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A Study on Landslide Detection Methods for Reducing Casualties

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Abstract: ***Landslides are one of the major disasters that frequently happen every year. Due to its occurrence,massive loss of lives arises. Recently Kerala was affected by this endangered disaster which happened at the hill tops of Kottayam district in Kerala. Landslides are nothing but the movement of mass of rock,debris down a slope. Mostly landslides are due to natural and man-made activities.***
We are available with different methodsto tackle this situation. Landslide early warning systems are one of the best ways to save individuals' lives.
This work deals with different methods to detect landslides such as IoT based alerting system, predictions using machine learning and deep learning, with the help of ZigBee networks and using fuzzy logic methods etc . This way we can detect whether there is a chance for a landslide occurrence.
Index Terms: Landslide, Machine Learning, Raspberry Pi

I. INTRODUCTION

Landslides are perhaps the most risky and disastrous regular perils that make huge harm to financial articles and human existence. The development pace of landslides fluctuates from the sluggish development of material in millimeters/centimeters range each year to an unexpected torrential slide of a huge amount of debris.
There are numerous instancesof the negative signs of landslides in different districts ofIndia. India has seen ruinous landslides in the last few years. Monitoring and advance notice framework is one of the arrangements that can forestall and limit misfortunes brought about via landslides. By using a landslide detecting system we can screen soil dampness, precipitation and other parametersin an area and according to it we can alert people and can relocate them to safer zones. Buzzer in the device will alert the people to move to safer zones before a landslide.

II. LITERATURE SURVEY

A. Edge assisted Reliable Landslide Early Warning System

In this research work Amrita Joshi et al. (2019) [1] has presented methods to monitor landslide occurrence in south- east Asian regions.
In many regions of the planet, including south-east Asia, landslides happen often. While some IoT innovations existfor landslide observing, a dependable and proficient early admonition framework remains slippery. It is possible to lose correspondence between IoT hubs and the cloud because of different kinds of disturbances in precipitous districts. In actuality, situations, this can influence decision making in the cloud. Consequently, the IoT framework should not bomb for any reason. An answer in view of edge figuring is given in thispaper to take care of the issue. As IoT applications become increasingly more deferral touchy, edge registering has arisen as a suitable answer for diminishing inertness. Also, it can possibly make an IoT application more dependable since the edge server can keep the framework running assuming the cloud goes down or a correspondence breakdown happens between the IoT and cloud hubs. This paper tells the bestway to execute solid information handling so that regardless of whether the association between the source/facilitator hub and the cloud server is lost, the information can in any case behandled and input received. In the execution stage, the edge server has restricted registering and stockpiling assets, how- ever adequate to process and dissect avalanche information, forexample, precipitation, pore tension, dampness, and relocation.The outcome is like that created from distributed computing. Indeed, even in case of an organization's disappointment between edge server and cloud server, or a cloud server crash, the framework will keep on running.

B. Design of Landslide Early Warning System Using Fuzzy Method Based on Android

In this research work Putri Fatimah et al. (2020) [2] has presented methods to monitor landslide occurrence in Indone- sia.
A landslide is among the numerous catastrophic events that frequently happen in Indonesia during the blustery season,especially in uneven regions, precipices, and slopes where misfortunes are extraordinary. Along these lines, an early avalanche recognition framework is essential. There are three primary factors that add to landslides : incline, vibration, and soil dampness. To quantify these boundaries, an Internetof Things (IoT) framework is utilized. It associates different sensors to the framework. In this review, the fluffy qualities were produced by estimating the MPU6050 Accelerometer and Gyroscope sensor, as well as the dirt dampness sensor, and shipped off an Antares server utilizing LoRa. Fuzzy calcula- tions are utilized for examining sensor discovery information and giving a bunch of three official choice principles in lightof master information on landslides , for example, Safe, Alert and Watch out, which are shown on an android gadget with a precision of 90 percentage and a 10 percentage blunder rate.

