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AI-DRIVEN SOCIAL MEDIA DATASET PROCESSING FOR AUGMENTING DISASTER RESPONSE AND RECOVERY EFFORTS-A REVIEW

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ABSTRACT
In recent years, the landscape of disaster response and recovery has been revolutionized by the widespread adoption of social media platforms, which offer real-time, user-generated data. In response to this paradigm shift, leveraging artificial intelligence (AI) techniques for processing multimodal datasets from social media has emerged as a promising strategy to enhance the efficacy of disaster management. This paper conducts a comprehensive review of the latest advancements in AI-driven methodologies for analyzing social media data to bolster disaster response and recovery efforts. Encompassing state-of-the-art techniques such as natural language processing (NLP), computer vision, machine learning, and deep learning, the review sheds light on the diverse array of AI-driven approaches available. The findings presented in this paper furnish valuable insights into existing AI-driven methodologies tailored for processing social media data within the realm of disaster management. Researchers stand to benefit from these insights, particularly in applications such as situational awareness, damage assessment, resource allocation, and social dynamics analysis. Additionally, the review brings to the fore the challenges and limitations inherent in processing multimodal social media data for disaster response and recovery, thereby offering crucial guidance for future research and development endeavours

Keywords: Artificial Intelligence (AI), Natural Language Processing (NLP), Machine learning (ML), Deep learning (DL), disaster response, disaster recovery, disaster management

Introduction
In recent years, the advent of social media platforms has transformed the landscape of disaster response and recovery efforts. The unprecedented volume of user-generated content, comprising textual posts, images, videos, and geolocation data, disseminated across these platforms during disaster events, has provided invaluable insights for emergency responders and relief organizations. However, the sheer magnitude and diversity of this data pose significant challenges in effectively harnessing its potential for enhancing disaster management processes.

To address these challenges, researchers and practitioners have increasingly turned to artificial intelligence (AI) techniques for the automated processing and analysis of social media multimodal datasets. By leveraging advanced machine learning algorithms, natural language processing (NLP) techniques, computer vision models, and geospatial analytics, AI-driven approaches offer promising avenues for extracting actionable information from the deluge of social media content generated during disasters. These insights can inform decision-making processes, facilitate resource allocation, and expedite response efforts, thereby potentially saving lives and minimizing the impact of disasters on affected communities.

This review paper provides a comprehensive overview of the state-of-the-art AI-driven methodologies and techniques employed in the processing and analysis of social media multimodal datasets for disaster response and recovery purposes. We delve into the various stages of the data processing pipeline, including data acquisition, preprocessing, feature extraction, sentiment analysis, event detection, geospatial mapping, and decision support systems. Furthermore, we explore the challenges and

limitations associated with existing approaches, such as data veracity, scalability, and ethical considerations, and discuss potential avenues for future research and development.
Through this review, we aim to elucidate the evolving landscape of AI-driven social media multimodal dataset processing in the context of disaster management and highlight its potential implications for improving the effectiveness and efficiency of response and recovery efforts. By synthesizing current research findings and identifying areas for further exploration, we hope to contribute to the advancement of this burgeoning field and ultimately enhance the resilience of communities in the face of natural and man-made disasters.
The structure of this paper is as follows: Section II provides insights into the approach adopted for conducting the review. In Section III, the review findings are presented in tabular format, mentioning objective/approach proposed in each paper. Section IV delves into the limitations identified during the review process and offers recommendations for future research directions. Finally, Section V concludes the paper by summarizing the key findings. This review aims to contribute to the ongoing discussion on the application of AI in disaster management and stimulate innovation in this vital field.

APPROACH FOR CONDUCTING THE REVIEW

In this section, we outline the systematic approach employed to conduct the literature review for this paper. The process involved several key steps, including identification of relevant literature sources, selection criteria, data extraction methods, and synthesis of findings. By adhering to a rigorous and comprehensive methodology, we ensured the inclusion of high-quality studies that contributed to a thorough understanding of the current state of AI-driven social media multimodal dataset processing in disaster response and recovery efforts.
To ensure direction, clarity, and focus throughout the research process we defined following research objectives:
RQ1 :Identify the existing AI-driven methodologies employed in disaster recovery and response utilizing multimodal data, including text, images, videos, sensor data, and social media feeds.
RQ2: Identify Limitations/Challenges in processing multimodal social media data
RQ3. Identify Future direction for using AI -driven methodologies for disaster recovery and response.

