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ImageB4Act to Optimize Contingencies and Crisis Relief Operations: Insights from Imagery Data and Computer Vision Approaches to Regenerate Dataset through AI-Powered Analysis

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Abstract: Natural disasters and emergencies constitute significant sources of both human suffering and economic losses. The need for effective emergency management has never been more critical. In recent years, there has been a noteworthy shift towards the usage of social media channels by individuals to disseminate immediate updates in both natural and manufactured catastrophes. The internet-generated data has proven to be immensely valuable for humanitarian organizations, enabling them to swiftly comprehend the evolving situation and efficiently coordinate relief efforts. In this work, highlights the findings of numerous studies that emphasize the significance of rapid and efficient processing of this online data for the benefit of humanitarian endeavors. This work provides an overview of the works carried out through computer vision in terms of given objectives: identified studies on required dataset for further research in emergency management, recent studies on various approaches to disaster management, further majorly aimed to process ImageB4Act dataset that helps to perform object detection on post disaster aerial images in order support humanitarian tasks during disaster management.

Keywords: *Computer Vision, Artificial Intelligence, AI-technologies, Machine learning, Emergency management, natural catastrophes, ImageB4Act dataset, Humanitarian tasks*

1. Introduction

Emergencies, encompassing a wide range of sizes and levels of severity, pose substantial threats in terms of both human suffering and economic losses. These events can vary from minor traffic accidents affecting only a handful of individuals to large-scale natural catastrophes capable of causing widespread devastation and impacting the lives of thousands. As such, the field of emergency management has taken on a pivotal role in alleviating the adverse effects of these occurrences. As a result of this, an ongoing area of research is the use of current technologies to develop creative ways to avoid, reduce, and investigate catastrophes.

As the availability of cameras are almost everywhere now a day's in terms of capturing real-time recordings or highly efficient cameras in smart phones to capture visual information on hotspots where an emergency occurs. This captured information is been transferred or shared over social media platforms immediately. By using current technologies extracting images from social media platforms and identifying the appropriate images in order to assist various emergency management teams during various emergencies or disasters which can be considered as man-made or natural is possible in the field of computer vision.

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BACKGROUND & SUMMARY

1.1. Background

This work provides an overview of objectives- studies on necessary dataset for further study in emergency management, studies on alternative ways to disaster or emergency management, Pre-process data with the help ML approaches that which further helps to identify objects in post-disaster images. In addition, numerous approaches or algorithms were discovered to be supportive in the area of computer vision in data analysis by integrating with machine learning techniques.

In this work, it was considered an emergency or disaster situation as an unexpected situation which keeps people in high risk, damage properties includes huge human or economical loss. During this situations SAR teams can get help of the computer vision applications which can provide situational awareness in order to give beneficial activities to avoid worsening of the condition.

1.2. Summary

As this section begin with an explanation about emergency and what is treated as disaster situation in the above. The further discussion in this article provides a brief overview of how computer vision helps to achieve various emergency management phase, a brief overview of various existing studies on datasets, a overview of work on various ways of disaster management within the realm of computer vision, Proposed ImageB4Act Dataset through AI approaches, also provides Algorithmic approach for the data generation, briefs the experimentation results. Finally, end of this work provides technical validations in terms of data

collection procedures of the work and also provides objectives for further research in disaster or emergency management through the field of computer vision with the ImageB4Act dataset.

Therefore, this work highlights the works carried out the dataset in disaster management through the field of computer vision. Figure-1 represents the visualization of the literature study done to achieve the objectives of this work and also in Table-1 the overview of the literature that helped to achieve the objective for dataset to achieve post disaster management activities is represented.

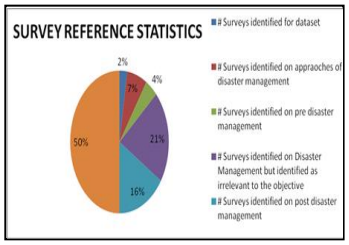

Fig 1. Represents the literature statistics or the articles referred to understand various approaches or technologies used in the field of computer vision for disaster management

1.3. Overview of EM phases with Computer Vision

Emergency management has become critical in reducing the effects of disasters. It is feasible to achieve solutions for various emergency management stages using contemporary technology. One of the numerous scientific disciplines aiming to better emergency management jobs is computer vision, which aids the search and rescue team during natural catastrophes.

