FLOOD MONITORING SYSTEM USING IOT AND MACHINE LEARNING

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Abstract

Detecting floods in real-time and taking rapid actions are of utmost importance to save human lives, loss of infrastructures, and personal properties. The main objective of our project is to develop a flash flood warning system to monitor the water level rise in rivers which are prone to severe flood. Here we develop a low-cost, low-power system using a Raspberry Pi camera to detect the rising water level. We employ image processing, edge detection and prediction method to detect the rising water level and predict the time of impact. In the hardware section we use Raspberry-Pi, which has main tasks as an image processor and do an update to the system. OpenCV library is used as Image Processing Software. Some method which we use in the project are Region of Interest, Edge detection, Grayscale and Threshold etc. The machine will read and track the water level using those methods. If the water level reaches the defined level, this device will produce an early warning of imminent floods by updating the water level timeline

Keyword: Hough Line Transform, Raspberry Pi, Grayscale, SIFT.

1.Introduction

Flood becomes one of the major problems in most of the countries around the world. Although we can forecast the rainfall or follow the storm path very precisely from the satellite images, it is important to have water level data tracked in real time to make a reasonable decision on the measures needed to prevent flooding. This strategy would assist in the efficient and timely implementation of urban flood relief and management. This data can also be used to assess floods taken in the past and to plan remedial measures in the future

1.1 General Background

The main objectives of our project is to develop a flash flood warning system to monitor the water level rise in rivers which are prone to severe flood, to predict the level of water in an area during flood at a particular time. Beginning in July 2018, severe floods affected our state, due to unusually high rainfall during the monsoon season, which is the main reason behind the implementation of this project. In such scenarios, a record of the flood levels at

different locations and at different times will be useful in order to take appropriate corrective action.

1.2 OBJECTIVE OF THE PROJECT

The main objectives of this project are:

1. To accurately monitor the increase in water level during the flood.
2. To predict the level of water in an area during flood at a particular time.

1.3 SCOPE OF THE PROJECT

This project can be used for flash flood warning. Flood monitoring system aims to

• Implementing an efficient flash flood warning system to predict the impact of flood.

LITERATURE SURVEY

Recently, many innovations are under development in the area of disaster management. There are many systems proposed to monitor the flash floods in the flood prone area. Most of the systems use participatory sensing techniques and is controlled remotely using the wireless sensor network that uses GPRS connectivity. The application server is a cloud-based system built using the web application PHP and JAVA as well as MySQL as its relational database.Real-time water state data can be remotely tracked using GPRS to use wireless sensor network. Users can view water condition in real-time, as well as water condition forecasting directly from the web via web browser or via WAP. On-site data collection cannot be applied for flood monitoring and field distribution monitor the water level in rivers and keeps updating the height of the water at regular intervals. Thus, it will predict the level of water rise in an area during flood at a particular time. If there's a chance of flood, the authorities will be informed by our-self and easier evacuation plans and rescue of the people can be made possible.

1.4 SCHEME OF THE PROJECT

The scheme of the project can be summarized as:

• Monitoring and analysing the water rise level in rivers.

satellite imagery methods which does not guarantee accurate results.

• JiraponSunkpho and ChaiwatOotamakorn, Real-time flood monitoring and warning system [1]

The developed system is composed of three major components: sensor network, processing unit, and application server. In order to relay measured data to the application server, called VirtualCOM, the real-time water state data networking. GPRS may be unstable, can cause difficulty in connecting the sensor at the remote site.

• Bhavana B Nair and Sethuraman N Rao,Flood Monitoring using Computer Vision"[2]

Estimate the water level in a flooded region using the human height as reference. Detection of human face and segmenting the human part in the image using deep learning algorithm. Human segmentation helps to find the pixel position of the water line. Classify each detected human face as male or female and

use average male/female height as the reference. Once the pixel positions of the human feet and the water line are known, they can be used to estimate the water depth. Use Computer Vision algorithms to estimate the depth of flooding based on images. Images are geotagged and time-stamped which will be easy to locate. This system cannot prevent the impact nor it doesn't send warning messages regarding the impact. This system is used after the impact of flood. Here only the depth of the water is estimated. Human face detection algorithm may fail with low resolution images.

• RamKumar Narayanan, VM Lekshmy, Sethuraman Rao, Kalyan Sasidhar,Urban Flood Monitoring Using Computer Vision"[3]

This paper presents a novel way of estimating flood level using participatory sensing and computer vision. GPRS and SMS were used to communicate data from remote stations to a datacenter server. The method involves the participants taking and transmitting photographs of concrete objects partially submerged, such as houses, lampposts etc. using their smart phones or other intelligent devices. The captured images are geo-tagged and uploaded to a server. The feature matching algorithm, SIFT finds the corresponding matching feature points between the captured and a reference image at the server. The flood line is then estimated and drawn against the reference image. Participatory sensing and computer vision to estimate the flood level. Yields immediate and considerably accurate results. Each and every observations of the flood levels at different locations and at different times is kept as a record. Here only the flood level is estimated and recorded for the future reference. It doesn't provide any warning system. Accuracy changes according to the resolution of images, as the images are taken in smart phone.