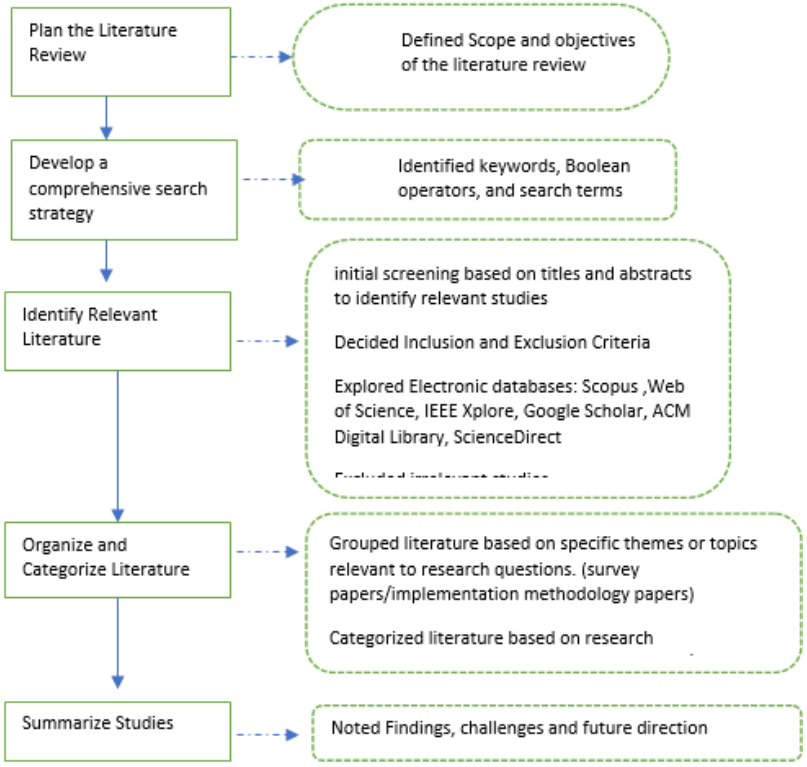

Fig 1: Steps followed for the review

Steps followed for the review process are shown in fig1. Details about year-wise distribution of surveyed papers given in fig2, distribution of survey papers as per technical approaches shown in fig3, distribution of implementation approaches reviewed shown in fig4.