TABLE I
SLOPE CLASSIFICATION

Levels	*Character*	*Slope Class (%)*
Level 1	Flat	0-2%
Level 2	Rather Ramps	2-7%
Level 3	Ramps	7-15%
Level 4	Rather Steep	15-30%
Level 5	Steep	30-70%
Level 6	Very Steep	70-140%
Level 7	Ramped	greater than 140%

TABLE II SOIL CONDITION

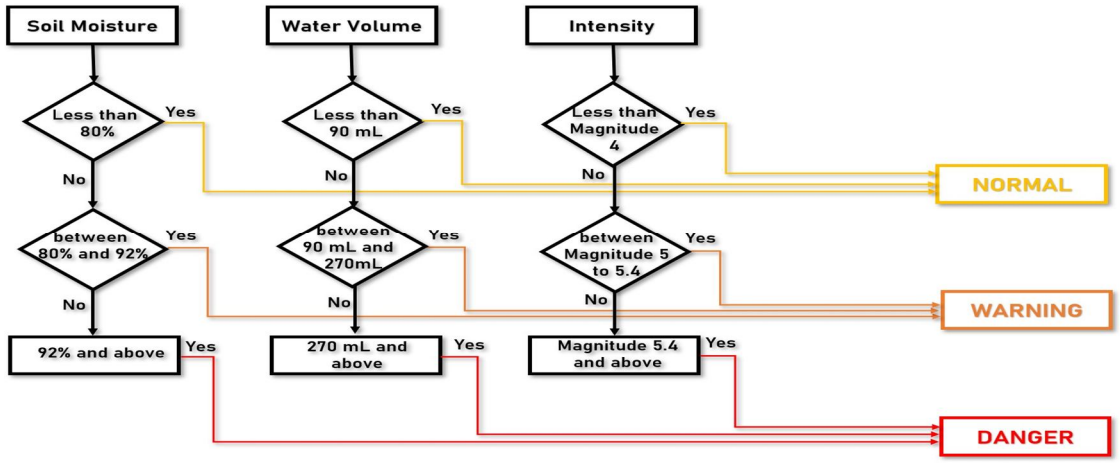
Levels	*Character*	*Saturation Degree (%)*
Level 1	Dry	0%
Level 2	Rather Moist	0-25%
Level 3	Moist	26-50%
Level 4	Very Moist	51-75%
Level 5	Wet	76-99%
Level 6	Saturated	100%

TABLE III VIBRATION CLASSIFICATION

Levels	*Vibration Class*	*Acceleration (g)*
Level 1	Micro	Less than 0.0017
Level 2	Weak	0.0017-0.0014
Level 3	Light	0.0014-0.039
Level 4	Moderate	0.039-0.092
Level 5	Strong	0.092-0.18
Level 6	Very Strong	0.18-0.34
Level 7	Severe	0.34-0.65
Level 8	Violent	0.65-1.24
Level 9	Extreme	Greater than 1.24

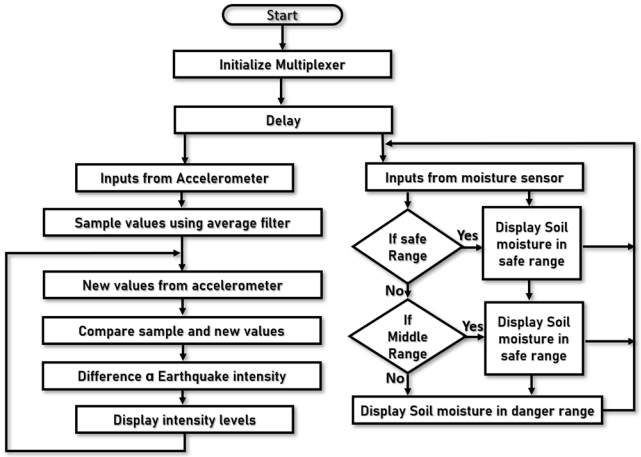
C. Mobile App-Based Early Warning System for Landslides Using Land Monitoring Through GSM

In this research work Marianne M. Sejera et al. (2020) [3] has presented methods to monitor landslide occurrence in the Philippines. In particular, this study centers around the advancement of alandslide early admonition framework to send notices through SMS by means of a GSM module with a versatile application with signs of Normal, Warning, and Danger. A few natural variables, like precipitation and seismic tremors, can set off landslides, which are perhaps the most well-known fiascosin the Philippines. An early admonition framework will be useful in recognizing a forthcoming calamity, yet additionally in advancing fiasco mindfulness and arrangement. The early admonition framework utilized sensors that had the option to distinguish natural circumstances that could set off avalanches.Arduino Nano examines the sensor information obtained by the sensors.