As the emergency management can be classified in four phases10 which includes- Emergency preparedness, in which recognizing risk indicators during an emergency can be preventive efforts to lessen the effect of a disaster. Emergency Response, which is the process of detecting and finding an emergency promptly after it occurs, is critical. Emergency Recovery is the phase where rescue team activities take place until normalizing the situation. Emergency Mitigation is a phase where understanding the emergency in such a way to avoid the impact of damage and this phase is achieved after the normality of situation. All these phases can be addressed with computer vision in scientific field. The techniques and models that help to process the EM phases are specified in Figure-2.

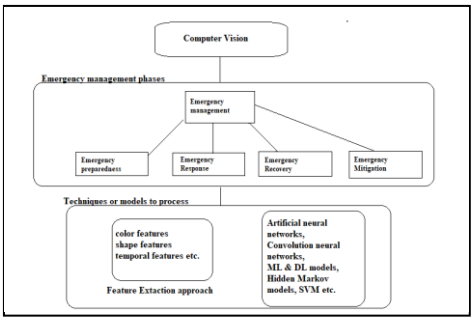

Fig 2. Architectural view of Computer vision field over Emergency Management (EM) Phases

2. Datasets For Disaster Management

The studies on Computer Vision System in the Disaster Management when compared to examining textual material which is vastly available in social media are comparatively few. With the recent successes of deep learning, studies are happening on social media images for humanitarian tasks. It has been reported that image data from social media is crucial for disaster response duties in[1, 4-9].

Table 1. Articles identified as datasets for further computer vision application on disaster management.

Year	Article reference	PROPOSED WORK	Architecture/ Algorithm / Models used
2022	**[1]**	They concentrated on supplying dataset visuals for disaster preparedness and multitasking in their study. The 71,198 pictures in the catastrophic response multi-tasking dataset have been categorized for four different tasks.	ReSNet18, ResNet50, ResNet101, VGG16, Dense Net, Squeeze Net, Mobile Net, Efficient Net
2020	**[2]**	The authors focused on picture classification in order to recognize crisis occurrences, They suggested a dataset for detecting disaster types, informative classification, and damage severity evaluation.	Using PyTorch library - ReSNet18, ResNet50, ResNet101, AlexNet, VGG16, Dense Net, Squeeze Net, InceptionNet, MobileNet, EfficientNet.
2018	**[3]**	This study relied on utilizing imagery data or textual content posted on social media for humanitarian organizations during disasters. They aim to release a multimodal dataset to address a crisis response tasks.	Crowd sourcing platform Crowd Flower to get manual annotations of sample data.

Currently, publicly available datasets include disaster type detection and informative classification using state-of-art algorithms2, MEDIC1 which includes 71,198 photos from a manually annotated multi-task dataset for calamity response image classification tasks and CRISISMMD3 consists of 1,28,893 images for several humanitarian tasks. Among these it is identified that MEDIC1 is the first dataset of its sort for inquiry into images from social media, emergency preparedness, and multitasking learning.

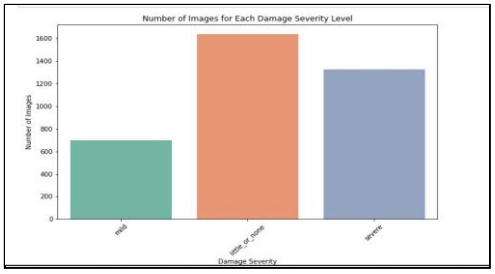

Fig 3. Represents Data visualization according to the level of damages during the calamity or the degree of damage provided in MEDIC data set for the multi-task learning

3. Computer Vision on Disaster Management

3.1 Existing review Existing review

The reviews of mostly used algorithms in computer vision applications for emergency circumstances are specified in this section. It has been observed that with the use of computer vision & pattern recognition techniques it is possible to predict the type of natural disasters and also generate early warning systems[11]. Various feature extraction & machine learning algorithms may be used to gather pertinent data from elaborated image data[10] with that prediction of objects from post-disaster images are possible.

Using artificial neural networks prediction capabilities with impressive accuracy is achieved, in an input layer it is made up of a large number of non-linear coupled pieces or neurons[12]. Convolution neural network models can also be used for object detection in an environment through[13] Tensor Flow object detection models like SSD (single shot Multi box detector), Faster Region CNN, YOLO (You Only Look Once)[14]. To classify multispectral images using deep CNN21, genetic algorithm-based feature selection GAF[22] can also use as feature selection techniques. Areal videos can also be analyzed using YOLOv3[23] approach for damaged scene detection. Intelligent robot systems can also be utilized using deep learning network algorithms[24]. Human posture detection approach [25] can also be considered as useful for emergency management tasks.