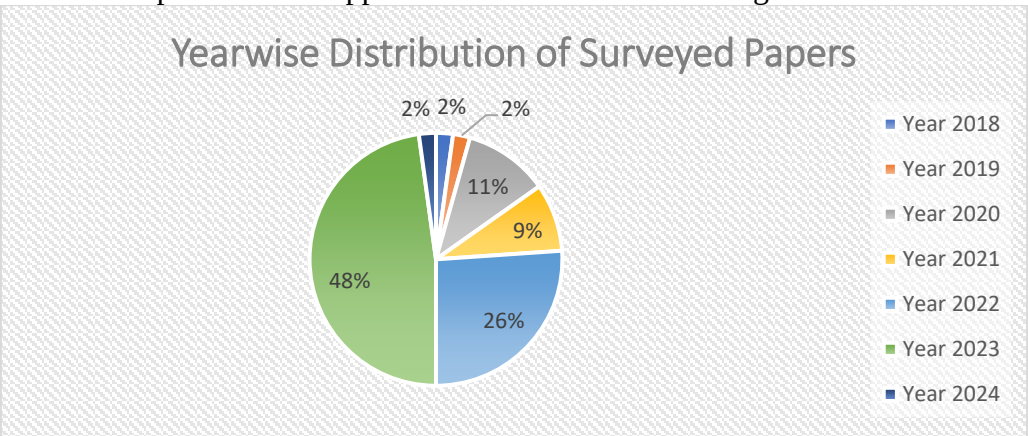

Fig 2: Year-wise Distribution of Surveyed Papers

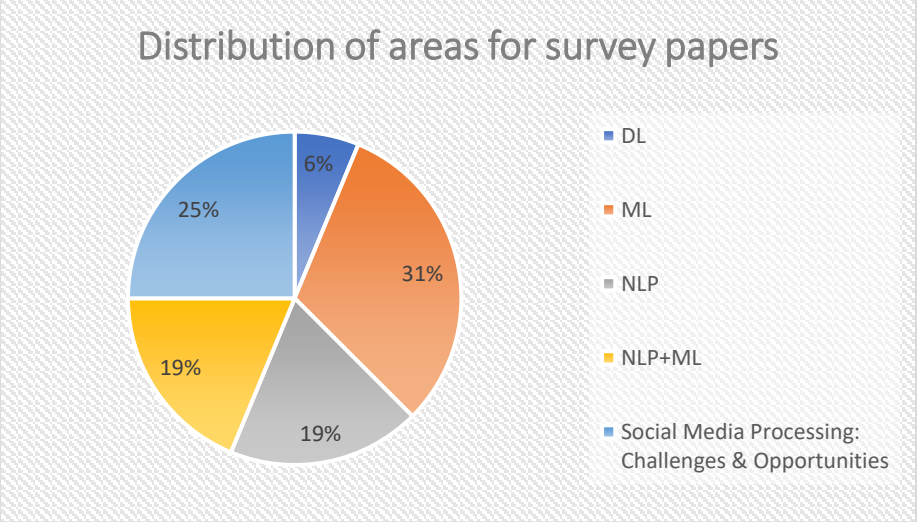

Fig 3: Distribution of areas of survey papers

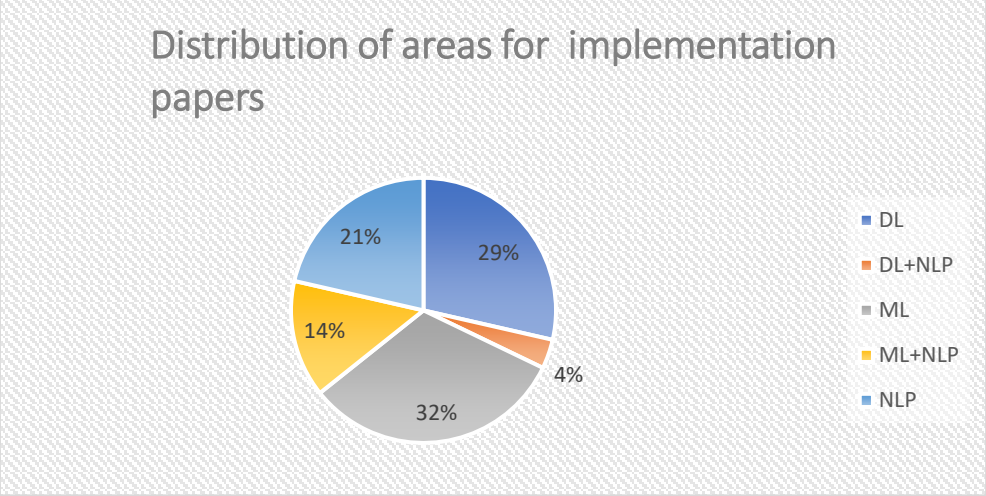

Fig 4: Distribution of areas of papers reviewed based on implementation approach

Findings at a Glance: Tabular Compilation

The comprehensive review is structured into two main parts: firstly, a meticulous examination of survey papers provides a broad overview of the current state of research. Secondly, an in-depth

review of individual papers focusing on NLP, ML, and Deep Learning is conducted. individual papers focusing on NLP, ML, and Deep Learning is conducted.

