IJIRCCE

e-ISSN: 2320-9801 | p-ISSN: 2320-9798

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

Volume 9, Issue 3, March 2021

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.488

9940 572 462 6381 907 438 ijircce@gmail.com www.ijircce.com

International Journal of Innovative Research in Computer and Communication Engineering

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.488 |

|| Volume 9, Issue 3, March 2021 ||

| DOI: 10.15680/IJIRCCE.2021. 0903121|

Disaster Prediction using Deep Learning

Rugesh M, Vishnu Parthiban V, Vishva S, Arun Dhayalan J, Sarmila,

Assistant Professor, Department of Computer Science and Engineering, Sri Eshwar College of Engineering, Coimbatore, India

UG Student, Department of Computer Science and Engineering, Sri Eshwar College of Engineering, Coimbatore, India

ABSTRACT: A natural disaster is a natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage. Various phenomena like earthquakes, landslides, volcanic eruptions, floods, hurricanes, tornadoes, blizzards, tsunamis, cyclones and pandemics are all-natural hazards that kill thousands of people and destroy billions of dollars of habitat and property each year. However, the rapid growth of the world's population and its increased concentration often in hazardous environments has escalated both the frequency and severity of disasters. With the tropical climate and unstable landforms, coupled with deforestation, unplanned growth proliferation, non-engineered constructions make the disaster-prone areas more vulnerable. Developing countries suffer more or less chronically from natural disasters due to ineffective communication combined with insufficient budgetary allocation for disaster prevention and management.

Natural disasters cannot be prevented — but they can be detected.
All around the world we use sensors to monitor for natural disasters:

- Seismic sensors (seismometers) and vibration sensors (seismoscopes) are used to monitor for earthquakes (and downstream tsunamis).
- Radar maps are used to detect the signature "hook echo" of a tornado (i.e., a hook that extends from the radar echo).
- Flood sensors are used to measure moisture levels while water level sensors monitor the height of water along a river, stream, etc.
- Wildfire sensors are still in their infancy but hopefully will be able to detect trace amounts of smoke and fire.
- Each of these sensors is highly specialized to the task at hand — detect a natural disaster early, alert people, and allow them to get to safety.

Using computer vision, we can augment existing sensors, thereby increasing the accuracy of natural disaster detectors, and most importantly, allow people to take precautions, stay safe, and prevent/reduce the number of deaths and injuries that happen due to these disasters.
In this study, we developed an automated calamity detection system using deep learning, which can predict disasters in real-time and send an alert message. For this purpose, we trained ResNet50 CNN model, and performance is measured by calculating the confusion matrix. Model is also tested with pre-recorded videos acquired from satellites and drones. Experimental results yield 91% accuracy and perform well when tested with videos collected from YouTube.

I. INTRODUTION

DEEP LEARNING CONCEPT

Deep learning is the most hyped branch of machine learning that uses complex algorithms of deep neural networks that are inspired by the way the human brain works. DL models can draw accurate results from large volumes of input data without being told which data characteristics to look at. Imagine you need to determine which fishing rods generate positive online reviews on your website and which cause the negative ones. In this case, deep neural nets can extract meaningful characteristics from reviews and perform sentiment analysis.
Deep learning is a subset of machine learning, but it is advanced with complex neural networks, originally inspired by biological neural networks in human brains. Neural networks contain nodes in different interconnected layers that communicate with each other to make sense of voluminous input data.
There are various types of neural networks such as convolutional neural networks, recursive neural networks, and recurrent neural networks. A typical neural network consists of the input layer, multiple hidden layers, and the output layer that are piled up on top of each other.

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.488 |

|| Volume 9, Issue 3, March 2021 ||

| DOI: 10.15680/IJIRCCE.2021. 0903121|

THE DEEP LEARNING PROCESS AND USE CASES

If we take a look at the pictures below, we will easily distinguish between corgis and loaves of bread. Machines, on the other hand, can't do the same thing so effortlessly. They need to learn from huge amounts of data, create algorithms, and transform input data into machine-readable forms before they can identify what's shown in the pictures and present accurate results.