3.2 Methods

During natural disasters, people are using technology to post content about injured or dead people to report updates over social media and studies have revealed that this online information can be helpful to perform disaster management operations to provide awareness of situations and search & rescue efforts to the disaster management team. It is also identified by the studies15 about Artificial intelligence (AI) and machine learning (ML) advancements in deep learning (DL), neural networks (NN), and computer vision (CV) are employed to deal with the effects of disasters.

4. Proposed Model

4.1. ImageB4Act for post-disaster rescue operations

With these advancements studies16 have been shown that it is possible: to identify damage severity during disasters, to predict the type of disasters, to develop early warning systems, and assess the damage as part of post disaster response operations. In order to perform all these availabilities of dataset is one of the challenges. From3 it is identified that limited work has focused on the usage of image data with a reason of lack of labeled image data and also it focused on releasing a large dataset related to natural disasters which is important for crisis management and response activities of humanitarian organizations. From2 new data set has been proposed for disaster type detection in order to achieve damage severity. From1 the first dataset was proposed to be used in future crisis management and multi-task learning research.

This work proposed a new data set ImageB4Act through data filtering technique on MEDIC data set with 71,198 images. Among these, data set on various humanitarian tasks is recognized. Based on image classification approach the categories of annotated images were filtered based upon the type of disaster in order to identify the affected, injured or dead people from the huge set of data. With the ImageB4Act data set it is possible to perform various post-disaster management operations like detecting objects which helps the rescue team to investigate the affected disaster area efficiently for many humanitarian tasks. In figure-4 the architecture view of proposed methodology is presented in detail.

Fig 4. Architecture view of proposed model of ImageB4Act dataset.

4.2. Proposed Algorithm for Data filtering process of ImageB4Act

Post-Disaster Image Analysis Pipeline
Input: MEDIC Dataset
Output: ImageB4Act Dataset
Step-1: Understanding Dataset Features-
Read and explore the MEDIC dataset to identify attributes and features. Store relevant metadata, image characteristics, and associated information.
Step-2: Attribute Identification for Information Retrieval-
Identify crucial attributes (e.g., image content, timestamps, geographical data) for retrieving post-disaster information from the dataset.
Step-3: Filtering Post-Disaster Affected Images-
Train a classification model using labeled data to discern post-disaster affected images. Apply the classification model to filter post-disaster images from the MEDIC dataset.
Step-4: Removing Irrelevant Noisy Data-
Utilize clustering techniques (e.g., K-means, DBSCAN) on the filtered dataset to identify and exclude noisy or irrelevant images. Generate the refined ImageB4Act dataset containing clearer and more relevant images.
Step-5: Data Visualization for Pattern Recognition-
Employ data visualization techniques (e.g., scatter plots, heat maps) on the ImageB4Act dataset to identify and conclude patterns, clusters, or trends within the data.

In the figure-5, algorithmic flow of dataset pre-processing through AI approaches is mentioned in a pictorial form. This preprocessing approach will retrieve an effective data set in order to help post disaster management operations that which helps the rescue team.

