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Disaster management using Remote Sensing on Unsupervised Data

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***Abstract**: One of the biggest challenges in real-world applications is recognizing various objects and the conditions of the land based on the natural disasters in a remote sensing image. Object recognition in remote sensing images is used to locate various geographical locations for monitoring and observing GIS information, but the accuracy is not satisfactory. This research considers it as a base problem and analyzes, and it is motivated to provide a better solution regarding classification accuracy. The main objective of this study is to design and implement a framework named Natural Disaster detection on Remote Sensing data (NDRSD) for detecting and classifying the objects from remote sensing images. The efficiency of the framework increased by applying various image processing stages such as Pre-processing, Image Enhancement, Object Detection, Bag-of-Words creation, and Training – Testing process. The bag-of-words process enables the user to maintain ground truth values for classifying the objects and improves the accuracy of classification. From the entire process, it notices that NDRSD is suitable for processing any RSD. The proposed framework experiments and results verified. By comparing the obtained results with the state-of-the-art methods and the performance is evaluated.*

***Keywords:** Disaster Management, Remote Sensing, SAR, BoW, Unsupervised Data.*

I. INTRODUCTION

Natural disasters are intense occurrences over the earth's technique (lithosphere, hydrosphere, biosphere or air) which is different greatly in the expression, leading to death or injury to human beings, along with loss or damage in valuable good, like buildings, and communication systems or agricultural soil, forest, environment. They're a profound effect of the pure environment up on the socio-economic technique. This affect may be rapid, as in case of earthquakes slow as in the case of drought. It's crucial to differentiate among your provisions tragedy and danger. A probably harmful occurrence (danger), like an earthquake from itself just isn't deemed a tragedy the moment it happens in temperate locations.

It's known as a tragedy the moment it does occur in a populated location, also attracts hurt, destruction or loss.

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Pure disasters come about in lots of areas of earth, even though every kind of tragedy is confined to specified locations. A sign of the geographic supply of lots of significant threats, like earthquakes, volcanoes and tropical storms and cyclones.

As could be understood using the amount earthquake along with volcanoes, as an instance, are focused chiefly about the planet's plate boundaries.

Disasters might be categorized in lots of divisions is listed detail in Table1. A Potential Sub-division is involving:

- ***Natural Disasters**:* All these include immediate effects on individual wellness insurance and secondary effects, like landslides and fires, and which may result in additional deaths, distress and more are listed in Table1.
- ***Environmental Disasters***: These largely contain of industrial and technological accidents, typically between the manufacturing, the usage of transportation of poisonous materials. Examples comprise Oil Spills and also Forest Fires caused by individuals are tabulated in Table2 under man-made disaster.
- ***Pandemic Disasters**:* will involve a surprising spread of the infectious illness that closely affects wellness ongoing products and services and companies. This is inclined to attract a whole lot of financial and societal expenses. Cases comprise Dengue disperse and SARS epidemic.
- ***Complicated Disasters**:* instils a breakdown of jurisdiction, looting, and strikes on strategic instalments. Cases include warfare and coup.

Table 1: The Centre for Research on the Disasters divides the natural disaster category into six sub-groups, which in turn include 17 disaster types, and 33 sub-types.

Nature disaster sub-group					
Climatological	Geophysical	Hydrological	Meteorological	Biological	Extraterrestrial
Nature disaster types and sub-types					
Drought	Earthquake	Flood	Storm	Animal Accident	Impact
Wildfire	Ground shaking	Landslide	Tropical Cyclone	Insect Infestation	Airbrust
Forest fire	Tsunami	Wave action	Cold / Heat wave	Viral diseases	Space Weather
	Lava flow	Coastal Flood	Fog	Bacterial diseases	Shockwave
		Seiche	Severe Winter Conditions	Fungal Diseases	

India is now home to over 50 global organizations focused on crisis management, humanitarian needs, global developmet human rights, women and children's rights and protections, HIV/AIDS loss and education, sanitation, food safety, sustainable growth, and health. India has provided resource and monetary help to regional countries in the wake of devastating disasters.