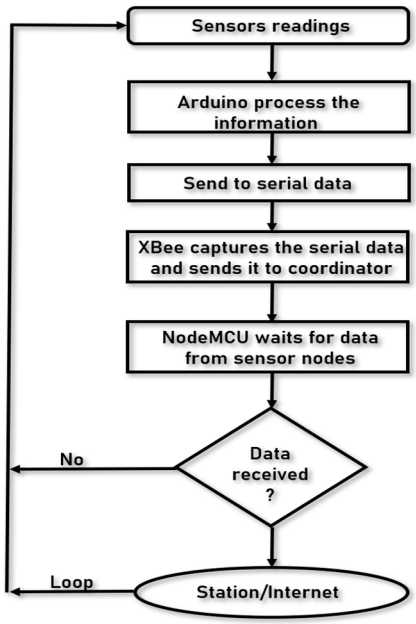
D. IoT Based Landslide Detection and Monitoring

In this research work Rathod Hardik et al.(2019) [4] haspresented methods to monitor landslide occurrence in kerala.Every year, landslides cause huge social harm. It very well may be characterized as the development of mass of rocks andtrash down an incline. This can happen normally or broughtabout by human action. It was observed that Asia had 75% oflandslides, a landmass with the largest number of landslides.The storm last year in Kerala prompted avalanches that killed many individuals in India. In the proposed framework, the principal objective is to identify specific circumstances that could prompt the event of avalanches and to inform them a long time before time to restrict, and conceivably save, human misfortunes. An accelerometer and soil dampness sen- sor are utilized in the framework. An accelerometer estimates movement of land while a dampness sensor demonstrates the dampness content of the dirt. At the point when the sensor's perusing passes a boundary, the residents get an alarm. MQTTis likewise used to send detected information to the Raspberry Pi (Rpi) that is utilized in the control room. A PC is utilizedto show the SAFE, MIDDLE, and DANGER zones. What's more, all readings from Rpi are shipped off the cloud with the goal that they can be dissected and the salvage group can be cautioned assuming the readings are in the MIDDLE and DANGER zones. It takes 10 ms for information to be gatheredfrom the sensor and communicated to the Rpi over MQTT. Likewise, it takes 20 extra ms for information to be transferredfrom the raspberry pi to the ThingSpeak cloud.



E. Integrated Earthquake and Landslide Monitoring Over Wireless Sensor Network

In this research work RomeshLaishram et al.(2019) [5] has presented methods to monitor landslide occurrence in hilly regions.
Landslides are catastrophic events that can cause huge pulverization of life and property in the impacted region. Certain locales are inclined to such occasions and upper east India incorporating Manipur is situated in Zone-V (extremely serious power seismic tremor zone). In Manipur, Landslides happen often during storms in bumpy regions in the state. Studies have reasoned that landslides in Manipur are for the most part man-made disaster due to the street extending and urbanization likewise increase the potential for Landslides.WSN can be successfully applied to huge geological regions and find its application detached spaces like contamination or air pollution checking systems,habitat checking regions, fire discovery frameworks,atomic reactor regulators, objectfollowing, and so on.



It requires an incorporated remote framework, for example, WSN that is an early warning and ready to distinguish early signs of regular calamities like avalanches and landslides and furthermore screen the huge scope of natural circumstances. Remote Sensor Network (WSN) gathers the data from the climate to gauge the rate of biological, thermal, mechanical, synthetic, optical or attractive and communicate data gathered from sensor hub to a sink hub or organization facilitator the data might be shipped off an observing station for additional handling. In this paper, we proposed a coordinated quake and landslide checking framework utilizing a remote sensor organization as a spine. The upside of a coordinated frameworkis that rather than various checking stations just a single observing station can be utilized for social occasion data aboutboth kinds of debacles. The proposed framework is being triedin Imphal, Manipur, India.