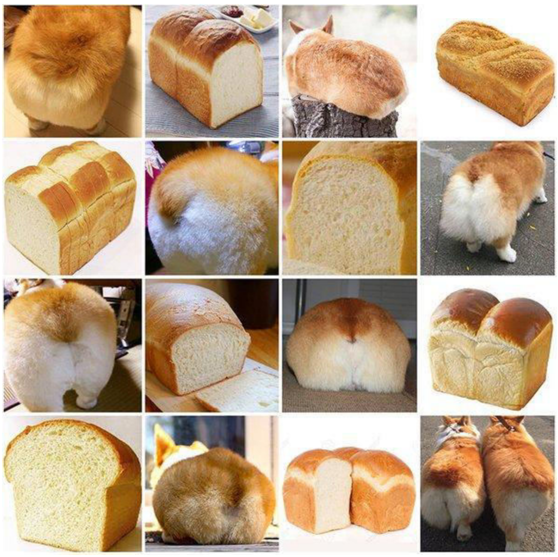

Figure.1: Corgi or loaf of bread image recognition example. Source: Imgur

So, let's say you want to create a program that identifies corgis in pictures, or, generally speaking, recognizes certain objects shown on images. Deep learning models are the best fit for imagerecognition or any data that can be converted into visual formats, like sound spectrograms.

Let's get back to the example. We take multiple images of corgis and loaves of bread with each picture consisting of 30×30 pixels. A bunch of neurons will correspond to each pixel of the input image (900 in total) and each neuron represents its activation (a number that shows the value of a certain pixel). Activations in one layer determine the activations of the next one.

The neurons are connected by lines called synapses and each of these lines has a weight determined by the activation numbers. The bigger the weight, the more dominant it will be in the next layer of a neural net.
In every layer, there are bias neurons that move the activation functions in different directions. The sum of weights, activation numbers, and bias numbers is called the weighted sum of the neural net layer. The weighted sum in one layer makes up the input for another one until it reaches the final, output layer.

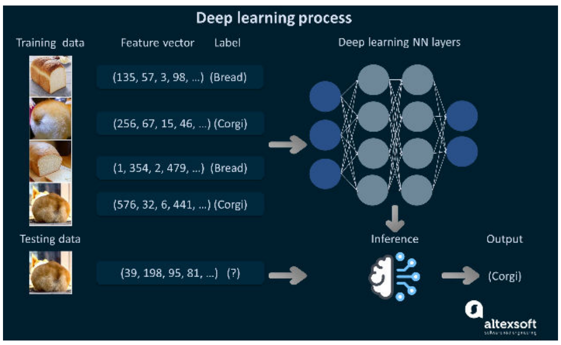

Figure.2: Deep learning process depiction.

The activation of neurons of the output layer represents how much a system thinks a given image corresponds to the classification task. In our case, this is the probability of a certain image to represent a corgi, not a loaf of bread. The

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.488 |

|| Volume 9, Issue 3, March 2021 ||

| DOI: 10.15680/IJIRCCE.2021. 0903121|

neural network is considered to be successfully trained when the value of the weights provides the output closest to the reality.

Deep learning finds lots of practical applications from speech recognition technologies that can convert spoken words into a textual format helping thousands of people who have trouble using buttons and keystrokes to drug discovery systems capable of predicting pharmacological properties of drugs in various biological conditions. Another bright example of successful implementation of deep learning algorithms is Google Translate that provides quality translations of written text into more than 100 languages.

DISASTER

A **disaster** is a serious disruption occurring over a short or long period of time that causes widespread human, material, economic or environmental loss which exceeds the ability of the affected community or society to cope using its own resources. Developing countries suffer the greatest costs when a disaster hits – more than 95% of all deaths caused by hazards occur in developing countries, and losses due to natural hazards are 20 times greater (as a percentage of GDP) in developing countries than in industrialized countries.No matter what society disasters occur in, they tend to induce change in government and social life. They may even alter the course of history by broadly affecting entire populations and exposing mismanagementor corruption regardless of how tightly information is controlled in a society.

II. RELATED WORK

Gautam used GoogleImages to gather a total of **4,428 images** belonging to four separate classes:

- **Cyclone/Hurricane:** 928 images
- **Earthquake:** 1,350
- **Flood:** 1,073
- **Wildfire:** 1,077

He then trained a Convolutional Neural Network to recognize each of the natural disaster cases.

IMAGE PROCESSING

Imageprocessing is divided into analogue image processing and digital image processing.
Digital image processing is the use of computer algorithms to perform image processing on digital images. As a subfield of digital signal processing, digital imageprocessing has many advantages over analogue image processing. It allows a much wider range of algorithms to be applied to the input data — the aim of digital image processing is to improve the image data (features) by suppressing unwanted distortions and/or enhancement of some important image features so that our AI-Computer Vision models can benefitfrom this improved data to work on.

