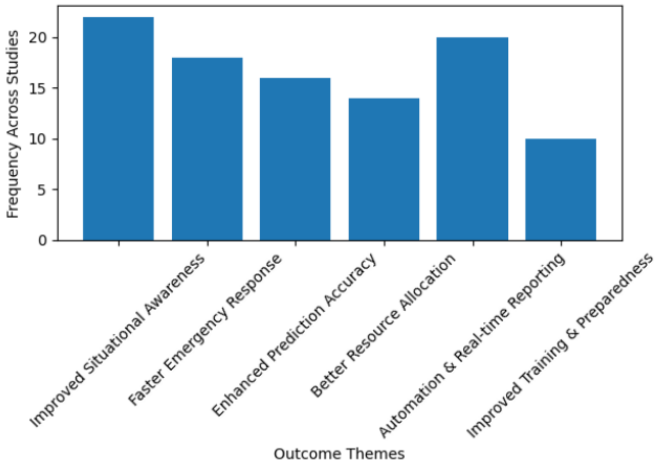

Fig. 3.3: Comparative Analysis of Research Outcomes in Disaster Management Studies.

3. Key Challenges

a) **Data Reliability and Quality:** Many systems are closely depending on extremely good, real-time datasets. Inaccuracies, noise in social media facts, and lack of standardized records integration frameworks avert powerful performance.

b) **Misinformation and Trust:** A most important barrier is the prevalence of misinformation on social media and crowdsourcing systems. Additionally, there may be a "consider deficit" amongst clinicians and responders regarding AI-driven selections.

c) **Technical and Physical Limitations:** Technologies like drones face confined battery existence, climate dependency, and constrained flight times. AI models frequently suffer from excessive computational fees, scalability issues, and "hallucinations" within the case of Large Language Models (LLMs).

d) **Ethical and Bias Concerns:** Algorithmic bias and privacy risks are continual across various programs, from triage systems to social media monitoring.

e) **Geographical and Contextual Gaps:** Most research and era improvement are concentrated inside the Global North, leaving disaster-inclined regions in the Global South underrepresented and understudied.

4. Future Directions

a) **AI-based autonomous reporting:** Development of fully automated, explainable AI systems for real-time disaster detection and accurate information extraction.
b) **IoT and digital twin integration:** Integration of IoT sensors and digital twin technology for real-time monitoring, predictive analytics and optimized evacuation planning.
c) **Advanced Drones and Remote Sensing Systems:** Expanding autonomous UAVs and AI-powered satellite imaging for rapid and accurate post-disaster damage assessment.
d) **LLM and Social Media Intelligence:** Use of large language models and NLP for automated report generation, multilingual communication and misinformation detection.
e) **Ethical and Scalable Global Framework:** Building transparent, privacy-preserving and scalable disaster reporting systems adapted to different regions, including the Global South.

5. Conclusion

Artificial Intelligence and rising technology like drones, IoT, and Digital Twins are basically remodelling catastrophe manage with the aid of permitting real-time detection and rapid situational awareness. These improvements notably lessen emergency reaction instances and decorate the accuracy of threat forecasting, which include predicting landslides a day in advance. However, the general ability of these structures is currently hindered by way of critical limitations, which includes data reliability troubles, the spread of incorrect facts, and moral issues regarding algorithmic bias. To ensure international resilience, the arena ought to transition toward Agentic AI and Human-LLM collaborative frameworks which is probably obvious and explainable. Ultimately, the destiny of disaster reporting lies in growing scalable and inclusive frameworks that address the needs of all regions, particularly the disaster-prone Global South.

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