Flood Monitoring by integration of Remote Sensing Technique And Multi-Criteria Decision Making Method.

Moksh Mehan, Khushi Wadhwa

Dept of computer science and Engineering
Chandigarh University
itzmemoksh2002@gmail.com
wadhwakhushi715@gmail.com
Mohali, Kharar punjab(India)
140413

Abstract

It takes a lot of time and work to monitor floods using traditional methods, especially for large areas. They frequently are unable to adequately cover entire districts. Since remote sensing (RS) is affordable and provides a wide perspective, it has gained popularity as a means of addressing these problems. Determining which regions of the light spectrum are most useful for detecting environmental changes is one of the difficulties in remote sensing, though. In this work, we employed the Elimination and Choice Expressing Reality (ELECTRE) decision-making technique to identify the most promising light spectrum regions in Sentinel-2 satellite images for identifying flood-affected areas. Using this process, we arrived at decisions based on six criteria and ten options. Ten distinct bands are visible in the Sentinel-2 satellite images.Our criteria included things like image quality and resolution, and the images were of various levels of detail (think of it as different slices of the light spectrum). We utilised MATLAB to create a programme that applies the ELECTRE method to these images. Using this technique, the top six bands from the ten are selected. Then, we divided areas with water before and after a flood using a classification technique called Support Vector Machine (SVM), which is a type of machine learning. Our outcomes were quite favourable. Our results show that we were able to classify areas before the flood with an accuracy of 93.65% and a Kappa Coefficient of 0.923, and after the flood with an accuracy of 94.52% and a Kappa Coefficient of 0.935. Our approach with the chosen bands proved to be more accurate when we contrasted our findings with those obtained with all of the original bands.

Key Words:
Flood monitoring , Remote Sensing (RS) Sentinel-2 satellite images , Multi-Criteria Decision Making (MCDM) , ELECTRE technique , Spectral bands , Decision making method , Support Vector Machine (SVM) , Machine Learning (ML) , Accuracy , Water classification , Image quality , Spatial resolution , Overall Accuracy (OA) , Kappa Coefficient (KC)

I. Introduction

Floods are natural disasters, and the effects they have depend on a number of variables, including the quantity and timing of rainfall, the local geology, the soil's capacity to hold water, and the topography. Due to factors like urbanisation, construction along rivers, and shifting weather patterns, there have been more destructive disasters in recent years (Alderman et al., 2012; Bond et al., 2008; Charron et al., 2004; Kondo et al., 2002; Lake, 2003; Li et al., 2012; Sun et al., 2012; Psomiadis et al., 2019, 2020). The agricultural sector is particularly vulnerable because floods frequently cover crops (Rahman et al., 2019). Due to floods' damage Large tracts of farmland in level areas have made it difficult to monitor floods in these areas (Rahman et al., 2017; Sanyal et al., 2004). Monitoring floods, mapping prone areas, and assessing the extent of damage to homes, farms, and other assets are critical tasks. Numerous scholars (including Amarnath, Chowdhury, Zoka, and others) have discussed this in their studies. Using remote sensing (RS) is one method people are using to do this. It is said to be extremely effective at monitoring and mapping floods. They accomplish this using tools like satellite images, which are an excellent source of information about locations on Earth. The cool

thing about satellite images is that they cover a lot of ground, saving time and allowing you to avoid travelling to every location. So, when we want to study how things change during natural disasters like floods, using these images is crucial. Additionally, the knowledge we gain from these images is useful for planning and safeguarding water resources, particularly when managing flood events by monitoring them, assessing their severity, and providing assistance to those in need. In summary, applying RS techniques to these satellite images is a very helpful way to identify and track floods and all the havoc they cause.
Remote sensing (RS) technologies have made significant strides in the last few decades in terms of monitoring natural disasters like floods and earthquakes as well as determining natural resources and landslides.Active (Radar) and passive (Optical) sensors are the two broad categories under which RS technology used in hydrology studies can be divided. Moderate to high spatial resolution and reliable data with a high temporal resolution are features of optical RS sensors. The Moderate Resolution Imaging Spectroradiometer (MODIS), the Landsat series, and the Sentinel-2 satellite are a few well-known sensors in this group. Particularly for the analysis of natural resources like surface water, optical RS has proven to be a useful information source. Furthermore, numerous studies have combined RS with Geographic Information System (GIS) methods for a variety of water resource management applications, including determining flood vulnerability and managing floods, tracking changes in water resource levels in coastal regions, and monitoring water quality in various bodies of water..

