Natural Disasters Intensity Analysis and Classification Using Artificial Intelligence

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1. INTRODUCTION

1.1 Overview

Natural catastrophes not only disrupt the ecology that supports human life, but they also obliterate vital facilities and properties in human society, changing the ecosystem permanently. Natural occurrences like earthquakes, cyclones, floods, and wildfires can bring disaster. To mitigate ecological losses from natural disasters, several deep learning approaches have been used by numerous researchers. However, identification of natural disasters still has difficulties because of the complex and unbalanced image structures. We created a multilayered deep convolutional neural network model that identifies natural disasters and indicates their intensity in order to address this issue.

1.2 Purpose

- To prevent ecological losses from natural disasters as we all know that "Prevention is better than cure".

2. LITERATURE SURVEY

2.1 Existing Problem

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.

2.2 References

SURVEY 1

Title:

“Neural Network Applications In Earthquake Prediction” Meta-Analytic And Statistical Insights On Their Limitations.Arnaud Mignan And Marco Broccardo neural Network Applications In Earthquake Prediction ; Meta-Analytic And Statistical Insights On Their Limitations Seismological Research Letters (May 2020).

Methods:

Deep learning has solved seemingly intractable problems, boosting the hope to find approximate solutions to problems that now are considered unsolvable. Earthquake prediction, the Grail of Seismology, is, in this context of continuous exciting discoveries, an obvious choice for deep learning exploration. We review the entire literature on artificial neural network (ANN) applications for earthquake prediction (77 articles, 1994-2019 period) and find two emerging trends: an increasing interest in this domain, and a complexification of ANN models over time, towards deep learning. Despite apparent positive results observed in this corpus, we demonstrate that simpler models seem to offer similar predictive powers, if not better ones. Due to the structured, tabulated nature of earthquake catalogs, and the limited number of features so far considered, simpler and more transparent machine learning models seem preferable at the present stage of research. Those baseline models follow first physical principles and are consistent with the known empirical laws of Statistical Seismology, which have minimal abilities to predict large earthquakes.

SURVEY 2

Title:

“Simultaneous Earthquake Detection On Multiple Stations Via A Convolutional Neural Network” Shaobo Yang; Hu; Haijiang Zhang; Guiquan Liu, Seismological Research Letter(202

1)

Methods:

As the amount of seismic data has grown rapidly, it is very important to develop a fast and reliable event detection and association algorithm. Generally, event detection is first performed on individual stations followed by event association through linking phase arrivals to a common event generating them. This study considers earthquake detection as the problem of image classification and convolutional neural networks (CNNs), as some of the widely used deep-learning tools in image processing, can be well used to solve this problem. In contrast to existing studies training the network using seismic data from individual stations, in this study, we train a CNN model jointly using records of multiple stations. Because the CNN automatically synthesizes information among multiple stations, the detector can more reliably detect seismic events and is less affected by spurious signals. The CNN is trained using aftershock data of the 2013 Mw 6.6 Lushan earthquake. We have applied it to two very different datasets of Gofar transform fault, East Pacific Rise and Changning shale gas field in southern Sichuan basin, China. The tests show that the trained CNN has strong generalization ability and is flexible with the number of available stations, different instrument types, and different data sampling rates. It can detect many more events than the conventional short-term average/long-term average detector and is more efficient than template-matching methods.

SURVEY 3

Title:

"A Deep Learning Approach of Recognizing Natural Disasters on Images using Convolutional Neural Network and Transfer Learning" International Conference on Artificial

Intelligence and its ApplicationsDaryl B. ValdezRey Anthony G. Godmalin December 2021.

Methods:

Natural disasters are uncontrollable phenomena occurring yearly which cause extensive damage to lives, and property and cause permanent damage to the environment. However, by using Deep Learning, real-time recognition of these disasters can help the victims and emergency response agencies during the onset of these destructive events. Methods used include: Deep learning(DL),Convolutional Neural Network(CNN)

SURVEY 4

Title:

"Storm intensity estimation using symbolic aggregate approximation and artificial neural network", Arthit Buranasing, Akara Prayote, 06 December 2014, IEEE.

Methods:

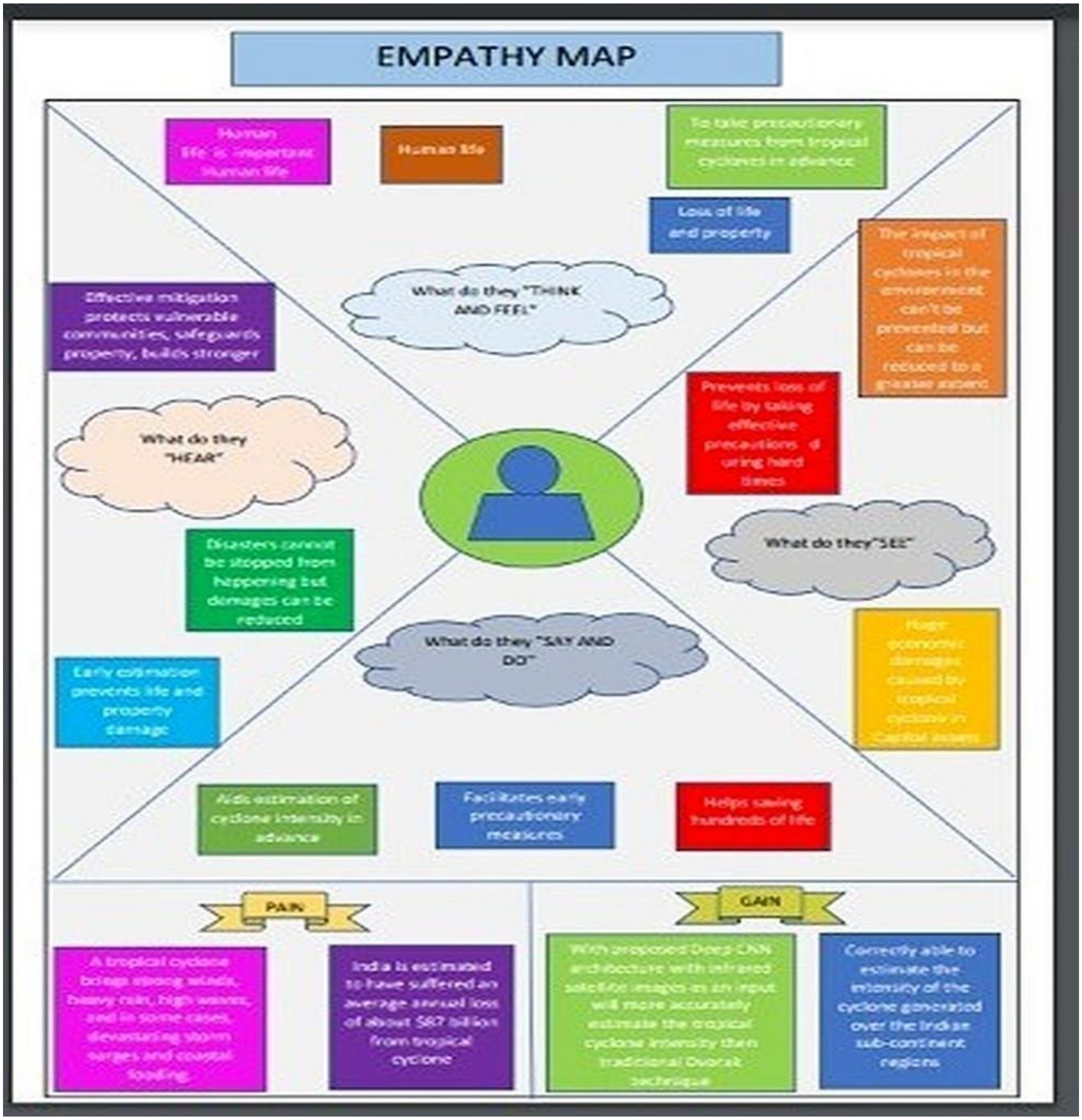
A storm disaster is one of the most destructive natural hazards on earth and the main cause of death or injury to humans as well as damage or loss of valuable goods or properties, such as buildings, communication systems, agricultural land, etc. Storm intensity estimation is also important in evaluating the storm track prediction and risk area that will be affected by the storm. In this paper, proposed the storm intensity estimation model by using only 8 features to categorize major types of storm with symbolic aggregate approximation (SAX) and artificial neural network (ANN). The performance of the model is satisfactory, giving an average F-measure of 0.93 or 93%.

2.3 Problem Statement Definition

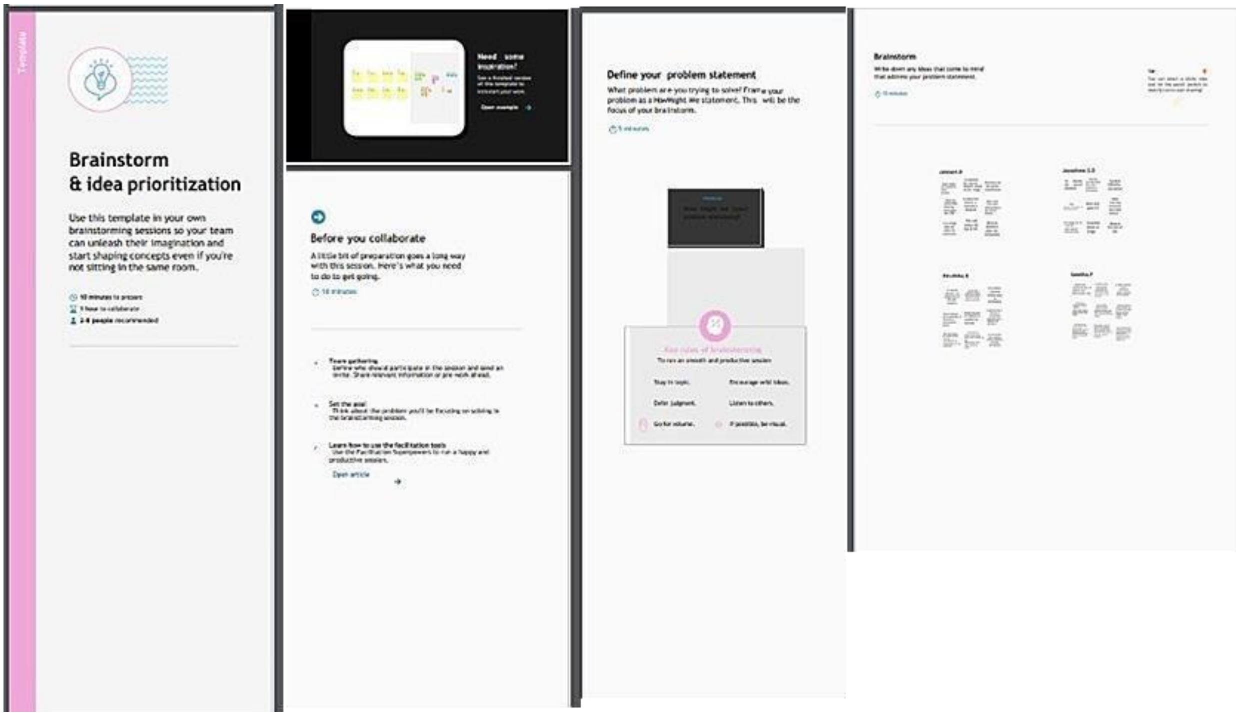
The solution to the problem is Artificial Intelligence, which is being used to implement the proposed system. Artificial intelligence (AI) models have shown remarkable success and superiority to handle huge and nonlinear data owing to their higher accuracy and efficiency, making them perfect tools for disaster monitoring and management. When using AI to detect extreme events such as avalanches or earthquakes, the availability of data can be a limiting factor. AI-based methods can be very effective if a training dataset covers very large events.

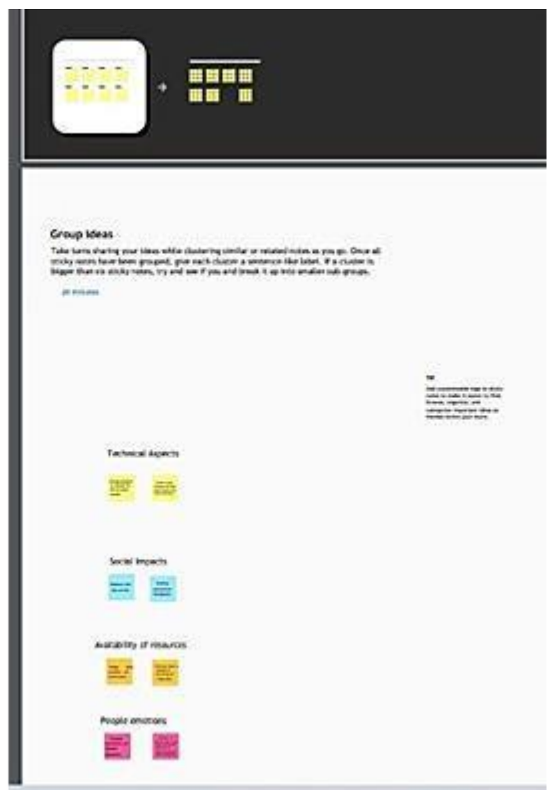
3. IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas



3.2 Ideation and brainstorming

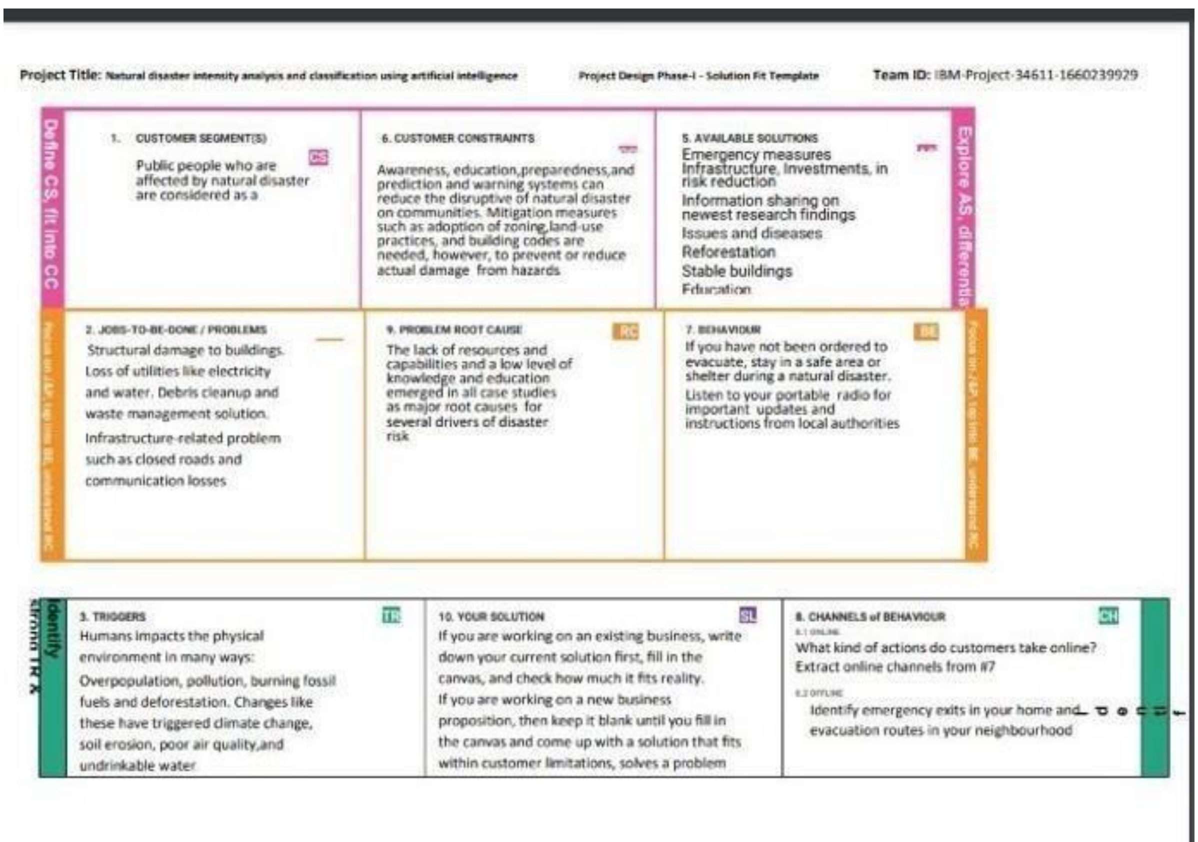




3.3 Proposed Solution

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	To classify the natural disaster and calculate the intensity of the disaster.
2.	Idea / Solution description	To develop a multilayered deep convolutional neural network model that classifies the natural disaster and tells the intensity of disaster.
3.	Novelty / Uniqueness	We are implementing neural networks to train our model instead using machine learning algorithms which expected to provide with better accuracy.
4.	Social Impact / Customer Satisfaction	With better accuracy in predicting intensities precautions are taken respectively.
5.	Business Model (Revenue Model)	The software is cheap, and the minimum requirements are affordable.
6.	Scalability of the Solution	Better accuracy in measuring the intensities of the natural disaster and in classifying it.

3.4 Problem Solution Fit


Project Title: Natural disaster intensity analysis and classification using artificial intelligence

Project Design Phase-I - Solution Fit Template

Team ID: IBM-Project-34611-1660239929

Define CS, fit into CC

1. CUSTOMER SEGMENT(S) CS

Public people who are affected by natural disaster are considered as a

6. CUSTOMER CONSTRAINTS

Awareness, education,preparedness,and prediction and warning systems can reduce the disruptive of natural disaster on communities. Mitigation measures such as adoption of zoning,land-use practices, and building codes are needed, however, to prevent or reduce actual damage from hazards

5. AVAILABLE SOLUTIONS

Emergency measures

Infrastructure, Investments, in risk reduction

Information sharing on newest research findings

Issues and diseases

Reforestation

Stable buildings

Education

Explore AS, differentia

2. JOBS-TO-BE-DONE / PROBLEMS

Structural damage to buildings.

Loss of utilities like electricity and water. Debris cleanup and waste management solution.

Infrastructure-related problem such as closed roads and communication losses

9. PROBLEM ROOT CAUSE RC

The lack of resources and capabilities and a low level of knowledge and education emerged in all case studies as major root causes for several drivers of disaster risk

7. BEHAVIOUR BE

If you have not been ordered to evacuate, stay in a safe area or shelter during a natural disaster.

Listen to your portable radio for important updates and instructions from local authorities

Identify strong TR &

3. TRIGGERS TR

Humans impacts the physical environment in many ways:

Overpopulation, pollution, burning fossil fuels and deforestation. Changes like these have triggered climate change, soil erosion, poor air quality,and undrinkable water

10. YOUR SOLUTION SL

If you are working on an existing business, write down your current solution first, fill in the canvas, and check how much it fits reality.

If you are working on a new business proposition, then keep it blank until you fill in the canvas and come up with a solution that fits within customer limitations, solves a problem

8. CHANNELS of BEHAVIOUR CH

8.1 ONLINE

What kind of actions do customers take online? Extract online channels from #7

8.2 OFFLINE

Identify emergency exits in your home and evacuation routes in your neighbourhood

4. REQUIREMENT ANALYSIS

4.1 Functional Requirement

FR No.	Functional Requirement (Epic)	Description
FR-1	Data collect	Collecting data from trusted sources, in addition to collecting analysis
FR-2	Data filter	Filtering of demographic information, as well as filtering of countries, region, state, or province with cases of disasters
FR-3	Data count	Counting, globally or from a specific location, of confirmed cases, recovered and deaths by serious disasters
FR-4	Displays information panel	Display of maps, histograms, or an interactive geographic panel
FR-5	Importing and exporting data	Exporting results, data, or information in CSV or JSON format, as well as importing data from CSV files
FR-6	Show orientation	Displaying disaster prevention tips, a page with information on how to protect itself, travel tips, emergency contacts, link to websites with important information about the disasters

4.2 Non-Functional Requirement

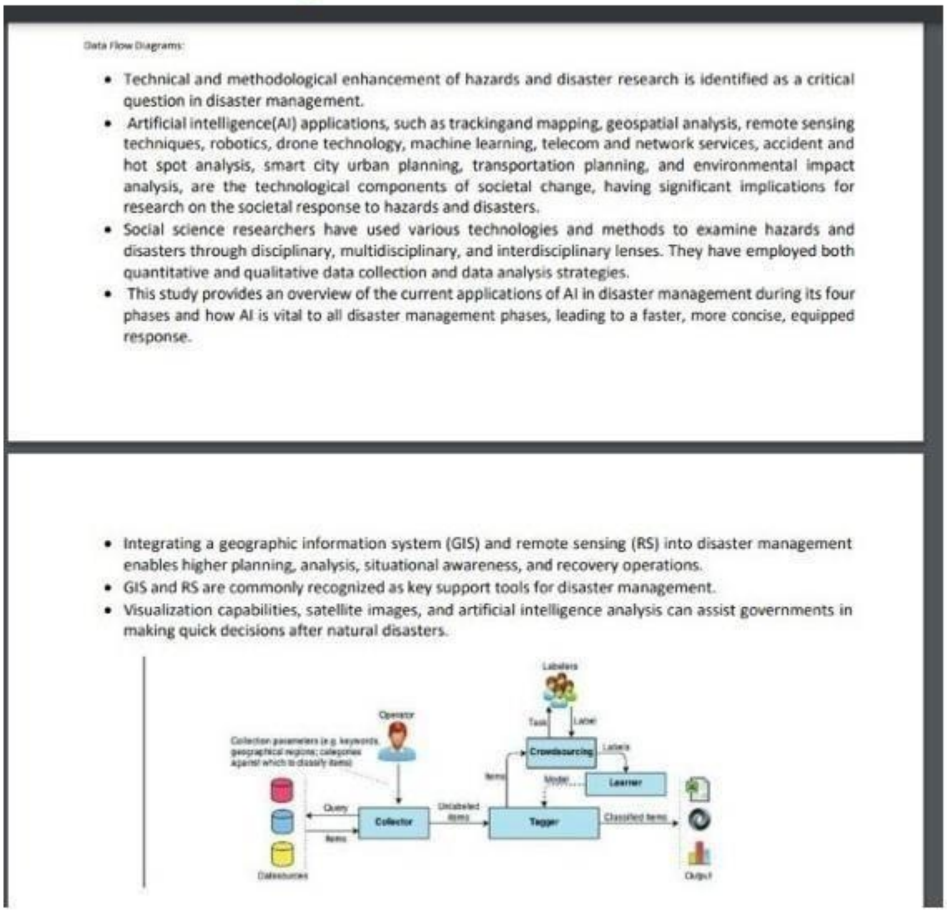
Non-functional Requirements:

Following are the non-functional requirements of the proposed solution.

NFR-4	**Performance**	AI shows great potential to support data collection and monitoring, the reconstruction and forecasting of extreme events, and effective and accessible communication before and during a disaster.
NFR-5	**Availability**	AI-based methods can be very effective if a training dataset covers very large events. However, the availability of such data is limited because of the rarity of these events.
NFR-6	**Scalability**	The ability to analyze a large amount of data will enable artificial intelligence systems to anticipate possible natural disasters before they happen, thus preventing the loss of human lives

5. PROJECT DESIGN

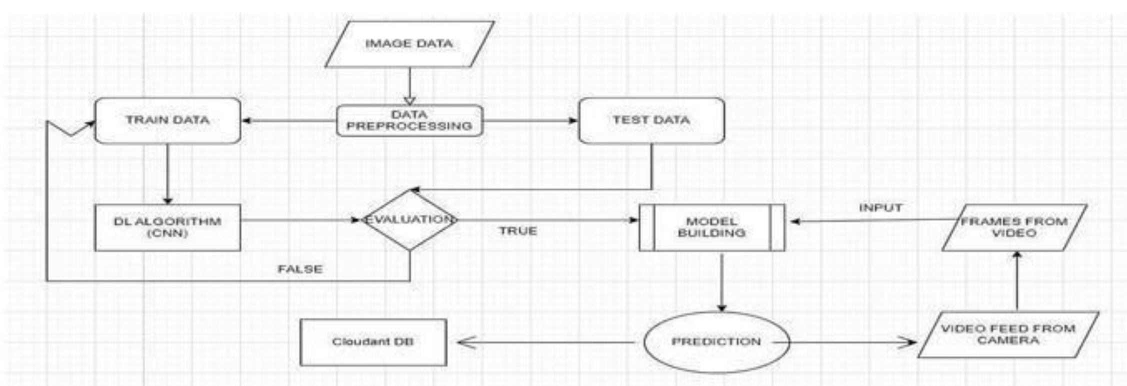
5.1 Data Flow Diagram



Data Flow Diagrams:

- Technical and methodological enhancement of hazards and disaster research is identified as a critical question in disaster management.
- Artificial intelligence(AI) applications, such as trackingand mapping, geospatial analysis, remote sensing techniques, robotics, drone technology, machine learning, telecom and network services, accident and hot spot analysis, smart city urban planning, transportation planning, and environmental impact analysis, are the technological components of societal change, having significant implications for research on the societal response to hazards and disasters.
- Social science researchers have used various technologies and methods to examine hazards and disasters through disciplinary, multidisciplinary, and interdisciplinary lenses. They have employed both quantitative and qualitative data collection and data analysis strategies.
- This study provides an overview of the current applications of AI in disaster management during its four phases and how AI is vital to all disaster management phases, leading to a faster, more concise, equipped response.

- Integrating a geographic information system (GIS) and remote sensing (RS) into disaster management enables higher planning, analysis, situational awareness, and recovery operations.
- GIS and RS are commonly recognized as key support tools for disaster management.
- Visualization capabilities, satellite images, and artificial intelligence analysis can assist governments in making quick decisions after natural disasters.



5.2 Technical Architecture

Technical Architecture

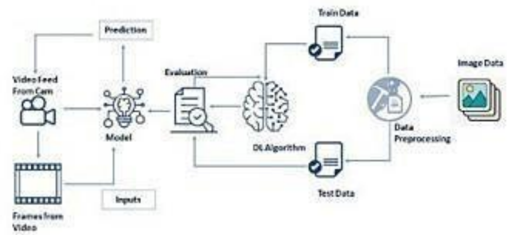


Table-1 : Components & Technologies:

S.No	Component	Description	Technology
1.	Rainfall data, slope, elevation data, flow accumulation, soil, land use, and geology data layers	Flood vulnerability mapping and plotting	Artificial neural network
2.	Satellite spatial images and field survey data	Landslide disaster exposure mapping	RFEs and NBT classifiers
3.	Satellite spatial images	Landslide and flood disaster risk reduction	CNN
4.	Social media application and satellite images	**Disaster risk reduction through social media**	CNN, SVM, RFS, and GVN networks
5.	Social media application and satellite images	Flood prediction by satellite images	CNN, SVM, RFS, and GVN networks
6.	Satellite images	Disaster assessment in coordinating relief (flood and fire management)	CNN and semantic segmentation models of satellite images
7.	3D point cloud	Earthquake prediction detection	CNN networks
8.	Satellite and UAV images	Classification of building damages (earthquake)	CNN networks
9.	UAV images	Near real-time damage mapping	CNN networks
10.	Satellite images	Post-earthquake damage mapping	ANN (the backpropagation algorithm) and support vector machines (radial basis function, RBF)

5.3 User Stories

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Operator	Connections	USN-1	Telecom and ICT operators form the backbone of connectivity across the world.	I can access any time from the world	High	Sprint-1
	Services	USN-2	But ICT services can be hard to maintain – let alone expand – during earthquakes, tsunamis or a pandemic	I can receives the information very quickly	High	Sprint-1
	Access	USN-3	Access to robust and secure ICT infrastructure is critical.	5G technologies lets telecom networks scale up rapidly with network	Low	Sprint 2
	Network	USN-4	Putting resilient networks and disaster management tools in place well ahead of time helps to mitigate negative impacts	The world upgrade to 4G or 5G, as well as educate staff and raise awareness	Medium	Sprint-1
	Effective	USN-5	Effective disaster management requires timely and effective information sharing via ICTs	cell-on-wheels (CoW) base stations to provide temporary cellular network coverage in areas where regular mobile connectivity was lost	High	Sprint-1
Collector	Area of causes	USN-6	The district collector is responsible for preand post-disaster management as well as implementation of rehabilitation schemes at the district level.	Customer plans, coordinates and controls the implementation of rehabilitation programme, gives out necessary instructions and reviews the entire system.	Medium	Sprint-1
Crowd sourcing	Surface Level	USN-7	Crowdsourced data helps fill the information gap and provides responders with contextualized, real-time information in disaster areas where conditions and needs on the ground are constantly shifting.	Currently being applied in the area of emergency management and proposes a taxonomy for its categorization	High	Sprint-1
Learner	SWOT Analysis	USN-8	Management practices to improve efficiency and effectiveness by eliminating waste	The core principle of lean is to reduce and eliminate non-value adding activities and waste.	Medium	Sprint-1
Outcome	Verifies the risk in the disasters the potential losses from hazards.	USN-9	Warnings, reduced vulnerability or the prevention of disasters during the next iteration of the cycle.	plans that either modify the causes of disasters or mitigate their effects on people, property, and infrastructure	LOW	Sprint-2

6 . PROJECT PLANNING & SCHEDULING

6.1 Sprint Planning & Estimation

Product Backlog, Sprint Schedule, and Estimation (4 Marks)

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming that.	2	Low	jaisnavi
Sprint-1	Registration	USN-2	As a user, I will receive confirmation email once I have registered for the application.	3	High	geetha
Sprint-1	Login	USN-3	As a user, I adapt to logging into the system with credentials.	2	Low	jayashree
Sprint-1	Designation of Region	USN-4	As a user, I can collect the dataset and select the region of interest to be monitored and analysed.	5	Medium	kiruthika
Sprint-2	Analysis of required phenomenon	USN-5	As a user, I can regulate certain factors influencing the action and report on past event analysis.	4	High	Jaisnavi,geetha
Sprint-2	Algorithm selection	USN-6	As a user, I can choose the required algorithm for specific analysis.	4	Medium	Jayashree kiruthika
Sprint-2	Training and Testing	USN-7	As a user, I can train and test the model using the algorithm.	4	High	Jaisnavi kiruthika

6.2 Sprint Delivery Schedule

Project Tracker, Velocity & Burndown Chart: (4 Marks)

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	20	6 Days	24 Oct 2022	31 Oct 2022	20	31 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	05 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	12 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

Sprint-3	Detection and analysis of data	USN-8	As a user, I can detect and visualise the data effectively.	4	High	Geetha,jayashree
Sprint-3	Model building	USN-9	As a user, I can build with the web application.	8	High	Geetha kiruthika
Sprint-4	Report generation	USN-10	As a user, I can generate detailed report on product data analysis.	4	High	Jaisnavi jayashree
Sprint-4	Model deployment	USN-11	As an administrator, I can maintain third-party services.	8	High	Jaisnavi,geetha

7. CODING & SOLUTIONING

7.1 Feature1

Index.html

from flask import Index, render_template

app = Index(_name_)

@ap

p.rou

```
te('/')
def
hom
e():
    return render_template('homepage.html', title='Disaster Classifier | Home',
active_page='home')

@app.rou
te('/intro')
def
intro():
    return render_template('intro.html', title='Disaster Classifier | About', active_page='intro')

@app.route(
'/launch')
def launch():
    return render_template('launch.html', title='Disaster Classifier | Launch',
active_page='launch')

@app.route(
'/output')
def output():
    return render_template('output.html')

if___name___== '_main_':
    app.run(debug=True)
```

7.2 Feature2

Train Test and Save the Model

Train Test and Save Model:-

Table of Contents:-

Step 1 – Import the library

Step 2 – Setting up the Data

Step 3 – Training and Saving the model

Step 4 – Loading the saved model

Step 1 – Import the library

```
From sklearn import model_selection, datasets
From sklearn.tree import DecisionTreeClassifier
From sklearn.externals import joblib
Import pickle
```

We have imported model_selection, datasets, joblib, DecisionTreeClassifier and pickel which will be needed for the dataset.

Step 2 – Setting up the Data

We have loaded inbuilt wine dataset and stored data in x and target in y. We have used test_train_split to split the dataset such that 30% of data is for testing the model.

```
Dataset = datasets.load_wine()
```

```
X = dataset.data; y = dataset.target
X_train, X_test, y_train, y_test = model_selection.train_test_split(X, y, test_size=0.3)
```

Master the Art of Classification in Machine Learning to Become a Pro

Step 3 – Training and Saving the Model

We are using DecisionTreeClassifier as a model. We have trained the model by training data. We can save the model by using joblib.dump in which we have passed the parameter as model and the filename.

```
Model = DecisionTreeClassifier()
Model.fit(X_train, y_train)

Filename = "Completed_model.joblib"
Joblib.dump(model, filename)
```

Step 4 – Loading the Saved Model

So here we are loading the saved model by using joblib.load and after loading the model we have used score to get the score of the pretrained saved model.

```
Loaded_model = joblib.load(filename)
```

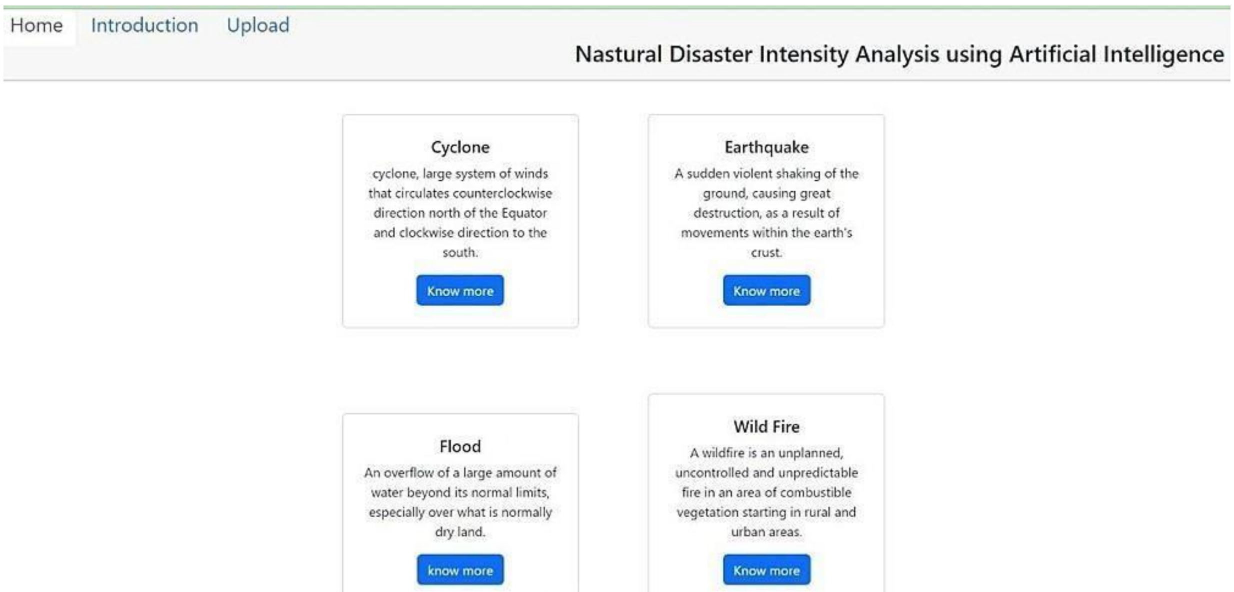
```
Result = loaded_model.score(X_test, y_test)

Print(result)
```

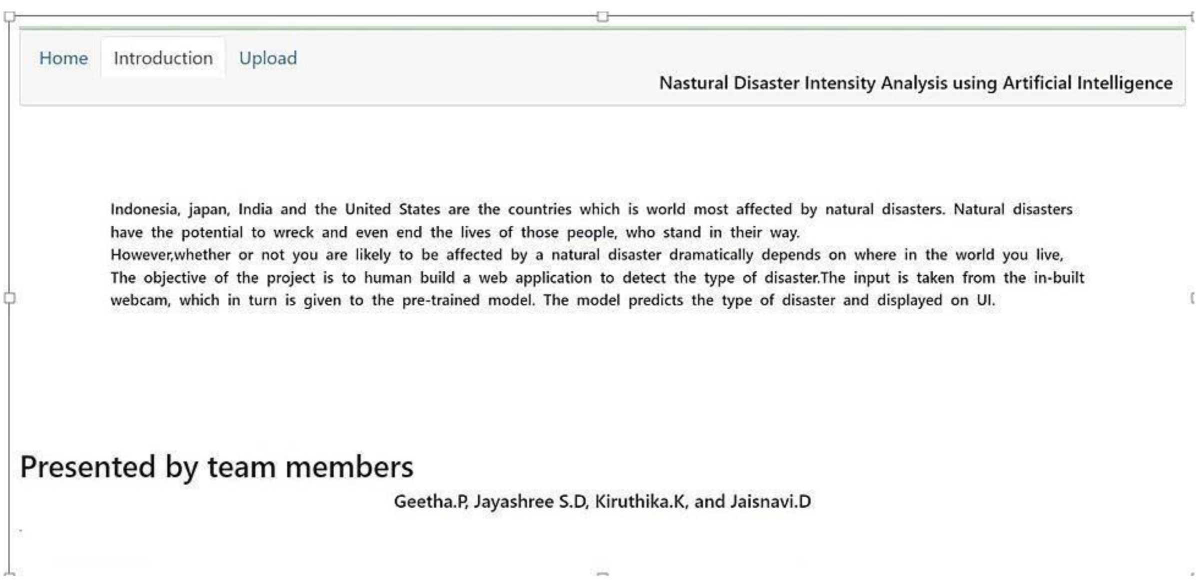
So the output comes as:

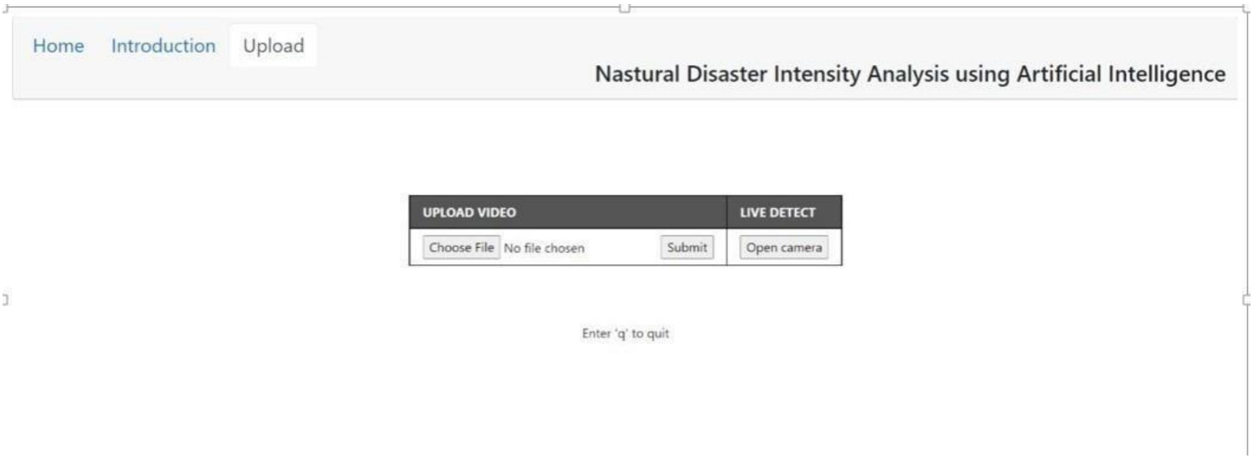
0.9444444444444444

8. TESTING AND RESULTS

8.1 Performance Metrics







10. ADVANTAGES AND DISADVANTAGES

ADVANTAGES

1. In order to balance their personal and professional lives, people require breaksand vacation time. However, AI can operate continuously without rest.
2. With the aid of various AI-based methods, we can also predict the weather forthe present day and the coming days.
3. Beneficial in regaining control of one's life.
4. Their alert temperament allows them to react quickly and effectively, protecting society from significant harm.

DISADVANTAGES

1. Getting outfitted costs a lot of money.
2. Issues with basic necessities.
3. Robots are one use of artificial intelligence that are replacing jobs and raising unemployment.
4. Machines can only do jobs for which they are created or programmed; if theyare asked to complete anything else, they frequently fail or produce uselessresults, which can create serious problems.

11. CONCLUSION

Numerous researchers have tried to detect natural disasters using various deep learning techniques. Deep learning algorithms for natural disaster detection still have a number of concerns with noise and severe class imbalances. We suggested a multilayered deep convolutional neural network for natural disaster identification and intensity classification to overcome these issues. The suggested method consists of two blocks: the first block is used to identify natural disasters, and the second block is used to address concerns with unequal class representation. As average statistical values, the following findings were derived for the suggested model: sensitivity, 97.54%; specificity, 98.22%; accuracy rate, 99.92%; precision, 97.79%; and F1-score, 97.97%. Due to its multilayered nature, the proposed model outperformed other cutting-edge techniques in terms of accuracy.

12. FUTURE SCOPE

Google's pilot effort in Patna, India, to use artificial intelligence to monitor floods, was a success last year. With an accuracy of over 90%, they were able to foresee floods and the areas that would be impacted by the natural calamity. It was made feasible by a mix of information from government organizations that supply on-the-ground data, including measurements taken with on-the-ground measuring devices and satellite photographs of flood-prone locations.

To forecast the flow of water, they performed hundreds of thousands of simulations using its machine learning (ML) models.

By using AI, disaster management organizations can deploy robots, sensors, and drones in the future to offer precise information on damaged structures and landscapes, impending floods, and safer rescue missions.

Smart technology must be included into our neighborhood communities. The degree of the harm can be decreased with an immediate response and technological remedies. However, there are some restrictions and mistakes with AI because it is based on machine codes. However, combining human empathy with vigilance could be extremely beneficial in the realm of crisis management.

13. APPENDIX GIT REPO LINK: https://github.com/IBM-EPBL/IBM-Project-34611-1660239929

DEMO VIDEOLINK:

https://drive.google.com/file/d/1sqzEzpc_cdESJVrTAJ-4SWQZ3a2OElb0/view?usp=drivesdk