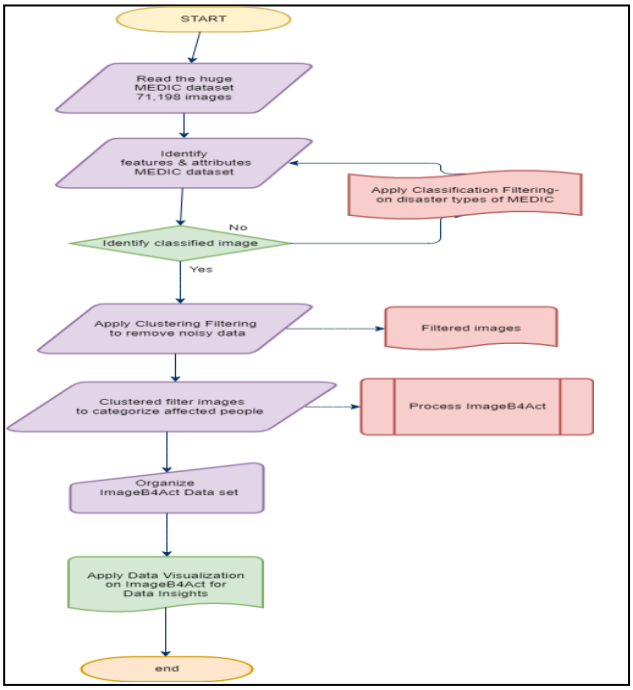

Fig 5. Experiment work flow diagram of the proposed algorithm

4.3. Data Records

In the ImageB4Act dataset, we used an approach to reduce computational complexity. The layers of data existed in MEDIC dataset was processed with a classification approach and filtering technique. Assuming that the filtering approach on classified MEDIC data is referred as D_{raw}, and filtered criteria on post disaster data is C. After applying optimized data filtering process the ImgaeB4Act dataset D_{filter} for post-disaster management tasks is updated using the following equation

$$D_{filter} = F_{dc}\ (D_{raw}, \mathrm{C})$$

Where, D_{filter} refers to the filtered dataset ImageB4Act, D_{raw} refers to the MEDIC dataset ,C refers to the filter conditions or criteria applied to the MEDIC, F_{dc} refers to the filtering operation on raw data set D_{raw} using data cleansing techniques to generate filtered data set D_{filter}.

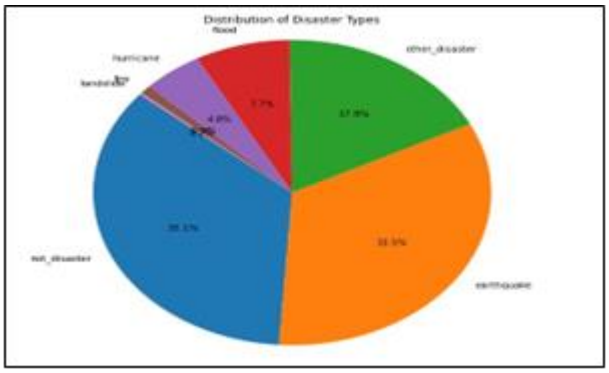

Fig 6 represents the data visualization results on MEDIC data set using AI classification approach.

4.4. Results

In table 2, we provide the primary performance indicators of ImageB4Act dataset. From the huge data set results of MEDIC which is a foundation for further developments of computer vision applications on post-disaster management tasks.

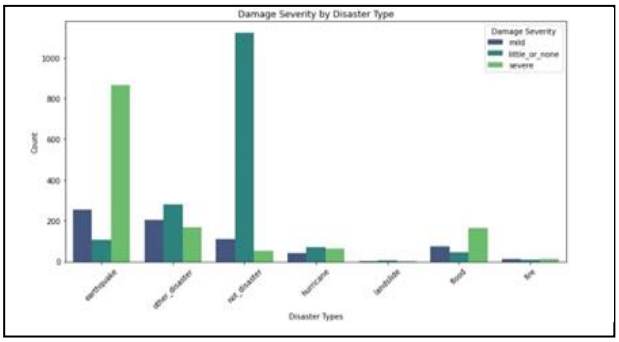

Fig 7. reflects damage severity from huge dataset of various types of disaster

In figure 7, we report the results of data visualization on MEDIC1 data set using AI classification models, which retrieves the image data classified on the variety of disasters, including storms, avalanches, flooding, and earthquakes identified irrelevant disaster images.

However, the results of ImageB4Act dataset are important for disaster-response system in order to rescue & reduce the operational cost of emergency management team during post-disasters.

Table 2 Classification results using data filtering techniques applied on MEDIC data set retrieves the humanitarian data useful for post-disaster management tasks

