NATURAL DISASTER INTENSITY ANALYSIS AND CLASSIFICATION USING ARTIFICIAL INTELLIGENCE

Project Report

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CHAPTER 1 INTRODUCTION

Project Overview

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. To tackle this problem, we developed a multilayered deep convolutional neural network model that classifies the natural disaster and tells the intensity of disaster of natural The model uses an integrated webcam to capture the video frame and the video frame is compared with the Pre- trained model and the type of disaster is identified and showcased on the OpenCV window.

Purpose

The purpose of this project to detect the natural disaster and reduce, or avoid, the potential losses from hazards, assure prompt and appropriate assistance to victims of disaster, and achieve rapid and effective recovery.

CHAPTER 2

LITERATURE SURVEY

TITLE : A Deep Learning Approach of Recognizing Natural Disasters on Images.

PROPOSED WORK

First, this work introduces to the research community a new dataset for the joint classification of natural disaster types and intensity. Moreover, this study primarily aims to explore natural disasters recognition using a convolutional neural network and transfer learning. An open source tool is used for finding and removing the repeated

images for analysis. Wildfire, Earthquake, Flood and Volcanic eruption are taken. In particular, this study attempts to build and train a lightweight convolutional neural network that can jointly recognize natural disaster types and intensity. Based on the intensity, it classifies as Severe, Moderate, Insignificant Lastly, this study attempts to measure the model performance using four performance measures; accuracy, precision, recall, and F1-Score.

TOOLS USED/ALGORITHM

- Image Processing
- Slope NDVI
- Location API
- Cloud Architecture
- Google Earth Engine
- K-Means and Classification Algorithm
- RGB Scale

TECHNOLOGY : Artificial Intelligence

TITLE : Disaster Intensity-Based Selection of Training Samples for Remote Sensing Building Damage Classification.

PROPOSED WORK

In this proposed work, two fully automatic procedures for the detection of severely damaged buildings are introduced. The fundamental assumption is that samples that are located in areas with low disaster intensity mainly represent non-damaged

buildings. Furthermore, areas with moderate to strong disaster intensities likely contain damaged and nondamaged buildings. Under this assumption, a procedure that is based on the automatic selection of training samples for learning and calibrating the standard support vector machine classifier is utilized. The second procedure is based on the use of two regularization parameters to define the support vectors. These frameworks avoid the collection of labeled building samples via field surveys and/or visual inspection of optical images, which requires a significant amount of time. The performance of the proposed method is evaluated via application to three real cases. The resulted accuracy ranges between 0.85 and 0.89, and thus, it shows that the result can be used for the rapid allocation of affected buildings.

TOOLS USED/ALGORITHM

- Automatic labelling
- Building damage
- Multi regularization parameters
- Demand Parameter
- Support Vector Machine (SVM)

TECHNOLOGY : Machine Learning

TITLE : Hurricane Damage Detection using Machine Learning and Deep Learning Techniques

PROPOSED WORK

In this proposed work, Disaster detection can be done through social media and

satellites. Images obtained from satellites are widely used since capturing and processing of these images can be done in a shorter span of time. Satellite images help to recognize damage pattern caused by the disasters. The images from social media are also useful since they provide information on an immediate basis. Since manual methods are error-prone, deep learning and machine learning are used which used for detecting the damage caused by disasters effectively.

TOOLS USED/ALGORITHM

- Social-media
- Satellite imagery
- Deep learning techniques
- CNN,VGG-16, ResNet
- Machine learning techniques · Support Vector Machine, Decision trees, random forest.

TECHNOLOGY : Machine Learning, Deep Learning

Existing Problem

Earlier we focus on post disaster relief and rehabilitation measures. Now the focus is shifted. As per sec.2(e) of DM Act 2005, Disaster Management means a coordination and integrated process of planning, organizing, coordinating, and implementing measures which are necessary or expedient for-

(i) Prevention of danger or threat of any disaster

(ii) Preparedness to deal with any disaster
(iii) Prompt response to any threatening disaster situation or disaster

(iv) Assessing the severity or magnitude of effects of any disaster

(v) Evacuation, rescue, and relief

(vi) Rehabilitation and reconstruction

References

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2. Tonini, M.; D'Andrea, M.; Biondi, G.; Degli Esposti, S.; Trucchia, A.; Fiorucci, P. A Machine Learning-Based Approach for Wildfire Susceptibility Mapping. The Case Study of the Liguria Region in Italy. Geosciences 2020, 10, 105. [CrossRef]

3. Islam, A.R.M.T.; Talukdar, S.; Mahato, S.; Kundu, S.; Eibek, K.U.; Pham, Q.B.; Kuriqi, A.; Linh, N.T.T. Flood susceptibility modelling using advanced ensemble machine learning models. Geosci. Front. 2021, 12, 101075. [CrossRef]

4. Schlemper, J.; Caballero, J.; Hajnal, V.; Price, A.N.; Rueckert, D. A deep cascade of convolutional neural networks for dynamic MR image reconstruction. IEEE Trans. Med. Imaging 2017, 37, 491–503. [CrossRef] [PubMed]

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Problem Statement Definition

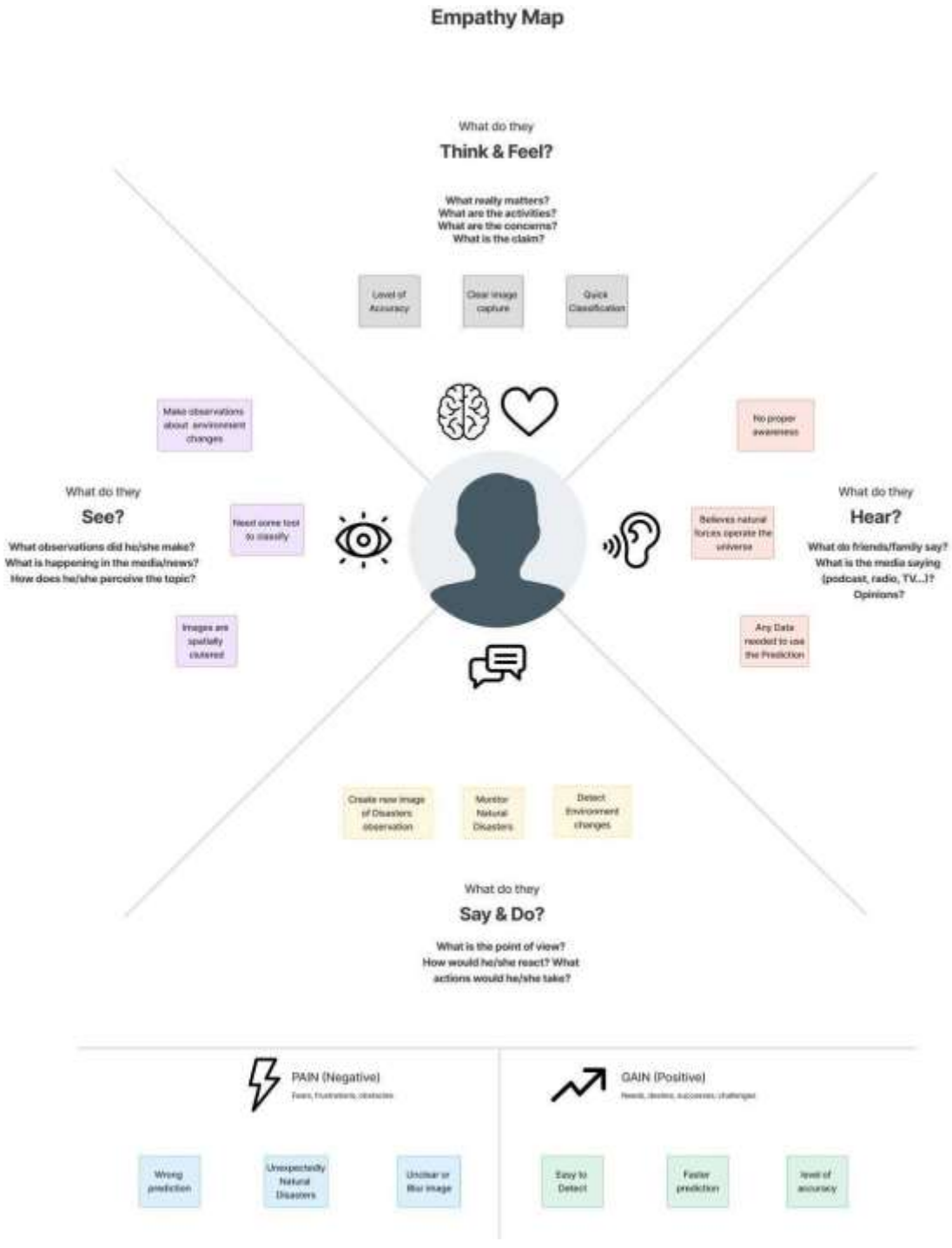
People needs a way to classify and analyse the natural disaster so that they can prevent themselves from losses due to the disaster and millions of lives.

People and animals are facing so many issues like loss of life, property, resources and deterioration of the air quality due to the natural disaster. So we need to analyse and detect natural disaster and protect them from such disaster.

CHAPTER 3

IDEATION & PROPOSED SOLUTION

Empathy Map Canvas



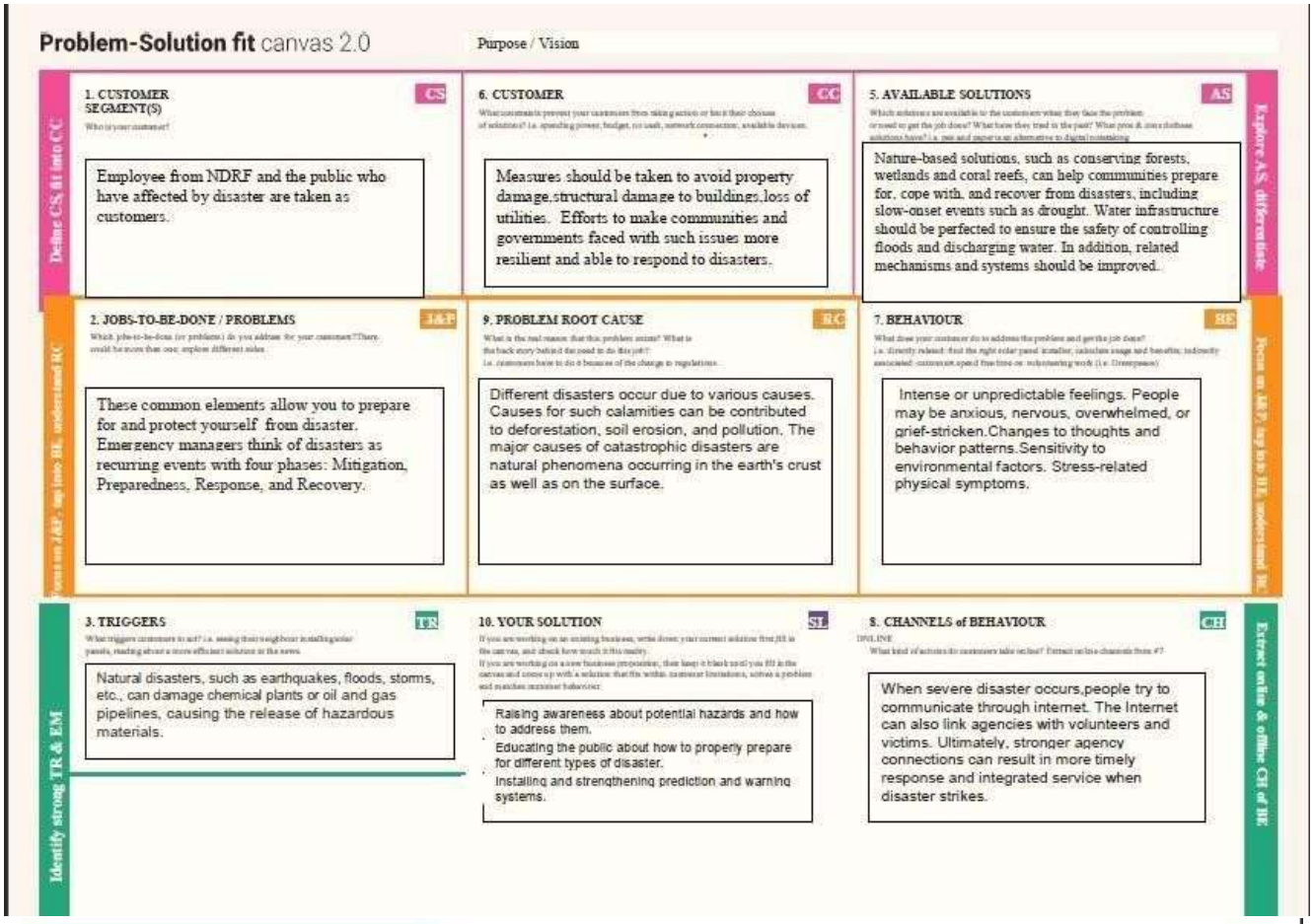
Ideation & Brainstorming

Proposed solution

S. No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	People needs a way to classify and analyse the Disaster priorly so that they can protect themselves from losses due to the Disaster and Millions of Lives.,

2.	Idea/Solution description	This project uses Multi-layered Deep Convolutional Neural Network (pre-trained) model to classify Natural Disaster and calculate the intensity of the Disaster.
3.	Novelty/Uniqueness	To reduce the issues due to imbalance structure of images, the model uses an integrated webcam to capture the video frame and test data is compared with pretrained data.
4.	Social impact/Customer Satisfaction	By the Application, economic damage caused by Disaster can be reduced. Detection of Natural Disaster will become easier while using videos in Deep CNN instead of images.
5.	Business Model (Revenue Model)	Multi-layered Deep Convolutional Neural Network Model.
6.	Scalability of the Solution	Highly expandible, dependable, reliable, scalable and has robustness.

Problem Solution Fit



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CHAPTER 4

REQUIREMENT ANALYSIS

Functional Requirement

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-l	User Registration	Registering via Google Accounts Registering via Product's own user mana system
	User Authentication	Verification through OTP Verification through Email Link
FR-3	Designation of Region	Ease of selection of necessary areas monitored Versatile and Flexible operations on des areas
	Analysis of Required Phenomenon	Simple and easy analysis on the phenomenon to be observed
FR-5	Accumulation of required Data	Fast and Efficient data gathering capa regarding past event analysis and prediction
FR -6	Organizing Unstructured data	Processing of raw and clustered data into and refined data which is useful for analys prediction tasks

	Algorithm selection	The freedom to choose from several cla algorithm to be used in the process Customization of algorithm to suit the nee specific purpose
FR-8	Prediction and analysis of data	Accurate results of the analysis provided process Advanced visualization techniques to visualize the processed data for e observation
FR -9	Report generation	Restructuring of obtained results into cle detailed report for future studies

NFR No.	Non-Functional Requirement	Description
NFR_ I	Usability	It is well suited for fields requiring application of processes with effic precision and ease.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-I	User Registration	Registering via Google Accounts Registering via Product's own user mana system
	User Authentication	Verification through OTP Verification through Email Link

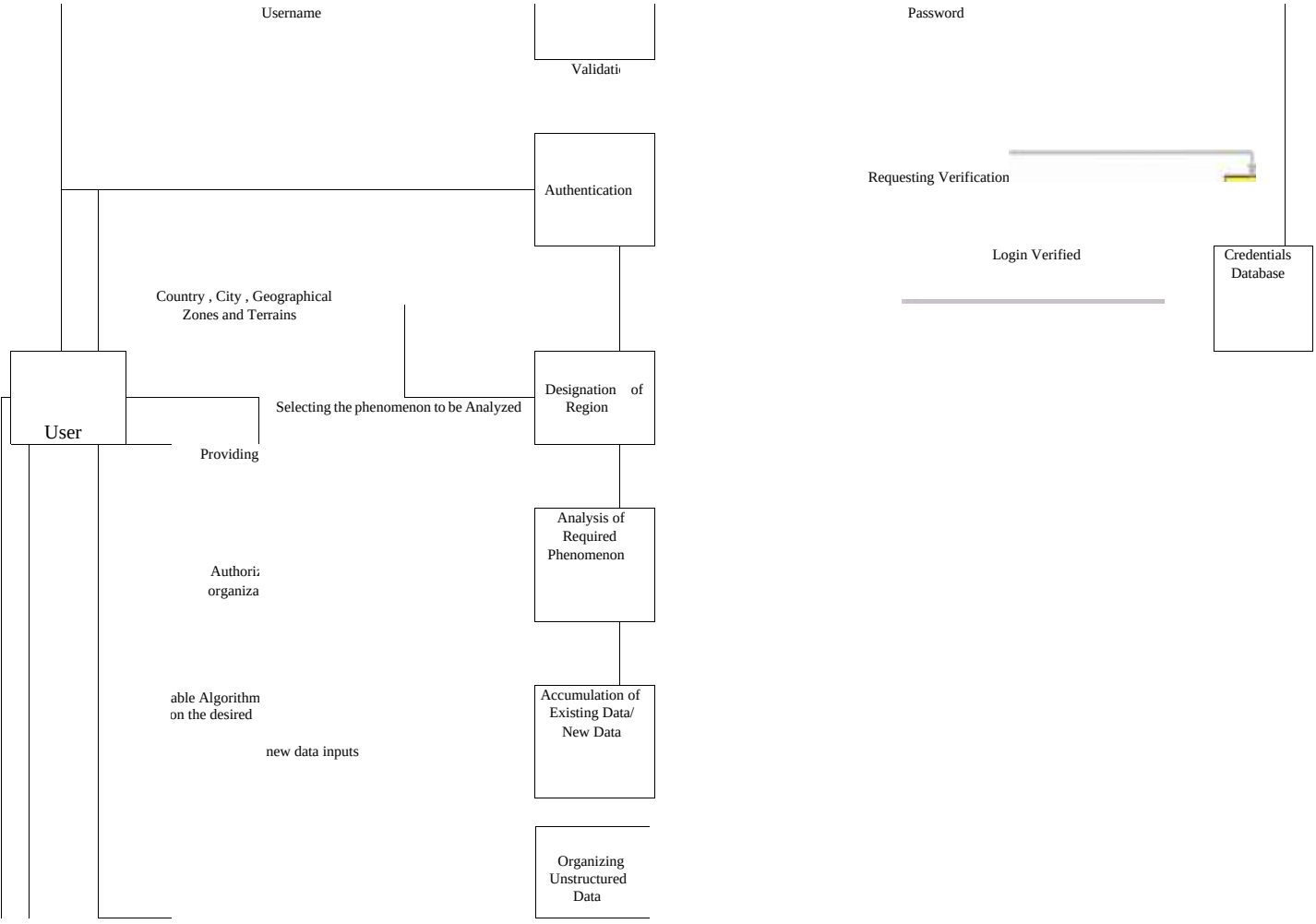
Non-Functional Requirement

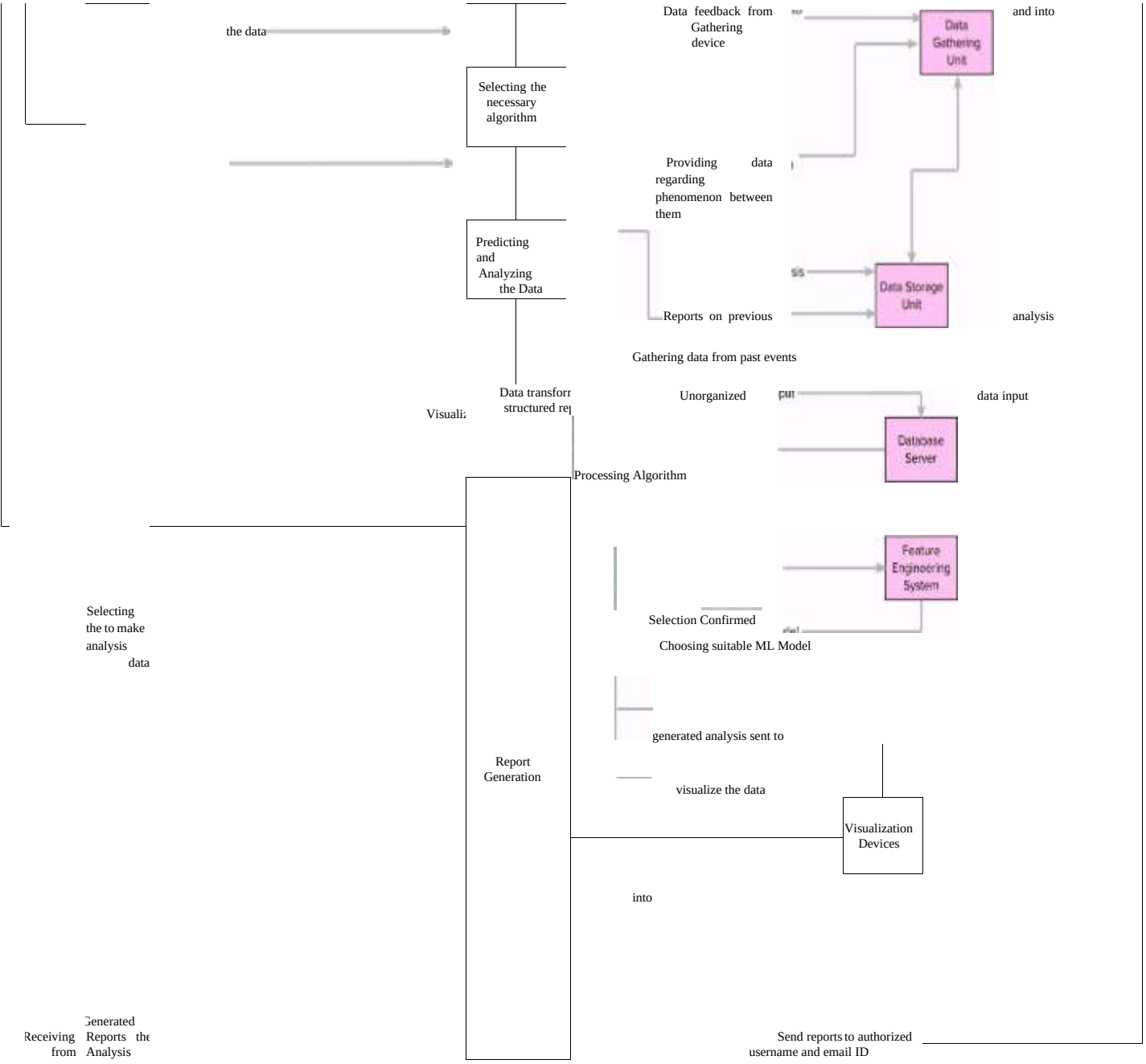
NFR-2	Security	It provides a distinct and secure encryption layer to the system interface for additional security standards.
NFR _ 3	Reliability	The product is robust and is capable of execution of processes even in the most difficult and unpredictable environments.
NFR _ 4	Performance	The product boasts a high precision and efficient working capacity which helps in escalating its performance to the highest degree.
NFR-5	Availability	Despite the complexity and degree of difficulty in its operation, the product is equipped with all-round maintenance and readily available technical services which provides the necessary support any individual requires in their duties.
NFR-6	Scalability	The product also possess enough room for the improvement of its specifications to upgrade its capabilities according to the needs of the user and their organization

CHAPTER 5 PROJECT DESIGN

Data Flow Diagrams

A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data to be enter and leaves the system, what changes the information, and where data is stored.





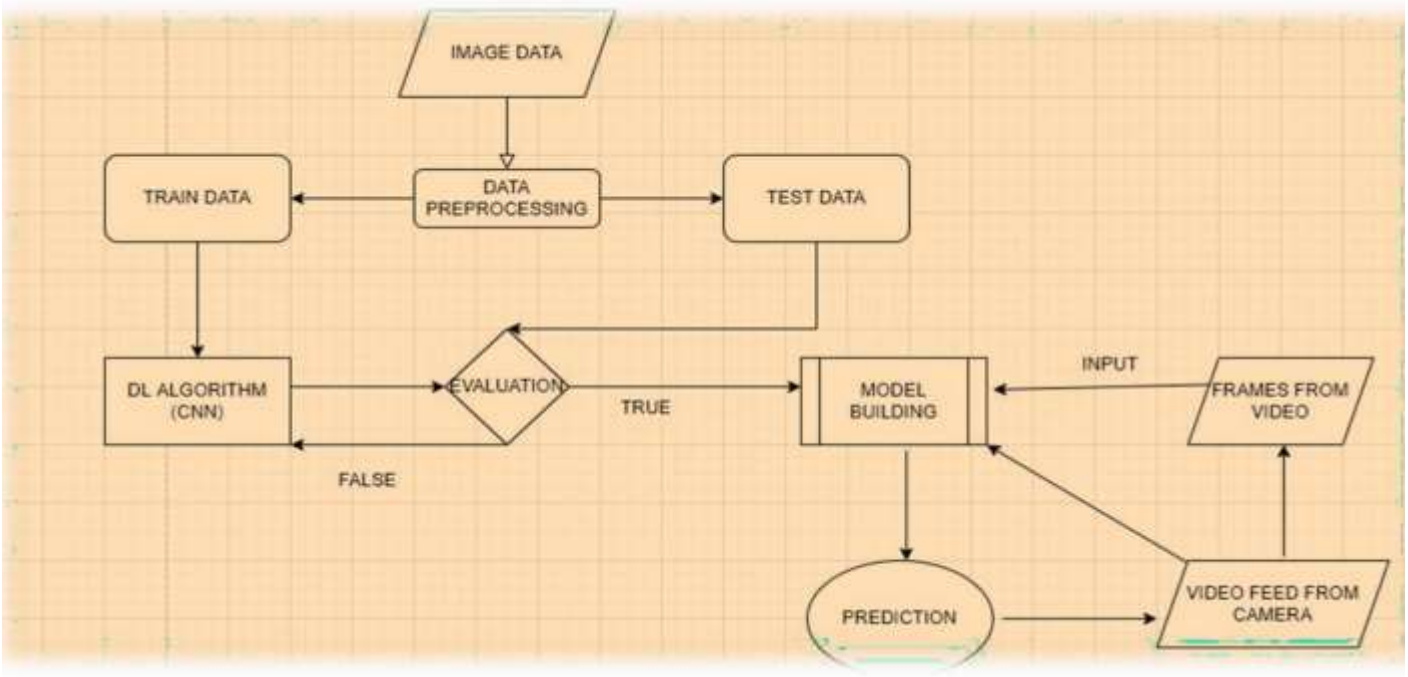
Solution & Technical Architecture

Solution Architecture

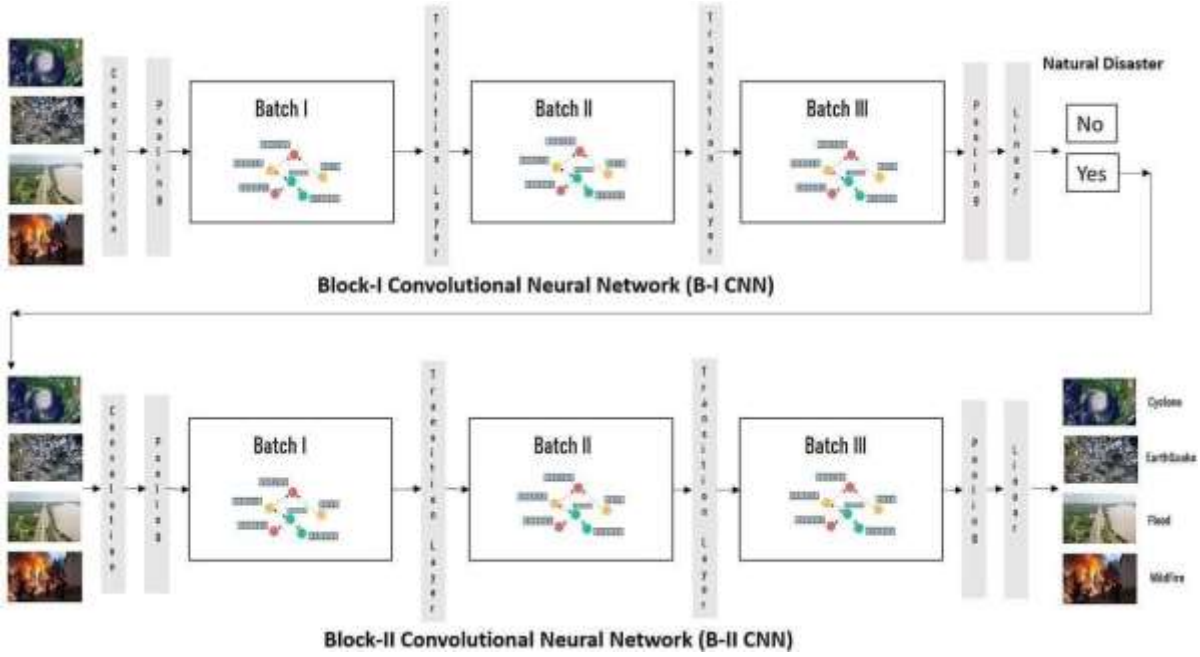
Solution architecture is a complex process – with many sub-processes – that bridges the gap between business problems and technology solutions. Its goals are to:

- Find the best tech solution to solve existing business problems.
- Describe the structure, characteristics, behavior, and other aspects of the software to project stakeholders.
- Define features, development phases, and solution requirements.
- Provide specifications according to which the solution is defined, managed, and delivered.

Solution Architecture Diagram



Technical Architecture



Components &Technologies:

S.No	Component	Description	Technology
1.	User Interface	User interacts with application for the detection of any Natural disaster's intensity and classify which happened just before.	HTML, CSS, JavaScript, Django, Python.
3.	Disaster Detection	This function is used to detect, Outcomes from the new trained data to perform new	Decision trees, Regression, Convolutio

		tasks and solve new problems.	nal Neural networks.
4.	Evaluation system	It monitors that how Algorithm performs on data as well as during training.	Chi-Square, Confusion Matrix, etc.
5.	Input data	To interact with our model and give it problems to solve. Usually this takes the form of an API, auser interface, or a command- line interface.	Application programming interface, etc.
6.	Data collection unit	Data is only useful if it's accessible, so itneeds to be stored ideally in a consistent structure and conveniently inone place.	IBM Cloud, SQLServer.
7.	Database management system	An organized collection of data stored in database, so that it can be easily accessedand managed.	MySQL, DynamoDB etc.

Application Characteristics:

S.No	Characteristics	Description	Technology
1.	Open-Source Frameworks	An open source framework is a template for software development that is designed by a social network of software developers. These frameworks are free for public use and provide the foundation for building a software application.	Keras, Tensorflow.
2.	Authentication	This keep sour models secure and makes sure only those who havepermission can use them.	Encryption and Decryption (OTP).
3.	Application interface	User uses mobile application and web application to interact with model	Web Develop ment (HTML,C SS)
4.	Availability (both Online and Offline work)	Its include both online and offline work. As good internet connection is need for online work to explore the software perfectly. Offline work includes the saved data to explore for later time.	Caching, backend server.

5.	Regular Updates	The truly excellent software product needs a continuous process of improvements and updates. Maintain your server and make sure that your content is always up-to-date. Regularly update an app and enrich it with new features.	Waterfall Approach, Incremental Approach, Spiral Approach
6.	Personalization	Software has features like flexible fonts, backgrounds, settings, colour themes, etc. which make a software interface looks good and functional.	• CSS

User Stories

User Type	Functional Requirement (Epic)	User Story Number (USN)	User Story / Task	Acceptance criteria	Priority	Release
End user (Customer)	Registration	USN - 1	As a user, I am able to register with the product using my valid email address	I should be able to register with my account credentials	High	Sprint - 1
End User (Customer)	Authentication	USN - 2	As a user, I am able to login into the system with my credentials	It should ensure smooth login capabilities without delay	High	Sprint 1

End User (Customer)	Designation of Region	USN - 3	I can select the region of interest to be monitored and analyzed	I must be able to choose certain specific places without error	High	Sprint - 1
End User (Customer)	Analysis of Required Phenomenon	USN -4	I am able to monitor certain factors that influence the actions of the phenomenon	It should consider and monitor most of the factors involved in the action	High	Sprint 2
End User (Customer)	Accumulation of required Data	USN - 5	I am able to gather data regarding past events and a detailed report on past analysis	It should allow the storage of data of past events for certain extent	Medium	Sprint - 2
End User (Customer)	Organizing Unstructured data	USN - 6	I am able to organize and restructure the raw data into refined data	It should ensure easy and efficient processing methods	Low	Sprint - 3
End User (Customer)	Algorithm selection	USN - 7	I am able to choose the required algorithm for a specific analysis	It must provide various options for the algorithm to be used	High	Sprint - 2
End User (Customer)	Prediction and analysis of data	USN - 8	I am able to easily predict and visualize the data	It should allow easy to use prediction and visualization techniques	High	Sprint 3

End User (Customer)	Report generation	USN - 9	I am able to generate a clear and detailed report on the analysis	Report generation must be fast and efficient and should not be complex	Medium	Sprint - 4

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CHAPTER 6

PROJECT PLANNING & SCHEDULING

Sprint planning & Estimation

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points
Sprint-1	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	2
Sprint-1		USN-2	As a user, I will receive confirmation email once I have registered for the application	1
Sprint-2		USN-3	As a user, I can register for the application through Facebook	2
Sprint-2		USN-4	As a user, I can register for the application through Gmail	2
Sprint-1	Login	USN-5	As a user, I can log into the application by entering email & password	1
Sprint-1	Dashboard	USN-6	As a user, I can access the services and information provided in the dashboard	2
Sprint-2	login	USN-7	As a user, I can log into the web application and access the dashboard	2
Sprint-4	Helpdesk	USN-8	As a user, I can get the guidance from the customer care	1
Sprint-3	Management	USN-9	As an administrator, I can collect new datasets and keep the model trained	2

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points
Sprint-3		USN-10	As an administrator, I can update other features of the application	2
Sprint-3		USN-11	As an administrator, I can maintain the information about the user	2

Sprint-4		USN-12	As an administrator, I can maintain third-party services	1

Sprint Delivery schedule

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)
Sprint-1	8	6 Days	26 Oct 2022	31 Oct 2022	8
Sprint-2	4	6 Days	1 Oct 2022	05 Nov 2022	4
Sprint-3	6	6 Days	6 Nov 2022	10 Nov 2022	6
Sprint-4	2	6 Days	10 Nov 2022	13 Nov 2022	2

Reports from Jira

Velocity:

Imagine we have a 10-day sprint duration, and the velocity of the team is 20 (points per sprint). Let's calculate the team's average velocity (AV) per iteration unit
(story points per day)

$$AV = \frac{sprint\ duration}{velocity} = \frac{20}{10} = 2$$

AV (Sprint 1) = 8/6 = 1
AV (Sprint 2) = 4/6 = 1

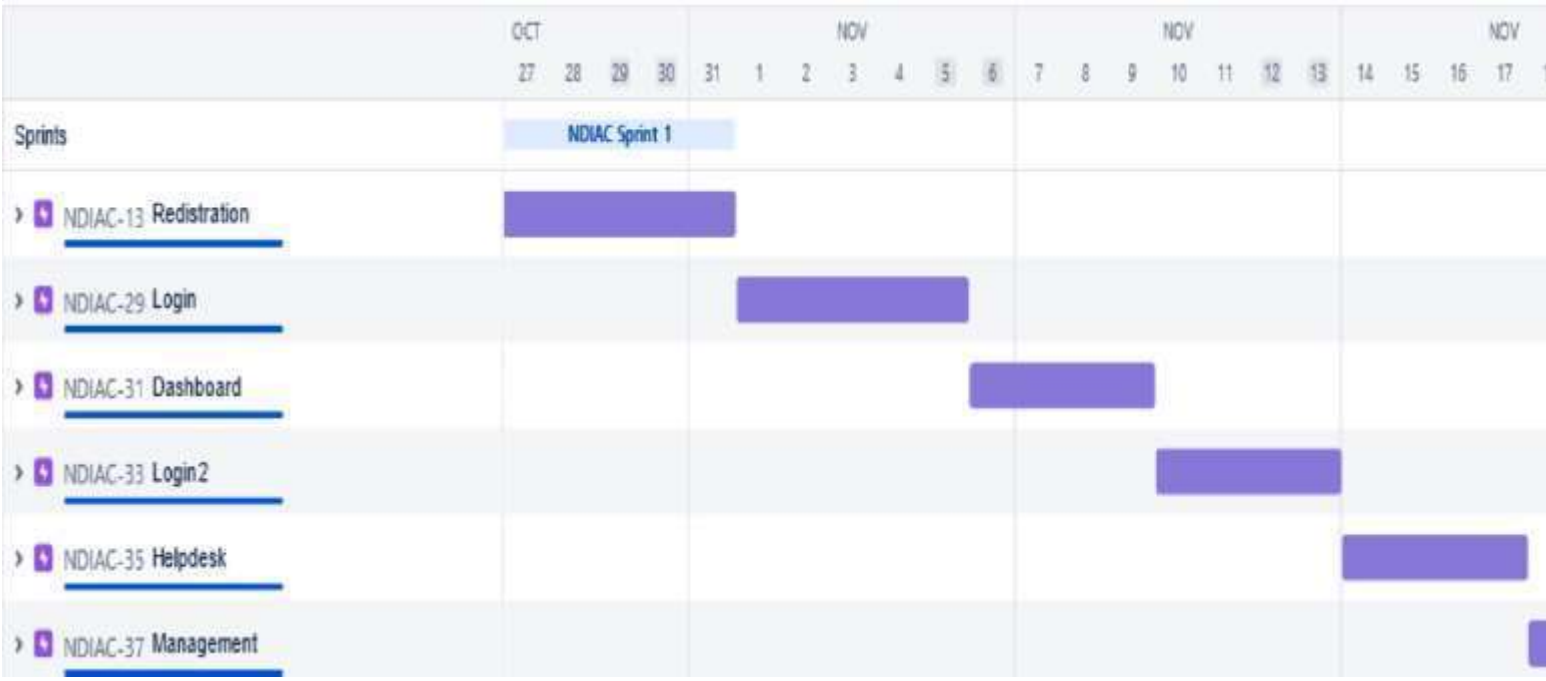
AV (Sprint 3) = 6/6 = 1

AV (Sprint 4) = 2/6 = 1

AV (Total) = 20/24 = 1 (appx., 1 sprint to be completed per day)

Burndown Chart:

A burn down chart is a graphical representation of work left to do versus time. It is often used in agile software development methodologies such as Scrum. However, burn down charts can be applied to any project containing measurable progress over time.



CHAPTER 7

CODING & SOLUTIONING

Feature 1

The project focuses on the analysis of intensity of Disaster for giving precautionary measures for the people living in the Danger zone.

It focuses on classifying the type of Disaster which oftenly occurs in that particular zone.

Feature 2

The accuracy of the project is improved more better than the previously submitted models.

The accuracy is improved by training and testing more images in the dataset.

CHAPTER 8
TESTING

Test cases

Test Case ID	Component	Test Scenario	Expected Result	Actual Result	Status
TC_001	Home Page	Verify user is able to see the Home page	Home page should Display	Working as expected	Pass
TC_002	Home Page	Verify the UI elements in Home page	Application should show below UI elements: Home page button Intro page button Open webcam button	Working as expected	Pass
TC_003	Home Page	Verify user is able to see the cards about Disaster	Application should show the cards about Disaster.	Working as expected	Pass
TC_004	Home Page	Verify user is able to navigate to the required page	Application should navigate to the Intro page	Working as expected	Pass
TC_005	Intro Page	Verify user is able to see the Intro page	Intro page should display	Working as expected	Pass

TC_006	Intro Page	Verify the UI Elements in Intropage	Application should show below UI elements: Home page Intro page Open webcam button	Working as expected	Pass

TC_007	Intro Page	Verify the user is able to see the introduction of the Disaster	Application should show the sentences about the Disaster	Working as expected	Pass
TC_008	Intro Page	Verify user is able to navigate to the required page	Application should navigate to the Open webcam page	Working as expected	Pass
TC_009	Webcam page	Verify user is able to see the webcam page	Webcam page is displayed	Working as expected	Pass
TC_010	Webcam page	Verify the Emergency pull button is visible while the webcam is not connected	Application should show below UI elements: a. Emergency pull button	Working as expected	Pass
TC_011	Webcam page	Verify user is able to see the output window	Application should detect the type of Disaster from the real time video	Working as expected	Pass

User Acceptance Testing

It is to briefly explain the test coverage and open issues of the natural disasters intensity analysis and classification using artificial intelligence project at the time of the release to User Acceptance Testing (UAT). **Defect Analysis:**

This report shows the number of resolved or closed bugs at each severity level, and how they were resolved

Resolution	**Severity 1**	**Severity 2**	**Severity 3**	**Severity 4**	**Subtotal**
By Design	1	0	0	2	3
Duplicate	1	0	0	0	1
External	0	0	0	0	0
Fixed	1	0	0	2	3
Not Reproduce	0	0	0	0	0
Skipped	0	0	0	1	1
Won't Fix	0	0	0	0	0
Totals	3	0	0	5	8

Test Case Analysis:

This report shows the number of test cases that have passed, failed, and untested.

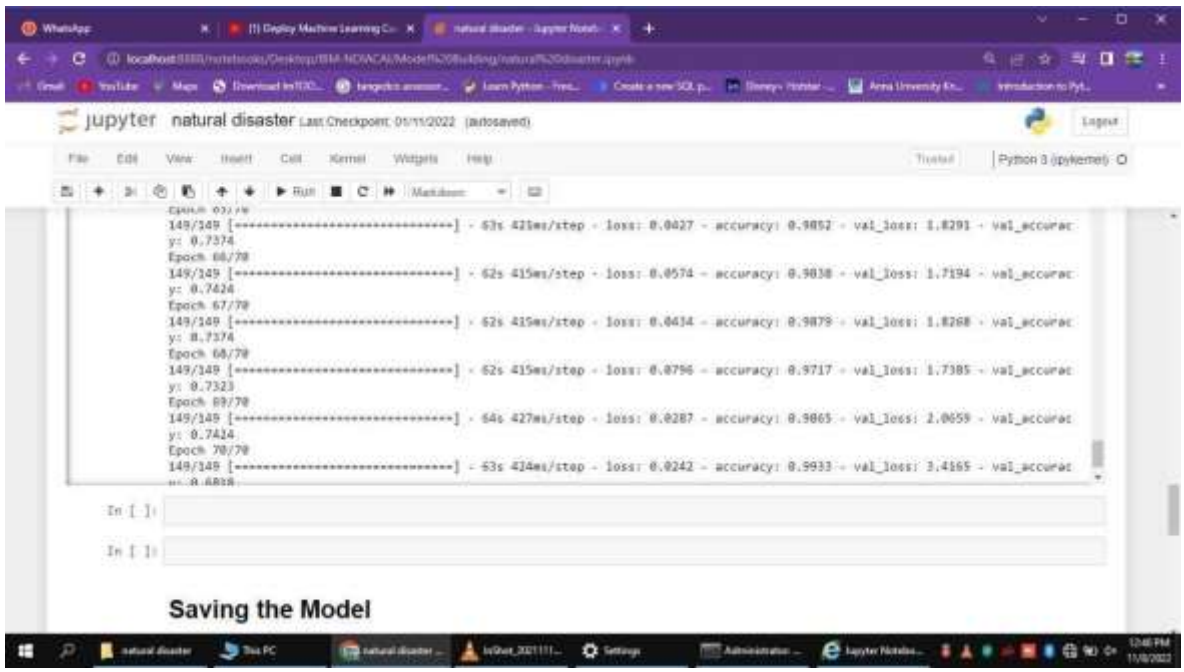
Section	Test Cases	Not Tested	Fail	Pass
Home Page	4	0	0	4
Intro Page	4	0	0	4
Open Webcam	3	0	0	3

CHAPTER 9 RESULTS

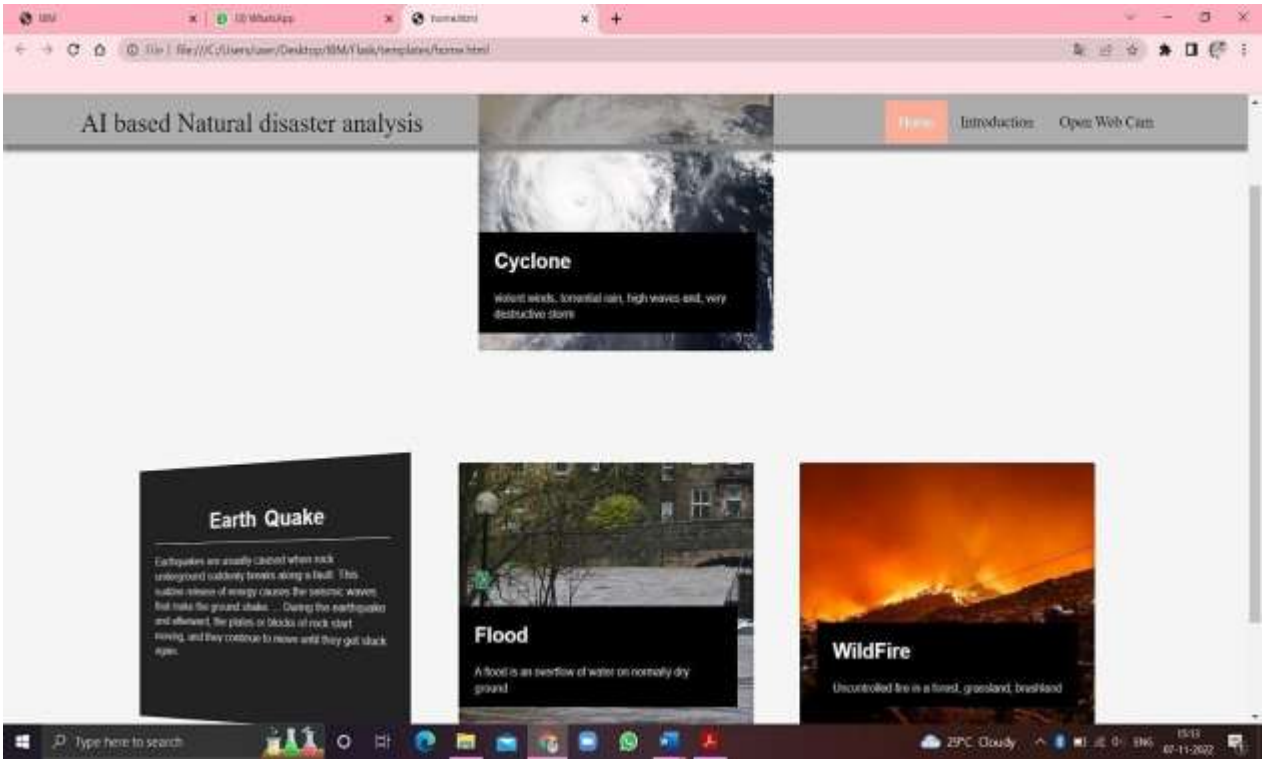
Performance Metrics

The nature disaster intensity analysis and classification with test data and train data has been executed successfully. The model has been trained over 1000+ images and the model have an accuracy of nearly 99% and the model has been tested withthe data which is separate from the trained data and has predicted the data well.

Output of application



HOME PAGE

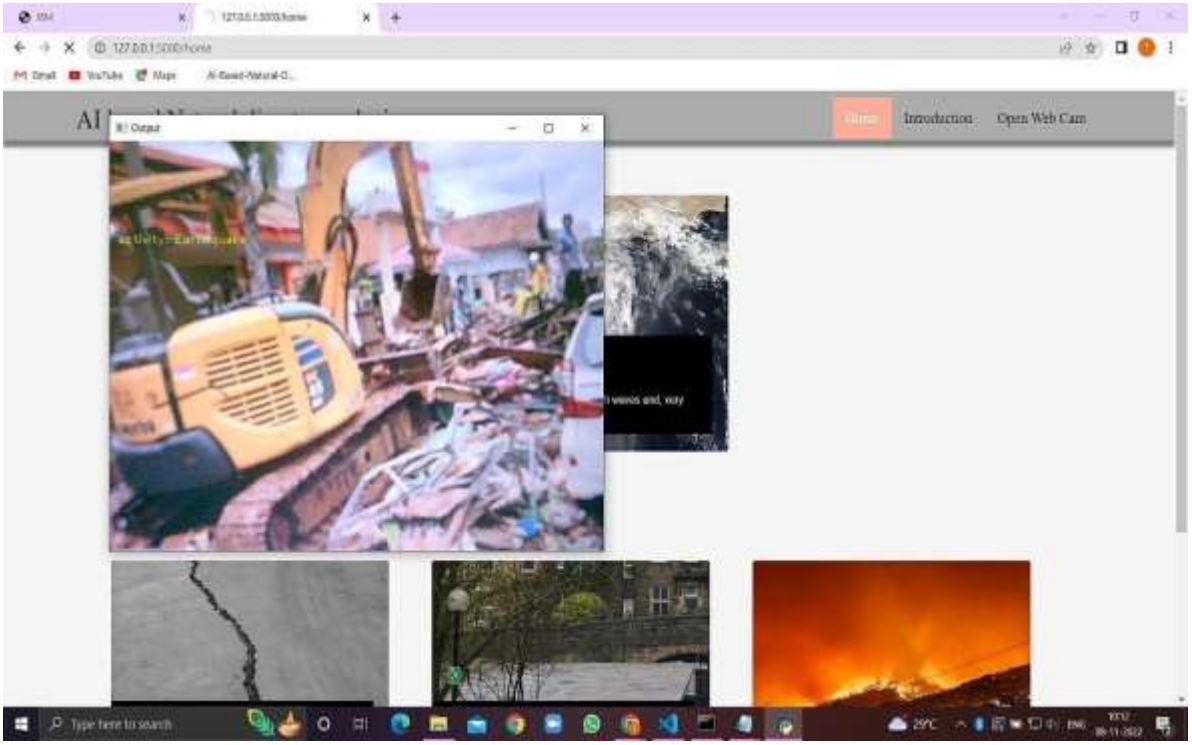


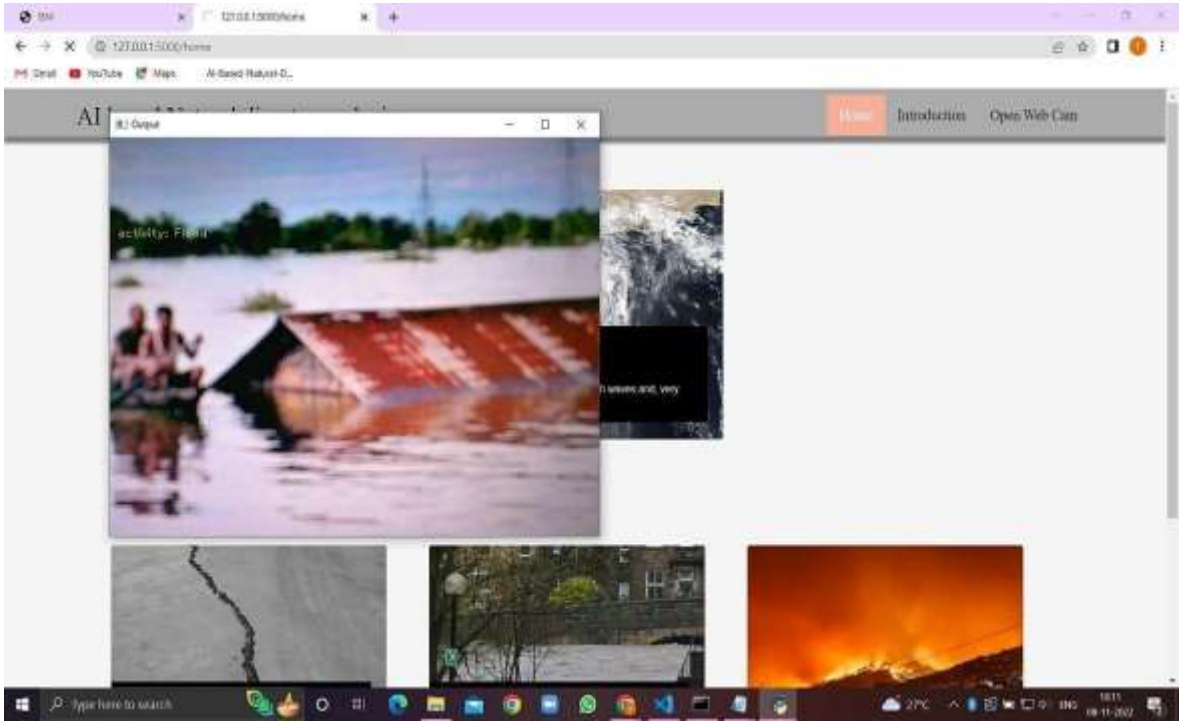
INTRODUCTION PAGE

China, India and the United States are among the countries of the world most affected by natural disasters.
Natural disasters have the potential to wreck and even end the lives of those people, who stand in their way. However, whether or not you are likely to be affected by a natural disaster greatly depends on where in the world you live, The objective of the project is to human build a web application to detect the type of disaster . The input is taken from the in built web cam, which in turn is given to the pre trained model . The model predicts the type of disaster and displayed on UI.

WEB CAM

DETECTION OF NATURE DISASTER




Home
Introduction
Open Web Cam
Output

CHAPTER 10

ADVANTAGES & DISADVANTAGES

ADVANTAGES

1. The proposed model will be used as a real time natural disaster detection model and provide some upcoming predictions for future disasters.
2. The model is to detect and classify the type of disaster and The model have a high accuracy rate (99.33).
3. The model was used to prevent natural disasters in the future and model can be used to predict future disasters and take some action against heavy loss of human ecological systems and property.
4. The proposed system helps to reduce the impact of hazards occur during natural disaster. This provides an efficient way to warn and educate people about disaster prone areas.
5. It will help us be prepared in times of disaster

DISADVANTAGES

1. The resultant model unable to validate the model performance under uncontrolled conditions.
2. The model cannot be used for various natural disaster

CHAPTER 11 CONCLUSION

It focused how image from given dataset (trained dataset) in field and past data set used predict the pattern of different nature disaster using CNN model. In the system had applied different type of CNN compared the accuracy. The natural disaster in Indonesia frequently happened, due to the geographical position of the country. Thus, natural disasters mostly occurred as an impact of the natural condition. However, the weather and climate condition has also influenced and triggered the disasters.

CHAPTER 12 FUTURE SCOPE

In the future, the research will be continued to obtain the data from all over the country, not only west java province, and with the use of more complete analysis, so that the government or related institution could make a better anticipation work as a mitigation effort.

CHAPTER 13 APPENDIX

Inserting necessary libraries

import numpy as np **#used for numerical analysis** import tensorflow **#open source used for both ML and DL for computation**

from tensorflow.keras.models import Sequential **#it is a plain stack of layers**

from tensorflow.keras import layers **#A layer consists of a tensor-in tensor-out computation function**

#Dense layer is the regular deeply connected neural network layer

from tensorflow.keras.layers import Dense,Flatten

#Faltten-used fot flattening the input or change the dimension

from tensorflow.keras.layers import Conv2D,MaxPooling2D **#Convolutional layer**

#MaxPooling2D-for downsampling the image

from keras.preprocessing.image import ImageDataGenerator

tensorflow.__version

tensorflow.keras._version ____

Image Data Augumentation

#setting parameter for Image Data agumentation to the training data

train_datagen =

ImageDataGenerator(rescale=1./255,shear_range=0.2,zoom_range=0.2,horizontal_

flip=True)

#Image Data agumentation to the testing data

test_datagen=ImageDataGenerator(rescale=1./255)

Loading our data and performing Data Augumentation

#performing data agumentation to train data

x_train=train_datagen.flow_from_directory(r'C:\Users\vasanth\Desktop\IBM Project\dataset\train_set',target_size=(64, 64),batch_size=5,

color_mode='rgb',class_mode='categorical')

#performing data agumentation to test data

x_test=test_datagen.flow_from_directory(r'C:\Users\vasanth\Desktop\IBM Project\dataset\test_set',target_size=(64, 64),batch_size=5,

color_mode='rgb',class_mode='categorical')

print(x_train.class_indices)**#checking the number of classes** print(x_test.class_indices)#**checking the number of classes**

from collections import Counter as c

c(x_train .labels)

Creating the Model

 # Initializing the CNN

```
classifier = Sequential()
```

 # First convolution layer and poolingo

```
classifier.add(Conv2D(32, (3, 3), input_shape=(64, 64, 3), activation='relu'))

classifier.add(MaxPooling2D(pool_size=(2, 2)))

classifier.add(Conv2D(32, (3, 3), input_shape=(64, 64, 3), activation='relu'))
```

 # Second convolution layer and pooling

```
classifier.add(Conv2D(32, (3, 3), activation='relu'))
```

 # input_shape is going to be the pooled feature maps from the previous convolution layer

```
classifier.add(MaxPooling2D(pool_size=(2, 2)))

classifier.add(Conv2D(32, (3, 3), input_shape=(64, 64, 3), activation='relu'))
```

 # Flattening the layers

```
classifier.add(Flatten())
```

 # Adding a fully connected layer classifier.add(Dense(units=128,

activation='relu'))

classifier.add(Dense(units=4, activation='softmax')) **# softmax for more than 2**

classifier.summary() #**summary of our model**

 # Compiling the Model

 # Compiling the CNN

 # categorical_crossentropy for more than 2

classifier.compile(optimizer='adam', loss='categorical_crossentropy', metrics=['accuracy'])
 # Fitting the Model classifier.fit_generator(generator=x_train,steps_per_epoch =

len(x_train), epochs=10, validation_data=x_test,validation_steps = len(x_test**))#**

No of

images in test set #

Saving the Model

classifier.save('disaster.h5') model_json =

classifier.to_json() with open("model-

bw.json", "w") as json_file:

json_file.write(model_json)

 # Predicting Results

from tensorflow.keras.models import load_model from

keras.preprocessing import image model =

load_model("disaster.h5") **#loading the model for testing**

img=image.load_img(r"C:\Users\vasanth\Desktop\IBMProject\dataset\test_set\Cyc

lone\921.jpg",grayscale=False,target_size= (64,64)) **#loading of the image\n**

x = image.img_to_array(img**)#image to array\n",**

x = np.expand_dims(x,axis = 0)**#changing the shape\n",**
pred = model.predict_classes(x**)#predicting the classes\n",**

pred

index=['Cyclone','Earthquake','Flood','Wildfire']

result=str(index[pred[0]]) result

Links to find files, documents and result related to this project,

GitHub: https://github.com/IBM-EPBL/IBM-Project-51156-1660974169

Project Demo Link:

https://drive.google.com/file/d/1Q7o9Q39c6qqdfAmOakM303TX1my2E79f/view