Table 2: Man- Made Disaster Sub-group

Man-Made disaster sub-group		
Industrial accident	Transport accident	Miscellaneous accident
Man-Made disaster types		
Chemical Spill	Air	Collapse
Explosion	Road	Explosion
Fire	Rail	Fire
Gas leak	Water	-
Poisoning	-	-
Radiation	-	-

Disaster management combined with India's National Disaster Management Authority (NDMA). Components of this national disaster management arrangement comprise the National Executive Committee (NEC), which help the NDMA with tackling national crisis management actions; the Central Government which preserves the ability to issue guidelines to NEC, and State Government and Government Emergency Committees (SECs) to enable or assist in disaster management. The State Governments are responsible for its key use of organizing emergency management actions to incorporate the appropriate establishment of early warning systems (EWS).India supports building disaster management capacity efforts in the Asia Pacific area. Because of climate and location, India itself is among the very disaster-prone regions of the earth. The nation exposed to a lot of all-natural hazards including floods, cyclones, droughts, and earthquakes and those disasters frequently causes significant harm to property and loss of life.One or more of those disasters/emergencies can disrupt major services like water supply, transport, communications, etc. Together with all these abrupt interruptions, see significant impacts medical, social and economic media of their community along with influenced nearby nations. These crises possess a long-term effect on people's lives after the quick impression was mitigated. So, badly intended relief tasks could have a bad sound effect on those tragedy sufferers.In the past several years, the frequency and size of the size of real disasters were rising. These crises generally get all types of negative consequences for sustainable improvement throughout environmental, societal and financial consequences. For this reason, it's critical to come up with sophisticated and helpful tools for disaster management.

Disaster Management:

The process of disaster management is often interpreted as a cycle consisting of four main phases: mitigation, reparedness, response and recovery.

Remote Sensing and GIS:

Additionally, there are two sorts of remote sensing technology, both passive and active remote sensing.

- Active sensors exude energy as a way to scan areas and objects after which a sensor subsequently finds and measures rays that are reflected or backscattered. RADAR and LiDAR are cases of remote sensing at which timing delay in between return and emission quantified, demonstrating the positioning, direction, and speed of an object.
- Passive sensors collect radiation that emits or represented from the object or surrounding places. Reflected sun has become easily the most frequently encountered source of radiation measured by passive sensors. Cases of passive remote sensors include picture photos, infrared, charge-coupled devices, along with radiometers.

With GIS engineering and its particular spatial investigation capacities, it's likely to look exceptionally correct interactive simulation devices which provide an even broader comprehension of various disasters, and their outcome as well as also the harm they can inflict over a particular field. GIS methods function like a decision support making tool also, fundamentally, most crises are present in nature. With all the assistance of different GIS layers, the decision making might create potential. It helps effectively organize emergency response actions which may subsequently evaluate. Geospatial data is necessary for a successful and fast reaction to crisis conditions. Remote sensing technologies are now omnipresent in crisis preparation, response, and recovery missions.

Figure 1. Disaster Management Cycle

II. PROPOSAL METHODOLOGY

Dataset Description:

The dataset used in this system is taken from TerraSAR-X [1]. This data follows single polarization channel, where the images are captured in some specific parts of China. It covers the following regions including industrial area, river, farms, urban regions, forests and other locations.The image data of forest regions alone are considered in this work. From each image types, around 160 image samples are taken with 64 x 64 sizes in pixels. It follows a pixel spacing length as 1.25 meters.

Natural Disaster Detection Framework:

SAR image pre-processing:

SAR images are highly prone to speckle noise [2]. It can reduce the image quality and leads to selection of low discriminative feature descriptors for image classification, which could poorly generalize the images. So, in order to enhance the quality, DWT is employed as preprocessing technique [3]. This method works based on the retention of high-frequency components of an image.The input image is divided into multiple levels of sub-bands.