An image is nothing more than a two-dimensional array of numbers(or pixels) ranging between 0 and 255. It is defined by the mathematical function f(x,y) where x and y are the two co-ordinates horizontally and vertically.
The value of f(x,y) at any point is giving the pixel value at that point of an image.
For our use case (segmentation model) we using the dataset from CamVid composed of 701 images.
If you want to learn to be a badass and apply image pre-processing on your dataset please follow my lead. The steps to be taken are:

- Read image
- Resize image
- Remove noise (Denoise)
- Segmentation
- Morphology (smoothing edges)

IMAGE PREPROCESSING

Image Pre-processing Projects is an automated tool to code your project in image processing. Pre-processing is an initial step for image processing projects. As pre-processing is a vast area and issues coupled with cannot solve by a single answer. For a recent case, it must be best as possible. Since inputs are lively, so it's adaptive to learn and react as per the inputs. Still, it is emerging and needs to solve. Hold our idea and trust the process that we follow and work!!!

Despite the fact, our way of pre-processing is better than others. Every bit of input is useful to produce the output data. Get detailed information about steps involved in image pre-processing projects. We talk about those in the current post. In detail, this page gives you a short view to know about the pre-processing domain.

International Journal of Innovative Research in Computer and Communication Engineering

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.488 |

|| Volume 9, Issue 3, March 2021 ||

| DOI: 10.15680/IJIRCCE2021. 0903121|

- Images Collected from Variety of Sensors (HD Cameras)
- Image Fusion (Satellite Application and also Medical)
- Security Issues (Watermarking, Steganography and also Encryption)
- Transmission of Image or Video over Real Wireless Channels
- No quality mining from Content based Retrieval

Image Pre-processing Life Cycle

- Colour Space Conversion
- Noise Reduction
- Contrast Enhancement
- Image Resampling
- Image-Smoothing and also Sharpening
- Image Restoration and also Enhancement
- Image-Compression and also Registration
- Image Region Extraction and also Projection Calculation

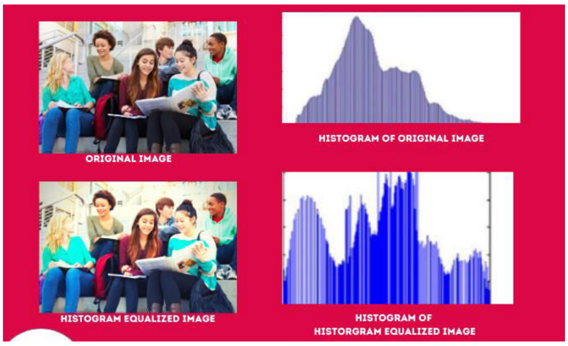

Figure.3: Image pre-processing

Of course, the above processes are open in image pre-processing. To do image pre-processing projects, Matlab is one of the ways. For instance, we can load live video streams to the Matlab tool. In truth, it accepts any number of frames per video. Within a second, it will pre-process all frames. But in this case, such ways and means are the key to take away the blurriness in frames. As a matter of fact, we list out those for you.

Model training:

Instead of training CNN model from sketch, we used transfer learning technique using pre-trained ImageNet weights. We used ResNet50 as the backbone model, all the internal layers up to global average pooling (GAP) layer remains unchanged. We have removed FC layer and added average pooling (pool size = (7, 7)), Flatten, Dense layer (512), Dropout layer (0.5) and Dense layer followed by Activation (SoftMax). The fine-tuned architecture is shown in Figure 4.

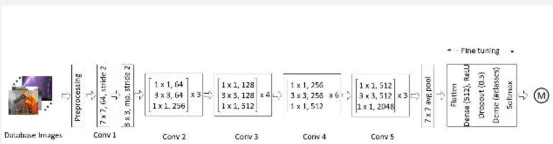

Figure 4: Fine tuning of ResNet 50

A model (M) is obtained by the training the CNN with 80 epochs. The performance of the model is evaluated in two phases. In the first phase, a sample test image dataset from the collected database is used to evaluate its performance. Evaluation metric such as precision, recall and accuracy of the system is measured. We also plot Receiver Operating Characteristics (ROC) curve to show trade-off between false

International Journal of Innovative Research in Computer and Communication Engineering

