Abstract:

Natural disasters not only disturb the human ecological system but also destroy the properties and critical infrastructures of human societies and even lead to permanent change in the ecosystem. Disaster can be caused by naturally occurring events such as earthquakes, cyclones, floods, and wildfires. Many deep learning techniques have been applied by various researchers to detect and classify natural disasters to overcome losses in ecosystems, but detection of natural disasters still faces issues due to the complex and imbalanced structures of images.To tackle this problem, we propose a multilayered deepconvolutionalneuralnetwork. The proposed model works in two blocks:

Block-I convolutional neural network (B-I CNN), for detection and occurrence of disasters.

Block-II convolutional neural network (B-II CNN), for classification of natural disaster intensity types with different filters and parameters.

The model is tested on 4428 natural images and performance is calculated and expressed as different statistical values: sensitivity (SE), 97.54%; specificity(SP),98.22%;accuracyrate(AR),99.92%;precision(PRE),97.79%;andF1-score(F1),97.97%. The overall accuracy for the whole model is 99.92%, which is competitive and comparable with state-of-the-art algorithms.

Literature survey

Studies analyzing the intensity of natural disasters have gained significant attention in the current decade. A. Ashiquzzaman et al. utilized a video source for fire detection; processing video sources is a feasible task due to convolutional neural networks (CNNs), which require high performance computational resources including graphics hardware, and thus a smart and cost-effective fire detection network is proposed based on architecture of convolutional neural networks.

In convolutional neural networks, a model to detect wild fire smoke named wild fire smoke dilated dense net was proposed by Li et al. consisting of a candidate smoke region segmentation strategy using an advanced network architecture.Mangalathuetal performed an evaluation of building clusters affected by earthquakes by exploring the deep learning method, which uses long short-term memory.

Natural disasters are unpredictable events, Hartawan et al enhanced multilayer perceptron algorithm by including convolutional neural network implemented on raspberry pi to find out the victims of natural disasters using streaming cameras and to aid the evacuation team to rescue the disaster victims. Amit et al. proposed applying automatic natural disaster detection to a convolutional neural network using the features of disaster from resized satellite images of landslide and flood detections. Aerial images are able to show more specific and wider surface area of the ground, which helps acquire a vast amount of information about the occurrence of disaster.

Socialmedia have been used as data sources to carry out disaster analysis. S. Yang et al. used the information related to earthquake shared by users on Twitter as a dataset and input it to the real time event detection system based on convolutional neural networks. Implementation of a CNN module made it possible to successfully achieve the detection of an

earthquake and its announcement by the government beforehand using information-based tweets. As the tweets provide a significant amount of information, Madichetty et al. implemented a convolutional neural network to perform feature extraction on informative as well as noninformative tweets, categorizing dataset containing tweets by an artificial neural network.

Social media is considered as a main sourceof bigdata,with datas hared in the form of images, videos and text; after the occurrence of a disaster, social platforms are overflowed with different sorts of information which helps response teams to rescue the victims. The majority of the data contain ambiguous contents which makes it difficult for the rescue teams to make the right decisions. Nunavath et al. reviewed previous research based on convolutional neural networks using social media as a dataset and efficiently analyzed the effectiveness of big data from social media during disaster management.

Using the two-layer architecture of a convolutional neural network(CNN),an efficient feature extraction method was applied to the extended Cohn-Kanade dataset to compare three object recognition techniques: linear support vector classification, linear discriminant analysis and softmax. More than 90% performance rates, with low standard deviations, were achieved by Boonsuk et al. The use of manpower is difficult in case of natural disaster occurrence in hilly areas, and continuous electric power supply is highly affected in these areas due to maintenance issues of transmission lines. Therefore, in this auto pilotaerial equipment is usedtogatherimages,andhiddencontentfromaerialimages needs to be identified in case of natural disasters such as landslides and heavy snowfall. Zhou et al. removed the noise from raw aerial images and extracted disaster characteristics using the interframe difference technique; they implemented a convolutional neural network to analyze the type of disaster. In some regions, disasters such as earthquakes are inclined to occur due to geographical factors. To locate the victim in a short time is crucial; Sulistijonoet al.acquired aerialimages, and locatingthe victimswas madepossibleby using a dedicated ground station server and proposed victim detection framework based on convolution neural networks. A simulation of real calamities was developed to test the framework.

Floods are a calamitous and remarkable disaster. Floods impact greatly on human lives, economically and financially affecting nations. With the help of a neural network, it is possible to predict floods and save the masses from the disaster. By implementing a convolutional neural network and Modified Particle Swarm Optimization (MPSO), Padmawar et al. developed a deep learning approach to foresee the flood circumstances and identify the individuals beforehand. Chen et al.proposed unmanned aerial vehicle image-based forest fire detection images of forest fires, stabilized the histogram and applied filters to smoothen the images beforetestingviaconvolutionalneuralnetwork. Smokedetectionwascarriedoutusingthe local binary pattern (LBP) and support vector machine (SVM). Comparison of processed and raw images was made to test the effectiveness of the proposed strategy.

Forest fires drastically affect human lives and economic situations, and locating the victims in a short time is complex task. Convolutional neural networks make it possible to helpfirefighterstolocatethelocationofvictimsbydetectingdensityofsmokefromimages acquired from the unmanned aerial vehicle. CNN-based simple feature extraction with a AlexNet single deconvolution (SFEwAN-SD)-based proposed approach helps develop a real time fire monitoring system (Gonzalez et al. Samudre et al successfully improved response time, reduced power consumption, and optimized performance by using pipelining among network layers of a CNN, executed on a field-programmable gate array. As the spatial resolution of satellite images was too low, these images could not be used for wildfire detection; Lee et al.

modified deep convolutional networks for high spatial resolution images, VGG-13 and Google Net, utilizing UAVs, a disaster forecasting system, web-based visualization system, alert system, and disaster response scenario database and achieved highly accurate results for early wildfire detection. It is a hectic job for a disaster management organization to assess the damage caused by natural disasters. Using images obtained from social media during and after the occurrence of four major natural disasters, Nguyen et al proposed a method by adapting CNN features based on event-specific and cross-events. Direkoglu et al proposed a method to produce motion information images computing optical flow vectors and employed a CNN; the proposed method efficiently differentiated normal and abnormal behaviors of people during a natural disaster. UMN and PETS 2009 datasets were used to performed experiments. Yuan et al proposed a wave-shaped neural network (W-Net) to label the density of smoke in images, which is difficult task, so virtual dataset was created. Convolutional encoder decoder architectures were assembled to maximize the input for information -Netwas proposed. The accuracy of the proposed system is improved by feeding previous encoding outputs to the decoding layers and combining them. Several data mining application were implemented using contents of social media; user generated content helps in disastrous events to gain vast amount of information. The CNN model is used to extract flood images from raw images and color filters are used to refine the desired detection. In the work of Layek et al the proposed system's efficiency and accuracy were tested on several datasets and it outperformed other methods to give the highest results. The proposed multilayered convolutional neural network in this research is used to detect and classify the natural disasters, as explained in the methodology section.

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