Reference no and year of publication	Summary of findings/Approach and future direction
Findings from Survey Papers	
[3] 2023	Survey of ML approaches and comparison for locating and deploying goods in case of disaster. GNN mentioned as future need.
[34] 2022	Survey of sentiment analysis, domain dependency is the constraint in reuse.
[36] 2022	NLP approach for social media post analysis, BERT & HMM are state of the art mentioned
[38] 2023	Survey of ML techniques for mining data from Social media ,highlighted challenges in social media data processing -privay,trust etc
[40] 2023	Survey of approach for handling misinformation from social media data
[42] 2022	Review of social media data usage in various domains -agriculture,disaster ,banking,BI etc
[21] 2023	Review on topic modeling techniques, contextual word embeddings. Application of neural approaches mentioned as state of the art.
[22] 2023	Review of utilizing social media data for disaster response, encompassing both natural and man-made hazards. The findings indicate a necessity for enhancing disaster response through a more refined and data-driven approach, utilizing the information gleaned from social media platforms.
[27] 2023	Discussed approaches CNN,KNN,LSTM,SVM for detection of the disaster.
[18] 2022	Review of papers addressing socioeconomic needs in case of disaster.
[35] 2021	Summarizes ML approaches,applications areas and lists challenges.Key findings is the list of datasets which resaerchers can use.
[45] 2022	Presents summary of ML approaches along with dataset used for various disaster type.
[10] 2023	Review highlights that LDA performs well on long text and not on short text
[9] 2023	Survey paper mention future research direction to prioritize the development of intelligence management systems for near-real-time transport network.
[31] 2023	Survey of topic modelling using NLP

[29] 2021	Survey of ML approaches for social media data analysis-Event detection,crime detection, behaviour analysis
Findings from Implementation Papers	
[1] 2023	Theoretical Framework for addressing social media data challenges.
[2] 2023	An ML and simulation framework designed to forecast the disaster readiness attitudes among the impacted population
[4] 2023	MEDIC dataset is proposed for social media images classification.
[5] 2023	Examines a flooding event in Henan Province as a case study to demonstrate the framework's effectiveness.
[6] 2023	Dempster–Shafer theory is used to create hybrid environment using fuzzy and linguistic environment.
[7] 2023	Model is proposed to measure semantic similarity, tackle analogies, and recognize unknown concepts
[8] 2023	Lexicon and ML approach, Random Forest and Support Vector Classification for sentiment analysis.
[11] 2022	Summarization of ML techniques according to the type of disaster
[12] 2022	Proposed DSS shown 97% and 99.7% accuracy in Twitter keyword extraction and entity classification .
[13] 2022	NER based algorithm: Sentiment analysis
[14] 2022	AI-SocialDisaster leverages NLP algorithms such as entity detection,category classification, and sentiment analysis to detect and pinpoint various natural disasters
[15] 2022	Survey of employing deep learning for disaster response tasks.
[16] 2023	For tweet preprocessing, and classify tweets.
[17] 2022	Classification of social media posts and generating visualization
[19] 2020	Extracting useful information such as location, population, damages to buildings roads, bridges etc
[20] 2024	Extraction of public sentiments related to global disasters based on geographical locations.

[23] 2020	A research project introduced a hybrid machine learning approach aimed to track the location of the disaster
[24] 2019	ML approach to assist first responders and government agencies
[25] 2020	Case analysis of Hurricane Florence aimed finding impact of the desaster
[26] 2020	ANN approach Identifies the category of the tweet, aiding in swift and efficient disaster response.
[28] 2020	ML Classifiers implemented to identify urgent requests
[32] 2023	LDA +BERT approach proposed for topic modelling
[33] 2022	Model for Extracting topic keywords through pretrained BERT
[37] 2023	NLP techniques to estimate geolocation from short text
[39] 2023	NLP based approach for co-occurrence analysis to identify frequently associated terms, and assessing sentiment to understand the emotional context of the tweets.
[41] 2023	A Python library has been created to seamlessly integrate geospatial data into the PyTorch deep learning ecosystem
[43] 2023	Proposed Deep learning approach fetch location information from social media data related to disasters.
[44] 2021	CNN-bilstm based system capable of accurately determining the city-level geolocation of real-time tweets.
[30] 2018	Proposed ML approach for image classification
[46] 2021	Aim to classify social media data using neural network

Future direction

As our review has synthesized existing literature, it has shed light on various gaps, unanswered questions, and areas ripe for further investigation. In this section, we outline potential avenues for future research and theoretical development within this domain.

- One pivotal necessity highlighted in prior research [1] emphasizes the need to construct a model equipped with the capability to seamlessly incorporate social media content into natural language processing frameworks such as BERT and GPT for real-time analysis of social media posts.