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.488 |

|| Volume 9, Issue 3, March 2021 ||

| DOI: 10.15680/IJIRCCE.2021. 0903121|

positive rate and true positive rate. We analysed the performance of the model by plotting precision-recall and area under curve.
In the second phase, real-time videos are provided as input to the system. From a live video stream source (S), a frame is extracted and pre-processed by resizing it (to the size of the image which was used to train model) followed by conversion of RGB channel ordering. Each extracted and pre-processed frame from the live video is fed to model to predict its class label. The algorithm calculates the probability of each class and returns a label corresponding to class for which probability is maximum. This process is repeated for each frame from a video stream. For each incoming frame, predicted class and its probability are annotated on the output frame. Therefore, we get output video as a series of the annotated frame showing class label and the probability of predicted class. However, there is a problem with this method called 'prediction flickering'. Due to this, label in the output video frequently changes among classes.

Principle of Rolling Averaging:

To reduce the flickering effect, we applied the principle of rolling averaging. It is also known as running average or moving mean or rolling mean and generally used for time series data to reduce fluctuations in the output. A subset of input time series data represented by a queue (Q) of size k = 64 is maintained to apply rolling averaging. Mean is calculated over the last 'k' prediction from the Q and class label (L) of the largest corresponding probability is selected to label the output frame. Please refer Figure 5 to understand this process mathematically.

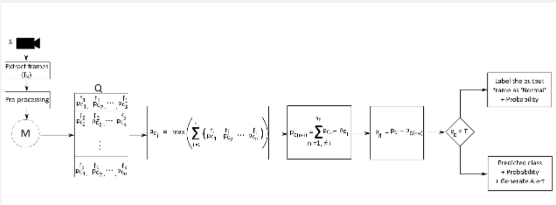

Figure 5: Mathematical representation of working process. Pci is the probability of calamity 'ci'

- Summarizing proposed method, algorithm:
- Extract frames in the loop from live video streaming source,
- Fed the extracted frame to trained CNN model,
- Obtain predicted label for each a frame and push it to Q,
- Repeat step 3 for 'k' number of frames,

Calculate mean of last 'k' predication and select label with corresponding high probability, If the difference between probabilities of the predicted class label and a sum of the probabilities of rest of the classes label is > 80%, annotate the output frame with predicted label as well as corresponding probability and generate alert message whenever change in label occurs else label output frame by 'Normal' alert message.

Evaluation

The database is divided into train and test set in a ratio of 80:20. CNN model is trained by 80% of database image while tested with 20%, and confusion matrix is plotted for the test set. We calculate True Positive (TP), False Positive (FP), True Negative (TN) and False Negative (TN). From these parameters, we calculate the Sensitivity, Recall, F-score, and Accuracy of the system. We also plot the Receiver Operating Characteristics curve (ROC) and Precision-Recall curve to analyze the result, which is shown in Figure 6 and 7 respectively. Figure 8 represents confusion matrix which shows the classification accuracy of all types of classes.

International Journal of Innovative Research in Computer and Communication Engineering