	image_id	event_name	image_path	damage_severity	informative	hu
3	ASONAM2017	ecuador_eq_mild_im_2573.jpg	data/ASONAM17_Damage_Image_Dataset/ecuador_eq/...	mild	informative	affected_injured_or_de
6	ASONAM2017	ecuador_eq_none_im_2486.jpg	data/ASONAM17_Damage_Image_Dataset/ecuador_eq/...	little_or_none	informative	affected_injured_or_de
20	ASONAM2017	ecuador_eq_none_im_152.jpg	data/ASONAM17_Damage_Image_Dataset/ecuador_eq/...	little_or_none	informative	affected_injured_or_de
27	ASONAM2017	ecuador_eq_severe_im_1995.jpg	data/ASONAM17_Damage_Image_Dataset/ecuador_eq/...	severe	informative	affected_injured_or_de
38	ASONAM2017	ecuador_eq_severe_im_817.jpg	data/ASONAM17_Damage_Image_Dataset/ecuador_eq/...	severe	informative	affected_injured_or_de
...	...	...	...	...	...	
48479	aidr_old_data	666031155725131777_0	data/aidr_info/paris_attack/15_11_2015/6660311...	little_or_none	informative	affected_injured_or_de
48778	aidr_old_data	979792855937048577_0	data/aidr_info/human-induced_disaster/30_3_201...	little_or_none	informative	affected_injured_or_de
49042	aidr_old_data	592883516565811200_0	data/aidr_info/nepal_earthquake/28_4_2015/5928...	severe	informative	affected_injured_or_de
49144	aidr_old_data	593279290197745664_0	data/aidr_info/nepal_earthquake/29_4_2015/5932...	little_or_none	informative	affected_injured_or_de
49167	aidr_old_data	902637372801679362_0	data/aidr_info/harvey/29_8_2017/902637372801679...	little_or_none	informative	affected_injured_or_de

4.5. Technical Validation

To validate our dataset, as there is lack of large collection of imagery data of disasters We gathered the MEDIC dataset, which is the first ever data on imagery content gathered from sources such as social media posts, disaster relief, and multitask learning research. For data collection the procedure we considered- (a) studies for data set that fall within the period 2018–2023, (b) Identified huge imagery dataset collection from MEDIC1, and (c) created ImageB4Act dataset for humanitarian tasks that helps to apply object detection techniques on post-disaster images as future research. We found that this ImageB4Act data can be helpful for post-disaster management operations in particular humanitarian tasks.

In the above table-3, the details of list of works made by authors Muhammad Imran, Firoz alam1 focused on dataset relevant to disaster information from 2013-2022 has been presented and it is identified that in 2022 MEDIC1 is published as first data set on imagery content of disaster by considering the above specified factors on disasters. And by refining the MEDIC dataset with filtering approach we created ImageB4Act dataset with 3662 images which is also shown in table-2 we particularly aimed for post-disaster management tasks such as object recognition, detection, and identification through computer vision techniques as part of future research.

Table 3. represents the list of articles published on dataset from 2013 to 2022 by authors further obtained MEDIC dataset for disaster-response tasks in 2022 that which utilized in this work to generate ImageB4Act dataset.

Year	**[S.no] Articles published by most common authors Muhammad Imran et.al. on Disaster Dataset since 2013.**	**Aim of Work**
2013	[1][18]	To categorize tweets that was published on social media amid natural disasters.
2014	[2][15]	To classify messages posted in social media in terms of needs & damage during calamities.
2015	[3][19]	To process social media images posted in disasters to extract situational awareness information.
2016	[4][17]	To present human-annotated twitter data trained on million crisis-related tweets.
2017	[5][20]	To examine photos shared following natural disasters, people use social media to gauge the magnitude of the damage the disasters caused.
2018	[6][9]	To demonstrate a pipeline for processing social media images that can gather and filter social media imagery for use in disaster situational awareness.
2018	[7][3]	To present an extensive multi-modal calamity dataset gathered from Twitter with 14,223,141 tweets and to annotate in order to help different humanitarian groups with various crisis management responsibilities.
2020	[8][2]	To suggest new datasets containing 1,28,893 photos for damage severity evaluation, classification of formativeness, and disaster type recognition.
2022	[9][1]	They proposed social media image classification dataset with 71,198 images for humanitarian response tasks during natural calamities.

5. CONCLUSION

During natural disasters there is lot of textual data and imagery data posted in social media to provide updates over networks and it is also observed that limited work has focused on usage of image data for disaster management tasks. Our research found that digital image data can be useful for managing operations after a disaster event particularly the rescue operations. As there is lack of large collection of imagery data of disasters, we identified MEDIC as the first data set which is providing a pathway guide to perform various multi-task learning tasks.

We also identified studies on various AI technologies for disaster-management operations. For post-disaster management operations like helping the search and rescue team through assessment of damage severity, aerial analysis, prevention of human loss and infrastructure that which affects the economy can be handled efficiently by the AI technologies. As MEDIC is with huge set of disaster imagery data, we provided classification results of the ImageB4Act data set through data filtering and noise reduction techniques to cluster the humanitarian images (affected dead or injured people).

We report that this clustered dataset aimed to develop efficient applications through Artificial Intelligence approaches, which helps to perform effective post-disaster rescue operations by the emergency management team.

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