F. IoT Based Landslide Detection Prevention System

In this research work Jadhav Kanchan eknath et al.(2018)
[6] has presented methods to monitor landslide occurrence in hilly regions.
Landslides, otherwise called landslips, are geographical pe- culiarities connected with development of ground. Landslides should be observed to anticipate their way of behaving and recognize storms that might cause huge quantities of them. Along these lines, various lives can be saved and propertycan be safeguarded, as individuals know about peril slidesand can go to fitting wellbeing lengths. In this undertaking, the data about avalanches is refreshed on the web utilizingthe organization of IOT. Landslides can be distinguished by dampness and vibration sensors as a basic worth will be set for the sensors, and assuming that worth surpasses that basic worth, individuals will be cautioned of the looming avalanche and weighty misfortune can be stayed away from. The Raspberry Pi (SOC) utilizes an MQTT convention to takethe data and update the website page. This telemetry project illuminates the inhabitants about the forthcoming calamity andworks with a more compelling reaction.

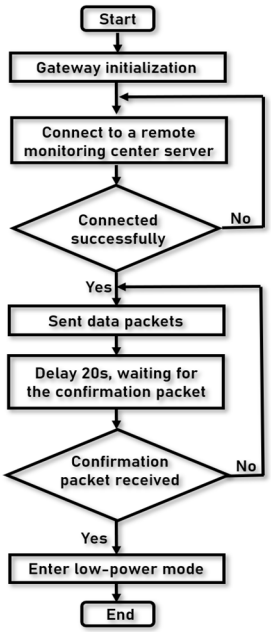
G. Smart Autonomous Self Powered Wireless Sensor Networksbased Low-cost Landslide Detection System

In this research work S. Karthik et al.(2015) [7] has presented methods to monitor landslide occurrence in south-east Asian regions. Most nations all over the planet experience landslides, which are among the most risky geologic dangers. All through the world, landslides cause a huge number of deaths and injuries every year as well as tremendous monetary misfortunes. Ordinarily, landslides occur inside a short measure of time and are eccentric. It is fundamental to create and involve compelling innovations in geographically unsafe regions with minimal expense to save human existence and keep away from misfortunes. Remote sensor organizations (WSNs) assume a pivotal part in ecological checking frameworks. In this paper, a minimal expense independent remote sensor network is utilized in the turn of events and execution of a landslide recognition framework that is coordinated with a self-energy collecting framework (WSN-SEH). WSN-SEH is made out of MEMS sensors, energy collecting frameworks, low power installed regulators, productive power the executives frame- works, as well as super capacitors.

H. Intelligent Early-warning System for Landslides Based on the ZigBee Network

In this research work Jian Xu et al.(2013) [8] has presented methods to monitor landslide occurrence in hilly regions.

A framework for landslides advance notice is proposed in this paper in light of the ZigBee organization. Cortex- M3 engineering of the chip is utilized as the installed center control processor to further develop framework coordination and information handling administrations. The ZigBee re- mote sensor network is worked with CC2530 equipment, and afterward GPRS is utilized as the innovation to sendinformation from a distance. Test results show the framework functions as planned. The gadget is adaptable and versatile, and can avoid conventional strategies for checking, which are low-productive and exorbitant. It can forestall antagonistictopographical circumstances under mountains by observingand forestalling landslides.



I. Research on Application of Temporal GIS Technology in Monitoring Landslide Hazard

In this research work Yinyin Chao et al.(2011) [9] has pre- sented methods based on GIS technology to monitor landslide occurrence in hilly regions.