- While certain AI-based approaches have yet to explore numerous application domains, there remains an underutilization of efficient methodologies like Random Forests (RF) and Graph Neural Networks (GNNs) in various contexts, as noted in the literature [3].
- Although advanced methods have been developed, many are not yet suitable for operational deployment, despite their potential to convey preemptive and remedial measures for assessing extreme weather events. In numerous applications of named entity recognition, human intervention is often necessary for post-processing to rectify model outputs, as highlighted in prior research [10].
- Research has indicated that leveraging deep learning methods such as Long Short-Term Memory Networks (LSTMs), Recurrent Neural Networks (RNNs), in conjunction with Natural Language Processing (NLP) techniques, holds promise for enhancing the desired outcomes, as highlighted in previous studies [14].
- To address fundamental hurdles in multimodal deep learning, such as handling missing data, varying noise levels, and effectively integrating heterogeneous data, there is a demonstrated need for the application of deep learning methodologies, as emphasized in prior research [15].
- Currently, the interpretation of semantic content within social network messages poses a multifaceted challenge, requiring a combination of automated methods and human intervention to achieve high levels of accuracy and adaptability, as noted in recent literature [19].
- Current research on disaster monitoring via social media faces inefficiencies in several areas, including inaccurate classification of disaster-related tweets, restricted language support, limited coverage of disaster types, imprecise identification of disaster locations, absence of disaster insights presented in plain language using Natural Language Processing (NLP), and inadequate support for disseminating these insights, such as unavailability on mobile apps for iOS or Android platforms, as outlined in recent literature [20].
- Research has highlighted the necessity for Natural Language Processing (NLP) applications focused on leveraging social media data autonomously, without the need for human intervention, as highlighted in recent literature [29].
- The findings indicate that the advancement of topic models does not adequately meet the requirements of users utilizing them for social media analysis. Additionally, there appears to be insufficient methodological assistance for researchers in constructing and deciphering topics, as discussed in recent research [30].
- The exploration of various topic modeling methods through a real case study involving Italian customer care offers valuable insights. This study could serve as a source of inspiration for similar case studies within the domain of Natural Language Processing (NLP), as indicated by recent research [31].
- Recent research [32] emphasizes the necessity to enhance topic modeling by incorporating the ability to infer topics using Deep Neural Networks (DNN) and BERT, a state-of-the-art language model.
- The survey findings [34] offer a comparison of classification methods for sentiment analysis, underscoring the necessity for future research to focus on developing classification models that account for domain dependence.
- Achieving domain-independent context-based interpretation remains a persistent challenge, highlighting the demand for enhanced domain-independent NLP models.[36]
- Addressing the demand for social media text processing to identify misinformation, memes, rumors, conspiracy theories, and viral posts remains a challenging task that requires attention, as emphasized in recent research [38].
- The real-time processing of tweets presents a significant challenge, particularly in light of the escalating usage of social media platforms. This underscores the future necessity for real-time data processing capabilities, as highlighted in recent research [39].

- Addressing misinformation during disasters poses a significant challenge, as noted in recent research [40], highlighting the demand for multimodal data processing techniques equipped with capabilities to tackle this issue.

By addressing the future directions outlined above, researchers can contribute to advancing knowledge, informing practice, and addressing pressing societal challenges associated with usage of AI for disaster management.

Conclusion

In this comprehensive review, we have examined the role of AI-driven social media dataset processing in enhancing disaster response and recovery efforts. Through the analysis of studies ,we have gained valuable insights into the potential applications, challenges, and future directions in this critical domain. Our review highlights the significant strides made in leveraging AI technologies to harness social media data for disaster management. From early detection and situational awareness to response coordination and resource allocation, AI-driven approaches have demonstrated their potential to revolutionize traditional disaster management practices.

However, despite the promising advancements, several challenges persist. Issues such as data quality, information overload, and the ethical implications of AI deployment require careful consideration. Moreover, the lack of standardization and interoperability among existing systems poses barriers to effective collaboration and knowledge sharing.

Findings suggests that, there are several promising avenues for future research and development. Integration of advanced AI techniques, such as deep learning and natural language processing, holds the key to improving the accuracy and efficiency of social media data processing.

Furthermore, collaboration between researchers, practitioners, and policymakers is crucial for advancing the field and ensuring that AI-driven solutions are deployed responsibly and ethically. By addressing these challenges and embracing emerging technologies, we can unlock the full potential of AI-driven social media dataset processing to augment disaster response and recovery efforts, ultimately saving lives and mitigating the impact of disasters on communities worldwide.

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