A resolution enhanced image is then generated by interpolating the high-frequency sub-bands of an image with low-resolution images using inverse DWT.

Feature key point detection using SIFT:

Identification of significant image pixels otherwise salient points is highly significant to extract discriminative features from an image. Detection of feature key points on an image can be widely classified into three sub-types such as affine invariant detectors, Single scale detectors and multi-scale detectors [4]. In this work, SIFT; an affine invariant detector method is used for key point detection. This technique is proposed by Lowe [5]. Difference of Gaussian operator is used to identify the interest points in an image. This method uses a 16 x 16 image gradient descriptor as image patch to extract the region of interest. The feature vector is then normalized to stabilize the invariance to some affine changes due to illumination and other conditions.

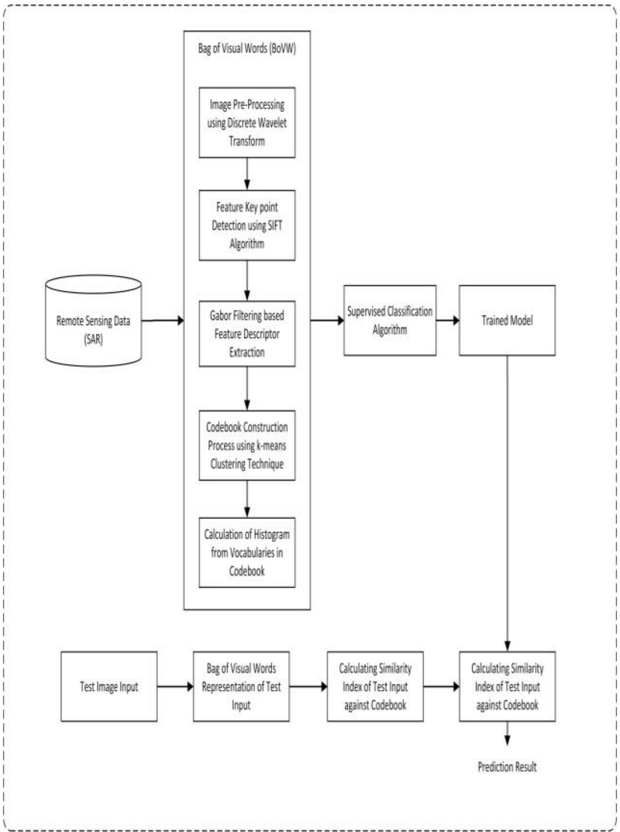

Figure 2. Architecture of Proposed Model

Gabor wavelet feature descriptors:

Gabor Wavelet filters works effectively on removing rotational and other motion effects from SAR images [6]. The features can be extracted based on two dimensional Gabor filters [7].These descriptors can be obtained from the convolution process of input image with Gabor wavelet filters. Then, the image patch obtained from the Gabor filter can be represented as histogram based on region level [8]. Then the resultant feature vector after complete processing contains multiple scale, orientation and frequency, which is extracted from the given image.

Codebook Construction with k-means Clustering Algorithm:

The salient points of the identified feature descriptors are consolidated and framed as a single feature vector. In this work, k-means clustering technique is applied to perform feature encoding [9]. The cluster center is represented as visual word and these cluster centers are collectively called as codebook, otherwise visual word dictionary.

BoVW representation from visual word dictionary:

The representation of visual words from the calculated salient points from the descriptors is done by generating the histogram [10]. The occurrence of each visual word is considered to calculate the frequency from which the histogram is projected. This single histogram is called a “BoVW representation”.