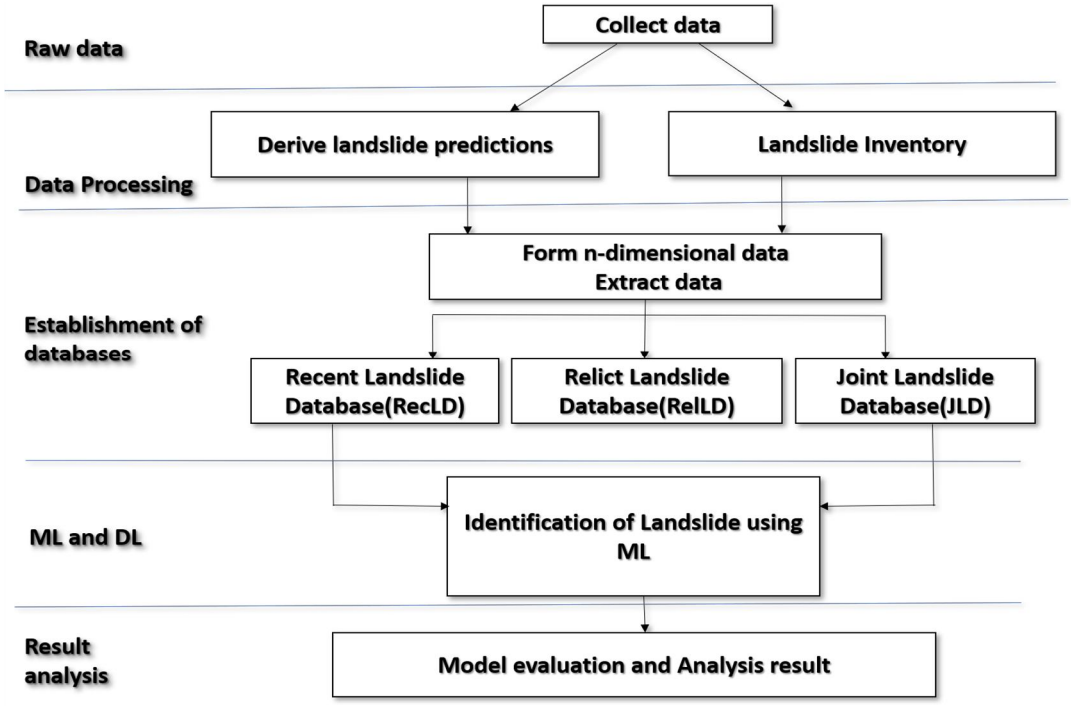
The key to geophysical disaster early detection and preven- tion is the long-term monitoring of regional geophysical dis- asters. For the most concurrent geological disaster (landslide) based on temporal GIS technology, WSN(Wireless Sensor Networks) were designed for acquiring real-time region-based geological data regarding the landslides from the monitoring areas coupled with unattended monitoring stations. Based on the geological disaster warning model systems and systemplatform designed by ArcGIS Server to analyze and process GIS data with time properties, to predict the chance of alandslide occurrence in the near future. By using WebGIS to publish, and to form a complete GIS based warning system platform for landslides.

J. Landslide-Hazard Mapping Using an Expert System and a GIS

In this research work Kavitha Muthu et al.(2007) [10] has presented GIS methods to monitor landslide occurrence in hilly regions. In this paper, we depict how to make landslide advance notice and ready guides utilizing a standard-based master framework that utilizes Earth perception information as wellas geographical, precipitation, and quake information to make maps. Rather than different frameworks, this framework uti- lizes changing information. An aggregate of sixteen archived landslides were utilized to test the model. The model canrecognize 11 of the 16 landslides as being among the 10% most in danger, covering a 100 km2 region.

K. Landslide identification using machine learning

In this research work Haojie Wang et al.(2021) [11] has presented machine learning and deep-learning methods to identify landslides. Landslides assume a significant part in normal disas- ters.This paper sums up the strategy to distinguish landslides, for example, AI and profound picking up utilizing coordi- nated geodatabases . At first the geographical data,geological information and the precipitation sum are consolidated and shapes a coordinated geodatabases like Recent Landslide database(RecLD), Relict Landslide Database (RelLD) and Joint Landslide Database (JLD).However, by utilizing Logis- tic regression,support vector machine,random woods, helping strategies and convolutional brain network we can assess every data set. A contextual investigation in Lantau, Hong Kong, is directed to exhibit the use of the proposed technique. From the consequences of the contextual analysis, CNN ac- complishes an ID exactness of 92.5% on RecLD, and beats different calculations because of its assets in include extractionand multi-faceted information handling. Supporting techniquescome next concerning precision, trailed by RF, LR and SVM. By utilizing AI and profound learning procedures, the pro- posed landslide ID strategy shows extraordinary heartiness andincredible potential in handling the landslide's recognizable proof issue.



L. Multi-Regional landslide detection using combined unsu- pervised and supervised machine learning

In this research work Giorgio Santinelli et al.(2021) [12] has presented machine learning methods to detect landslides in multiple regions.

Landslides make dangerous living organic entities and the environment.Natural habibat and the biological system at that specific locale should be impacted. Presently,there are numer- ous innovations created for the identification of landslides; however, this has poor geological degrees. So they are wastefulwhen applied to various geological locales.