• Alvin E. Retamar, Felan Carlo C. Garcia, Jasmin Jane M. Yabut, Joven C. Javier, Development of a Remote Station for Real-time Monitoring ofUrbanFlooding" [4]

This paper presents the design and development of urban flood monitoring stations that use pressure sensor to determine flooding levels. GPRS and SMS were used to communicate data from the remote stations to a server located at a data centerA web-based visualization tool was created to allow real-time access to the data. Depending on tests, the sensor dimensions of actual values range from 0.872 cm to 3.067 cm. The larger variations tend to be associated with higher water levels whereas smaller differences.

with lower water levels have been observed. With further research, these differences can be used

as correction factors for accurate reading, mainly for R&D or modeling purposes, although these differences are small enough for issuing warnings to the public, especially when notifications are mostly based on factual definitions such as knee-deep or waist-deep flood levels.The flood conditions are tracked in real time, information and warnings can be issued to

the public. Participatory sensing and computer vision to estimate the flood level. Yields immediate and considerably accurate results. Image processing is currently under development. They use pressure sensor which may not last for long. GPRS may be unstable in low network coverage areas.

LITERATURE SURVEY				
Ref	Technology	Advantages	Disadvantages	Keywords
[1]	GPRS, VirtualCOM, WAP, Wireless Sensor	Real-time data, Wireless sensors network which enables GPRS communication	GPRS may be unstable, Networking coverage areacannot beimplemented	Sensors, Real-time monitoring, Flood control.
[2]	Sensors, GPRS	Water depth estimation, Geo-tagged images	Detection algorithm may fail, doesn't send warning messages	Computer Vision, Geotag.
[3]	Participatory sensing techniques	Estimate flood level, Immediate result, Observations are recorded	No warning system, No Accuracy	Computer vision, Feature matching, Flood monitoring, Participatory sensing.
[4]	GPRS, Web-based tool, Pres-	Sensing differences are small enough to issue warning	No accuracy, No reliability	Urban flooding,Flood monitoring, Image processing.

	sureSensor			

3 PROBLEM STATEMENT & PROBLEM SOLUTION

3.1 PROBLEM STATEMENT

Every year, the flood destroys lives and valuable resources throughout the world. The aim of the project is to develop a flash flood warning system to monitor the water level rise in rivers which are prone to severe flood. Since the existing systems are not much accurate.

3.2 PROBLEM SOLUTION

So with this system we can accurately predict the impact of flood and send warning/alert for evacuation. We used raspberry pi 3, HD webcam to monitor the water level. All the operations are carried out in raspberry pi 3.

MODULES

The main objective of our project is to develop a flash flood warning system to monitor thewaterlevelriseinriverswhicharepronetos evereflood.Herewedevelopalow-cost,low-power system using a Raspberry Pi camera to detect the rising water level. We employ image processing, edge detection and prediction method to detect the rising water level and predict the time ofimpact. InthehardwaresectionweuseRaspberry-Pi,whichhasmaintasksasanimageprocessor and do an update to the system. OpenCV library is used as Image Processing Software. Some method which we use in the project are Region of Interest, Edge detection, Grayscale and Threshold etc. By using these methods, the system can read and monitor the water level. Ifthe waterlevelexceedsthespecifiedlevel,thissys temwillgenerateanearlywarningofimpendin g floods by doing update timeline of water levelconditions.

IMAGEACQUISITION

Image processing is defined as the action of retrieving an image from some source, usually a hardware-based source for processing. It is the first step in the work flow sequence because, without an image, no processing is possible. The image that is acquired is completely unprocessed. Herethecapturedtime-variantimagesofrising/recedingwaterleveli nthestreamisproduced. The raspberry pi camera connected to a Raspberry Pi which takes real time video of the flowing river, which can be used for monitoring. The most crucial task for our work is being able to capture time-variant images of rising/receding water level in the stream. As our system is to be deployed in the wild, so we needed a portable image capturing unit.Therefore, we encased raspberry pi micro-computer and a camera into the watertight enclosure with its

battery supply. The raspberry pi camera connected to a Raspberry Pi which takes a time-lapse picture with an increment of one minute betweenimages.

IMAGEPREPROCESSING

Theaimofpreprocessingisanimprovementof theimagedatathatsuppressesunwilling distortions.Thisinclude Grayscale conversion of input image and ROI trimming. Gray scale color space codes information related to the intensity variation in the image. Through ROI, a portion of the frame which we want to filter or perform some other operations are obtained. A region of interest (ROI) is a subset of an image identified for a particular purpose. The ROI is defined by given boundaries on the image. We have the option of using a function select ROI that is natively part ofOpenCV.

EDGEDETECTION

For the purpose of the edge detection canny edge algorithm is chosen. The canny edge detector describes the isolation of the most dominant intensity differences in an image where strongly emphasized and thinned out edges will finally be delivered in the end of the process. Edge detection is done by using canny edge detection algorithm. Edges of any objects can be traced and present on a picture using canny edge detection algorithm

Canny Edge Detection

The Canny edge detector is an edge detection operator that uses a multi-stage algorithm todetectawiderangeofedgesinimages. Cannyedgedetectionisatechniquetoextractu seful structuralinformationfromdifferentvisionob jectsanddramaticallyreducetheamountofdat a to be processed. It has been widely applied in various computer vision systems. Canny has found that the requirements for the application of edge detection on diverse vision systems are relatively similar. Thus, an edge detection solution to address these requirements can be implemented in a wide range of situations. The general criteria for edge detectioninclude:

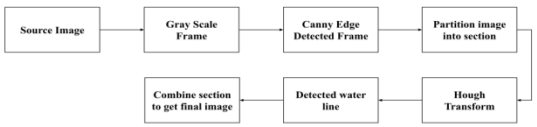
1.Detection of edge with low error rate, which means that the detection should accurately catch as many edges shown in the image aspossible

2.Theedgepointdetectedfromtheoperatorsh ouldaccuratelylocalizeonthecentreofthe edge.

3.A given edge in the image should only be marked once, and where possible, image noise should not create false edges.

HOUGH LINETRANSFORM

The Hough Line Transform can be used in image processing to detect any shape and can be represented in mathematical form. Lines can be detected using Hough line Transform. For this purpose, we need the edge detected frame. Hough Transform is a popular technique to detect any shape, if



you can represent that shape in mathematical form. It can detect the shape even if it is broken or distorted a little bit. We will see how it works for a line. In the hough transform, even for a line with two arguments, it takes a lot of computation. Probabilistic Hough Transform is an optimization of Hough Transform. It doesn't take all the points into consideration, instead take only a random subset of points and that is sufficient for line detection. Just we have to decrease thethreshold. OpenCV implementation is based on Robust Detection of Lines using the Progressive ProbabilisticHoughTransform;Thefunction usediscv2.HoughLinesP().Ithastwonewarg uments: **minLineLength**- Minimum length of line. Line segments shorter than this are rejected. **maxLine Gap**- Maximum allowed gap between line segments to treat them as singleline.

Fig. Hough Line process

HEIGHTESTIMATION &PREDICTION

Height of the water level can be analyzed using the Hough Line Transform. Linear Regression is a machine learning algorithm based on supervised learning. It performs the task to predict a dependent variable value (y) based on a given independent variable (x). So, this regression technique finds out a linear relationship between x (input) and y(output), ie, wecan plot a graph on the basis of the input andoutput.

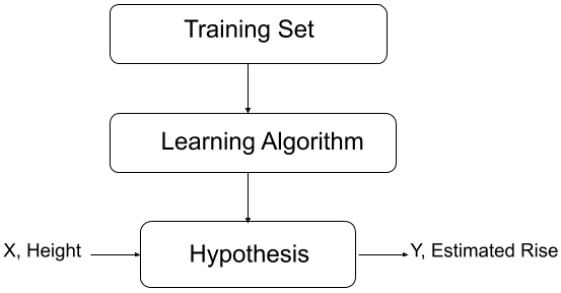


Fig. Height estimation

Insimplelinearregression,wepredictscoreso nonevariablefromthescoresonasecond variable. The variable we are predicting is called the criterion variable and is referred to as Y. Thevariablewearebasingourpredictionsonis calledthepredictorvariableandisreferredtoas X.Whenthereisonlyonepredictorvariable,th epredictionmethodiscalledsimpleregression . Linear regression consists of finding the best-fitting straight line through the points. The best- fitting line is called a regression line. Using regression to make predictions doesn't necessarily involve predicting the future. Instead, you predict the mean of the dependent variable given specificvaluesofthedependentvariable(s).F orourexample,welluseoneindependentvaria ble to predict the dependentvariable.

CONCLUSION & SCOPE OF FUTURE WORKS

Here we describe the project flood level monitoring and early warning system via computer vision techniques. These are basically implemented under Python with the use of the OpenCV Computer Vision Library. As already mentioned, the entire application is primarily running on a raspberry pi 3 single chip-card computer. Though the setup was prototypical, we can

lay a foundation for future expansion into this work. Therefore, the developed approach is very flexible in terms of adaptations and can be used under real world conditions. Thus, an efficient and also cheap solution to a real time Flood monitoring and early warning system could be provided with plenty of potential for further improvements and optimization on the system side. These experiments were performed at the same camera distance and ambient weather condition. The effect of distance can be added in the next modification. As a future modification one could integrate the camera into an Unmanned Aerial Vehicle platform so that it can be used to analyze real time flood level by moving over water and into remote areas, which is a more complex extension. Also, the predicted impact information and the height details can be made available for the public through a small ios/android app.

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