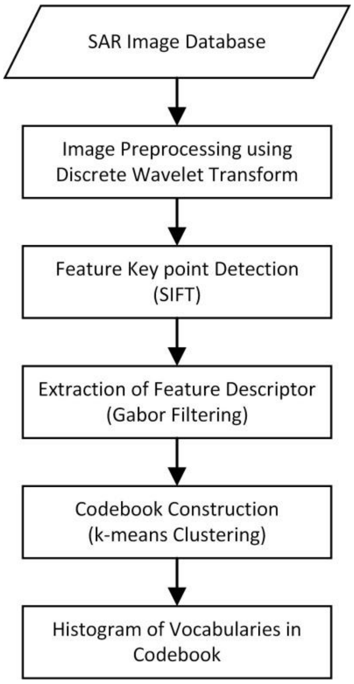

Figure 3. Flowchart of Bag of Visual Words

Classification:

Machine Learning plays a significant role in computer vision. High performance algorithms boost up the predictive power of a computational model. Moreover, these algorithms follows generalized mathematical models, so interpretation becomes more transparent and robust. In this system, the performance of the model is calculated with SVM, RF and NB algorithms.

III. Result Analysis

This experiment is conducted on SAR images for natural disaster detection. For model evaluation, k-fold cross-validation technique is applied on the dataset. Accuracy, precision and recall metrics are calculated to evaluate the model performance. Confusion matrix is a widely adopted evaluation metrics for binary classification systems. It is calculated from four metrics such as True Positive (TP), False Positive (FP), True Negative (TN) and False Negative (FN).

$$Acc = \frac{TP + TN}{TP + TN + FP + FN} \quad [1]$$

$$Precision = \frac{TP}{TP+FP} \quad [2]$$

$$Recall = \frac{TP}{TP + FN} \quad [3]$$

From Table 1, the performance of the proposed workflow is evaluated. SVM, NB and RF is deployed to classify the images.

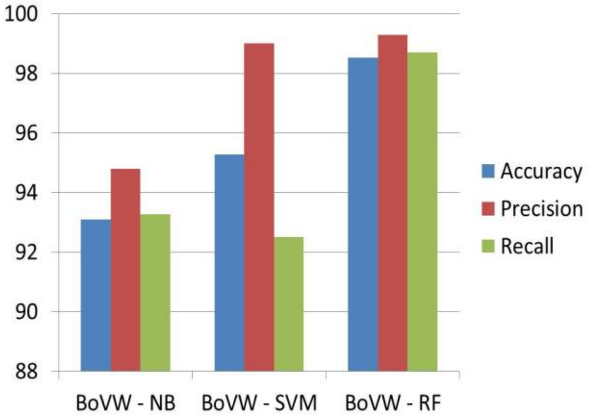

Figure 4. Performance Comparison of three classifiers with BoVW

Out of three, BoVW – RF model performed well than other two models. Also, it outperformed the benchmarked results of previous works.

Table 3 Performance Comparison of SVM, RF and NB classifiers with BovW representation.

TerraSAR-X	Accuracy	Precision	Recall
Attribute Learning [1]	92.37	-	-
BoVW – SVM	95.28	99.00	92.5
BoVW - NB	93.10	94.80	93.27
BoVW-RF	**98.53**	**99.28**	**98.70**

So, from the results, it is clearly highlighted that, ensemble models have better predictive performance than probabilistic and linear models for SAR images.

IV. CONCLUSION

In this paper, a robust automaticpost-disaster detection system is developed to automatically map the damage occurred in a specific region after a natural disaster. As in preprocessing stage, to enhance the image quality, DWT is used.BoVW is the key part of this system that embeds key point detection, feature descriptor identification and visual word dictionary generation. Since, there are many techniques available for key point detection and feature descriptor extraction, SIFT and GWT is applied in this algorithm respectively. K-means clustering is employed to calculate the visual words and the single vector histogram is calculated from the collection of visual words from 'k' clusters. This model is validated with k-fold cross validation scheme. SVM, NB and RF classifiers are used to measure the system performance. Among them, BoVW-RF model achieved 98.53% accuracy, highest among the other models. The performance of the model is improved with BoVW feature extraction methods. Moreover, the model complexity is very less, since the size of image patch is comparatively less than other methods. This method can be further improved by applying some better mechanism for codebook construction instead of any unsupervised methods.

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