2. LITERATURE REVIEW

Panchal looked into how to categorise flood levels using smartphone sensor data from gait analysis [1]. Based on extensive research, Miau [2] examined anomaly detection and flood forecasting. Results from tide gauge, GPS, and SAR observations by Tang [3]. Akhtar looked into a Hierarchical Colour Petri-Net Based Multi-Agent System for Flood Monitoring, Prediction, and Rescue (FMPR) [4]. [5] looked at IoT Enabled Flood Severity Prediction through Ensemble Machine Learning Model. Du conducted research on "Satellite Flood Inundation Assessment and Forecast Using SMAP and Landsat" [6]. Lessons from Field Experiments for the Citizens' Campaign for Environmental Water Monitoring, according to Assumpcao [7]. Research on the potential for water discharge during the hydroelectric power generation process was done by Liu [8].Chen [10] investigated CRML: Convolutional Regression Model with Machine Learning for Hydrological Forecasting, whereas Wakabayashi [9] investigated CRML: Convolutional Regression Model with Machine Learning for Hydrological Forecasting.Zhu conducted research on flood prediction using rainfall flow patterns in watersheds [11]. Hashemi-Beni conducted research on Flood Area Mapping: An Integrated Method Using Deep Learning and Regional Development Using UAV Optical Data [12]. A remotely controlled syphon system to drain water from wetlands and small ponds was investigated by Qin [13]. Using interannual time series satellite imagery, Milani [14] investigated the characterization of flood impacts on the Swiss Flood Plain. Research by Pourghasemi [15]. Ebi's study [16] on Synchronous LoRa Mesh Networks for Monitoring Underground Infrastructure Processes. The SMAP Case Study, conducted by Forgotson, describes how satellite measurements of soil moisture can be used to monitor the effects of climate change [17]. According to Sentinel-1 and Sentinel-2 Images, Tropical Cyclone Idai caused the Mozambique Flood in 2019. researched by Guo [18]. In the US West, Fleming [19] researched a machine learning metasystem based on strong probabilistic regression for forecasting seasonal water availability. based on Wu's research into deep learning [20]. The Pekanbaru City Public Works and Spatial Planning Office still lacks an automated system for identifying vulnerable points in flood-prone areas. You can be sure that Kulim Street, Tampan Village floods as well as causes economic losses that lead to damage to houses and the contents of objects in the house as well as the loss of other valuables because, as we've seen, floods on Jalan Kulim, Tampan Village can occur twice a year with a flood intensity of 2 metres, where the tributary of the Siak River on Jalan Kulim, Tampan Village reaches a height of 2.5 metres. Health issues are also a result of floods. The authors came up with a solution to this issue for Pekanbaru's Public Works and Spatial Planning Office City in building a flood detection system in flood-prone areas. The authors employed a GSM SIM 900A tool to communicate with the parties involved about the water's condition. 2. The community can reduce losses by using this tool because it will periodically inform users of the height of the tributaries on Jalan Kulim in Tampan Village, allowing them to evacuate and save what they can.

3. Component Required For Implementing The Flood Detection System.

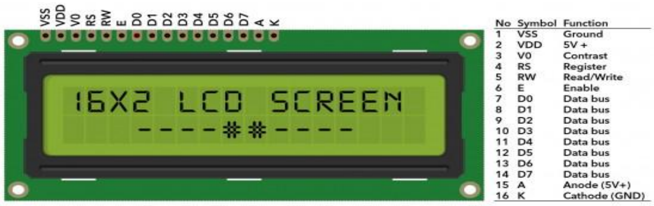
1. Arduino UNO

Electronics research is developed using the open-source platform Arduino. It is easily programmable, erasable, and reprogrammable at any point in time. Market-available Arduino boards include the Arduino UNO, Arduino Nano, Arduino Mega, Arduino Lilypad, and others with various features depending on their intended use. Typically, a micro-USB cable is used to programme this board using the Arduino IDE programme. It is simpler to upload the code without the aid of external hardware because the ATmega328 comes with a preprogrammed onboard boot loader. It is widely used when creating electronics-related projects or products.. The

C and C++ languages are used to program the board, which is very easy to learn and use.

2. Ultrasonic Sensor HC-SR04.
The HC-SR04 is an ultrasonic sensor that aids in measuring distances without the need for human contact in numerous locations. It offers a reliable method of measuring distances very precisely and operates on the same principles as radar and SONAR. In practise, it can measure distances from 2 cm to 80 cm with a 3 mm accuracy, though theoretically it can measure distances up to 450 cm. It is run at 5 volts, at a frequency of 40 Hz, with a current of less than 15 mA. One transmitter and one receiver are installed on the HC-SR04. The basic speed, distance, and time formula that we all learned in school, Distance = Speed x Time, is used to calculate the distance. The receiver of the sensor picks up the reflected wave in the air if it is reflected by an object within the sensor's field of view. Therefore, we need to know the speed and the time in order to calculate the distance using the formula above. We are aware that the ultrasonic wave travels at a speed of approximately 330 m/s. The circuit installed on the microcontroller measures the passage of time. For the duration that the ultrasonic wave takes to return to the receiver, the echo pin goes high. By doing so, we can determine how far away the object is from the HC-SR04 ultrasonic sensor.