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.488 |

|| Volume 9, Issue 3, March 2021 ||

| DOI: 10.15680/IJIRCCE.2021. 0903121|

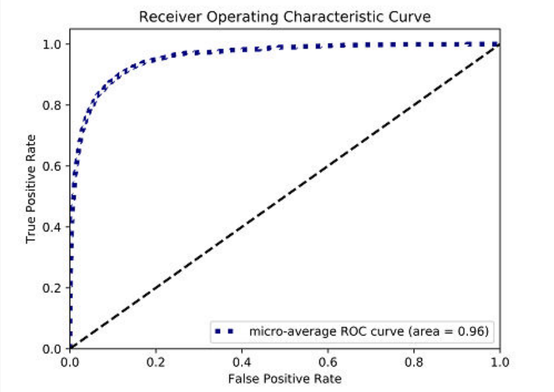

Figure 6: ROC Curve

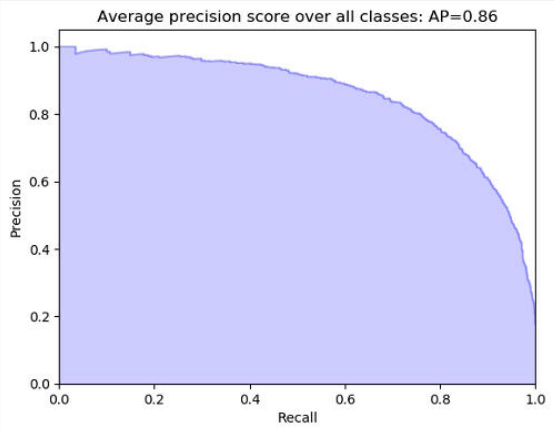

Figure 7: Precision-Recall Curve

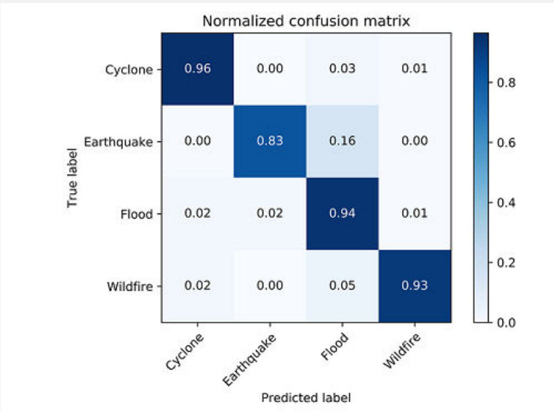

Figure 8: Confusion Matrix

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.488 |

|| Volume 9, Issue 3, March 2021 ||

| DOI: 10.15680/IJIRCCE.2021. 0903121|

III. EXPERIMENTAL RESULT

The developed system takes pre-recorded video or real-time video as an input, extract frames from the video and fed it to trained CNN model. CNN model takes each frame sequentially and process it to predict the type of calamity and produces a sequence of labeled frames as output. Each output frame is annotated with the type of predicted calamity along with its corresponding probability. In case no disaster is detected, the frame is annotated as 'Normal'. An alert message is generated only when there is a change in the label of the output frame. For frames annotated as 'Normal', no message is generated.

IV. CONCLUSION

The proposed real-time calamity detection system can be used to detect disaster and generate an alert automatically. This system can be used for two different purposes. First, to process satellite images to predict and warn cyclone and forest fire. Second, to process satellite images for quick detection of affected regions during natural calamities like flood and high-intensity earthquakes. This idea can be used to predict the disaster through a satellite camera. For example, a geostationary satellite which is situated over the coastal region can detect cyclone while polar satellite can easily capture a live stream of forest, mountains, rivers, flood areas etc and if it finds any sign calamity, system can automatically generate an alert. Therefore, it dramatically reduces human effort and time to analyse the satellite image for any type of disaster. For earthquake, it is difficult to predict in advance using a satellite image, but the system can record details of the affected/destroyed areas. Similarly, in case of flood, the proposed method can quickly detect and generate an alert in an automated way which can help us to take necessary steps against these calamities. Therefore, the proposed system can be used as a 'eyes in the sky' and can help the research community to predict disaster in advance and to optimize the damages during natural calamities.

REFERENCES

1. Gautam Kumar, Teaching Assistant Professor at Sardar Vallabhbhai National Institute of Technology, Surat
2.Mosavi A., Varkonyi-Koczy A. R.: Integration of Machine Learning and Optimization for Robot Learning. Advances in Intelligent Systems and Computing 519, 349-355 (2017).
3.Bannister, A.: Biometrics and AI: how Face Sentinel evolves 13 times faster thanks to deep learning (2016).
4.Bengio, Y.: Learning deep architectures for AI. Foundations and trends in Machine Learning 2, 1-127 (2009).
5.Mosavi, A., Varkonyi-Koczy, A. R., Full stack, M.: Combination of Machine Learning and Optimization for Automated Decision-Making. MCDM (2015).
6.Deng L, Yu D Deep learning: methods and applications. Foundations and Trends® in Signal Processing 7, 197-387 (2014)
7.Goel, B.: Developments in The Field of Natural Language Processing. International Journal of Advanced Research in Computer Science 8, (2017).
8.Vaezipour, A.: Mosavi, A. Seigerroth, U.: Machine learning integrated optimization for de-cision making, 26th European Conference on Operational Research, Rome (2013).
9.Hinton G E, Simon O, Yee-Whye T A fast learning algorithm for deep belief nets. Neural computation 18, 1527-1554 (2006)
10.Hisham, A., Harin, S.: Deep Learning – the new kid in Artificial Intelligence. (2017)
11.Kim I W,Oh, M.: Deep learning: from cheminformatics to precision medicine. Journal of Pharmaceutical Investigation: 1-7 (2017)
12.Mosavi, A., Vaezipour, A.: Developing EffectiveTools forPredictive Analyticsand In-formed Decisions. Technical Report. University of Tallinn (2013)

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING