

Flood Area Detection and Image Segmentation using Deep Learning for Disaster Monitoring

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Abstract

One of the most damaging natural disasters, floods seriously harm human lives, infrastructure, and agriculture. Effective disaster response and management depend on the early identification of flood-affected areas. Conventional flood monitoring techniques mostly rely on satellite analysis and human observation, which can be ineffective and slow in emergency conditions. This study suggests a deep learning-based flood picture segmentation system that automatically identifies flooded areas from aerial photos in order to solve this problem. The suggested method creates binary masks that depict flooded areas by identifying flood areas using a segmentation model based on convolutional neural networks. An overlay visualization that prominently displays the flooded areas is created by combining the predicted masks with the original image. Additionally, a web-based interface is created that enables users to upload photographs and receive real-time prediction results. The highlighted flood areas, the original image, and the anticipated segmentation mask are all shown by the system. The suggested method may successfully identify flood-affected areas and produce useful visual outputs, according to experimental results. During emergency response activities, this device can help disaster management authorities monitor flood conditions and make quicker choices.

Keywords: Flood Detection, Deep Learning, Image Segmentation, Semantic Segmentation, Disaster Management, Computer Vision, Flood Area Detection, Remote Sensing

I. Introduction

One of the most frequent and destructive natural catastrophes that strike many parts of the world is flooding. They seriously harm human communities, transportation networks, agriculture, and infrastructure. For efficient emergency response and catastrophe management, flood-affected areas must be quickly identified. Conventional flood monitoring techniques mostly depend on field surveys, physical inspection, or satellite image analysis, all of which can be laborious and cause rescue and recovery efforts to be delayed.

Automated image analysis has emerged as a successful option for environmental monitoring jobs due to the quick development of deep learning and artificial intelligence technology.

Convolutional neural networks (CNNs), in particular, have demonstrated exceptional performance in a variety of computer vision tasks, including semantic segmentation, object detection, and image classification. By categorizing each pixel into distinct groups, image segmentation is one of these methods that is crucial for identifying particular areas within an image. One method for automatically identifying flooded areas in aerial or satellite photos is called flood picture segmentation. Disaster management authorities can better comprehend the amount of flooding and take appropriate action by precisely identifying locations that are covered in water. Because deep learning-based segmentation algorithms can learn intricate spatial information from photos, they have been employed extensively for flood detection in recent years.

II. Dataset Description

Flood photos and the segmentation masks that go with them make up the dataset used in this study. The associated mask image depicts the ground truth flood locations, while each input image shows an aerial or satellite perspective of flood-

affected areas. Black pixels are used to represent non-flood areas in the mask images, whereas white pixels are used to indicate flood areas. The deep learning model learns the spatial features of flooded areas with the aid of this labeling. The segmentation model is trained and assessed using a variety of image-mask pairs found in the dataset. These photos depict various flood situations, including flooded land areas, water buildup close to roadways, and urban floods. The program learns to recognize flood patterns under various environmental situations thanks to the variance in photos.

III. Proposed Methodology

To identify flood-affected areas from input photos, the suggested method employs a deep learning-based image segmentation technique. Data preprocessing, model training, flood region prediction, and results visualization via a web-based interface are all part of the overall methodology.

The flood picture dataset and the matching mask images are gathered and preprocessed in the first step. Preprocessing entails dividing the data into training and validation sets, standardizing pixel values, and resizing the images. This stage enhances the model's performance and guarantees that the data is appropriate for deep learning model training.

Following preprocessing, the prepared dataset is used to train a deep learning segmentation model. By examining the connection between the input photos and their matching segmentation masks, the model gains the ability to recognize flood patterns. In order to correctly categorize every pixel in the image as either flood or non-flood, the model modifies its internal parameters during training.

The model is utilized for prediction after training is finished. The trained model analyzes a new image uploaded by the user via the web interface and creates a forecast mask that emphasizes the areas damaged by flooding. An overlay visualization that clearly displays the flooded areas is created by combining the original image with the forecasted mask.

IV. Implementation

The suggested flood picture segmentation solution uses deep learning frameworks and Python to automatically identify flooded areas in aerial photos. The system offers a user-friendly platform for flood analysis by combining machine learning algorithms with a web-based interface.

Popular Python libraries for image processing and model training, including TensorFlow, Keras, NumPy, and OpenCV, are used in the development of the deep learning model. Labeled flood picture datasets, in which each input image is linked to a matching mask image depicting the flooded area, are used to train the segmentation model. Important visual characteristics like flooded terrain patterns, water boundaries, and texture variations between water and non-water areas are taught to the model during the training phase.

Prediction generation, model loading, and image preprocessing are all handled by the system's backend. The system first preprocesses the image by scaling and normalizing it to meet the model input criteria when a user uploads it via the web interface. The trained deep learning model then receives the preprocessed image and uses it to forecast the flood segmentation mask.

The technique generates the predicted mask and then combines it with the original image in post-processing to provide a visual overlay. For easier reading, this overlay clearly identifies areas damaged by flooding.

Users can upload photographs and view prediction results with ease thanks to the frontend interface. The original image, the anticipated segmentation mask, and the overlay result displaying flood regions are the three outputs that the interface shows. This implementation makes it possible to identify floods effectively and offers a useful tool for monitoring and analyzing disasters.

V. Results and Discussion

The ability of the suggested deep learning-based flood picture segmentation system to precisely identify areas damaged by flooding was assessed using flood photographs. After analyzing the input image, the trained segmentation algorithm creates a prediction mask that draws attention to the flooded areas. The original input image, the anticipated segmentation mask, and the overlay visualization are the system's three primary outputs.

The user supplied the original image via the web interface, which depicts the area damaged by flooding. The trained deep learning model uses this image as its input. The image is processed by the model, which then examines the visual characteristics associated with flooded areas and bodies of water.

The segmentation model analyzes the input image and produces the expected mask. The non-flood areas are shown as black pixels in this mask, while the flood-affected areas are highlighted with white pixels. The degree of flooding in the picture

may be easily determined thanks to this binary representation. The anticipated mask and the original image are combined to create the overlay result. This visualization makes it simpler for viewers to visually grasp the flood-affected areas by highlighting the flood spots on the original image with a colored overlay.

VI. Output



Fig: Flood Area Segmentation Interface

The flood image segmentation system's user interface is depicted in this picture. The file selection feature on the UI enables users to upload pictures of floods. The user can begin the prediction process by clicking the "Predict Flood Area" button after choosing a picture. After that, the system uses a deep learning model that has been trained to process the image. This interface offers an easy-to-use platform for automatically identifying locations affected by flooding.



Fig: Flood Prediction Results

The flood image segmentation system's predicted output is displayed in this picture. Three panels are shown by the system: the overlay result, the predicted segmentation mask, and the original image. Flood-affected areas are highlighted by white patches in the forecasted mask, whereas non-flood areas are shown as black. The overlay image highlights the flooded areas in red by combining the original image with the forecasted mask. This visual aid makes it simple for users to locate and examine locations in the provided image that have been affected by flooding.

VII. Conclusion

A deep learning-based flood image segmentation method for identifying flood-affected areas from aerial photos is presented in this study. The suggested method analyzes photos using a segmentation model to produce masks that draw attention to flooded regions. Users can upload photographs and quickly receive prediction results through a web-based interface. To make flood areas easy to see, the system shows the original image, the predicted mask, and the overlay result. The model can successfully identify flooded locations, according to the trial data. In an emergency, this strategy can help disaster management authorities monitor flooding and make quicker choices.

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