3. A 162 LCD screen.
It's not difficult to connect an Arduino UNO to a 16 x 2 LCD. There are many different kinds of LCDs on the market, but the one we're using for this project is a 162 type, which has two rows and can display 16 characters in each row. This module includes a Hitachi HD44780 driver that facilitates interaction and communication with the microcontrollers. Both 4-bit and 8-bit modes are supported by this LCD. For a connection to be made between the LCD and the microcontroller in 4-bit mode, only four data pins are needed, whereas eight pins are needed in 8-bit mode. Let’s look at the pin description of the 162 LCD [36].



4. Conclusions

The "Flood Monitoring by Integration of Remote Sensing Technique and Multi-Criteria Decision Making Method" project represents a thorough approach to flood monitoring and management. To address the complex problem of flood management, remote sensing technology and multi-criteria decision-making methods can be combined. Finally, the project has several important lessons to be learned:

1. Enhanced Flood Monitoring: Accurate, real-time monitoring of flood-prone areas is possible through the use of remote sensing techniques, such as satellite imagery and GIS data. As a result, preparedness plans and early warning systems are more effective.

2. Data-Driven Decision Making: To analyse and interpret sizable datasets, the project makes use of multi-criteria decision-making techniques. By taking into account various factors, such as environmental, social, and economic aspects, when forming flood management strategies, this promotes the use of informed decision-making.

3. Risk reduction: The project helps to lower flood risks and vulnerabilities by integrating remote sensing and decision-

making. The ability to better allocate resources and identify high-risk areas can increase disaster resilience.

4. Effective Resource Allocation: The project aids in the more effective resource allocation and deployment of response teams. This is crucial for reducing flood damage and ensuring prompt and efficient disaster relief efforts.

5. Community Involvement: Including local communities in the project's decision-making process fosters a sense of ownership and improves the chances that efforts to manage and mitigate flooding will be successful.

6. Scalability and Adaptability: The techniques and methods used in this project are scalable and adaptable to various geographic regions and types of disasters, making it a valuable tool for a variety of disaster management applications.

7. The project should be viewed as an ongoing effort to improve. It will need to be updated frequently, incorporate new technologies, and have its decision-making models improved in order to remain useful and efficient.

ACKNOWLEDGMENT

The heading of the Acknowledgment section and the References section must not be numbered.

Causal Productions wishes to acknowledge Michael Shell and other contributors for developing and maintaining the IEEE LaTeX style files which have been used in the preparation of this template. To see the list of contributors, please refer to the top of file IEEETran.cls in the IEEE LaTeX distribution.

REFERENCES

[1] S. M. Metev and V. P. Veiko, *Laser Assisted Microtechnology*, 2nd ed., R. M. Osgood, Jr., Ed. Berlin, Germany: Springer-Verlag, 1998.

[2] J. Breckling, Ed., *The Analysis of Directional Time Series: Applications to Wind Speed and Direction*, ser. Lecture Notes in Statistics. Berlin, Germany: Springer, 1989, vol. 61.

[3] S. Zhang, C. Zhu, J. K. O. Sin, and P. K. T. Mok, “A novel ultrathin elevated channel low-temperature poly-Si TFT,” *IEEE Electron Device Lett.*, vol. 20, pp. 569–571, Nov. 1999.

[4] M. Wegmuller, J. P. von der Weid, P. Oberson, and N. Gisin, “High resolution fiber distributed measurements with coherent OFDR,” in *Proc. ECOC’00*, 2000, paper 11.3.4, p. 109.

[5] R. E. Sorace, V. S. Reinhardt, and S. A. Vaughn, “High-speed digital-to-RF converter,” U.S. Patent 5 668 842, Sept. 16, 1997.

[6] (2002) The IEEE website. [Online]. Available: http://www.ieee.org/

[7] M. Shell. (2002) IEEEtran homepage on CTAN. [Online]. Available: http://www.ctan.org/tex-archive/macros/latex/contrib/supported/IEEEtran/

[8] *FLEXChip Signal Processor (MC68175/D)*, Motorola, 1996.

[9] “PDCA12-70 data sheet,” Opto Speed SA, Mezzovico, Switzerland.

[10] A. Karnik, “Performance of TCP congestion control with rate feedback: TCP/ABR and rate adaptive TCP/IP,” M. Eng. thesis, Indian Institute of Science, Bangalore, India, Jan. 1999.

[11] J. Padhye, V. Firoiu, and D. Towsley, “A stochastic model of TCP Reno congestion avoidance and control,” Univ. of Massachusetts, Amherst, MA, CMPSCI Tech. Rep. 99-02, 1999.

[12] *Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specification*, IEEE Std. 802.11, 1997.