To handle this situation,this paper works on Object Based Image Analysis philosophy based on unaided and directed Machine figuring out how to learn the locales where avalanches happen in numerous areas across the world. There are two sorts of used information, for example, Sentinel-2 multi-ghastly satellite symbolism and ALOS Digital Elevation Model. Utilizing K- implies bunching, the pre and post avalanche pictures go through division in the division stage. Following the division stage and dataset arrangement and eliminating profoundly related highlights from the dataset,two Random Forest clas- sifiers (RF1 And RF2) are prepared and tried on two different datasets to quantify the speculation level of the calculations with RF1 dataset traversing over additional topographical varieties than RF2 dataset.The results demonstrate the way that the Random Forest models can effectively distinguishavalanche sections with test accuracy ¼ 0.96 review ¼ forRF1 and test accuracy ¼ 0.90 and review 0.87 for RF2.By looking at RF1 and RF2,RF1 results in less mislabelled nn- landslide portions.

M. Landslide detection in the Himalayas using machine Learning algorithms and U-Net

In this research work Sansar Raj Meena et al.(2021) [13] haspresented machine learning algorithms and U-Net to monitor landslide occurrence in himalayas.

Occasion-based landslide inventories are fundamental sources to expand how we might interpret the causal con- nection between setting off occasions and the happening of landslides. Landslide inventories are made in light of manual translation, and there can be massive contrasts in the planning inclinations among mediators. To resolve this issue, we utilized two different datasets to investigate the capability of U-Net and AI approaches for mechanized avalanche location in the Himalayas. Dataset-1 is made out of five optical groups from the RapidEye satellite symbolism. Dataset-2 is madeout of the RapidEye optical information, and ALOS-PALSAR determines geological information. We utilized a little dataset comprising of 239 examples obtained from a few preparation zones and one testing zone to assess our models' exhibition utilizing the completely convolutional U-Net model, Support Vector Machines (SVM), K-Nearest Neighbor, and the Ran- dom Forest (RF). We made 32 distinct guides to assess and comprehend the ramifications of various example fix sizes andtheir impact on the precision of avalanche identification inthe review region. The outcomes were then looked at against the physically deciphered stock order utilizing hands-on work and visual understanding of the RapidEye satellite picture.We utilized exactness appraisal measurements, for example, F1-score, Precision, Recall, and Matthews Correlation Coeffi- cient (MCC). With regards to the Nepali Himalayas, utilizing RapidEye pictures and AI models, a practical fix size was researched. The U-Net model prepared with a 128×128 pixel fix size yields the best MCC results (76.59%) with the dataset-1. The additional data from the advanced height model helped the general identification of avalanches. Nonetheless, it doesn'twork on the model's general exactness; however, it separates human settlement regions and waterway shoals. In this review,the U-Net accomplished somewhat improved outcomes than other AI draws near. In spite of the fact that it can rely upon the engineering of the U-Net model and the intricacy of the geological elements in the symbolism, the U-Net model is as yet a starter in the area of avalanche discovery. There is next tono writing accessible connected with the utilization of U-Net for avalanche identification. This study is perhaps the earliest exertion involving U-Net for avalanche identification in the Himalayas. By and by, U-Net can possibly further develop additional robotized avalanche locations in store for fluctuatinggeological and geomorphological scenes.

III. CONCLUSION

Never-ending occurrence of landslides is extremely riskyto all living sorts in our environment.However there is a requirement for effective advance notice framework and by themanner in which it assumes a significant part for the security of our well creatures. Many individuals lost their lives becauseof the landslide. This work portrays various techniques for theearly location of landslides and ready individuals to move to more secure regions. As of now there are a few techniques to identify it. The most dependable strategy is by various AI and profound learning models which are performed via preparinga dataset given. Boundaries utilized are incline, measure of precipitation, soil dampness, vibration, etc. By utilizing proper sensors we can gather ongoing qualities. Another way is an IoT based identification technique. Habitually gathering information through sensors, these readings assist us with foreseeing landslides by utilizing Raspberry Pi or Arduino. Pieces of information are saved on mists for later assessment. Discovery of dangerous landslides recognition utilizing Zigbeeis another important technique. With the Zigbee network securing and progressing information, we can simply distin- guish landslides. It has an insightful examination and sendsa cautioning message to the premises. Fluffy based technique is one of the plans for this. It has a high accuracy level of around 90 rate. These strategies are exceptionally important and helpful for landslide identification.

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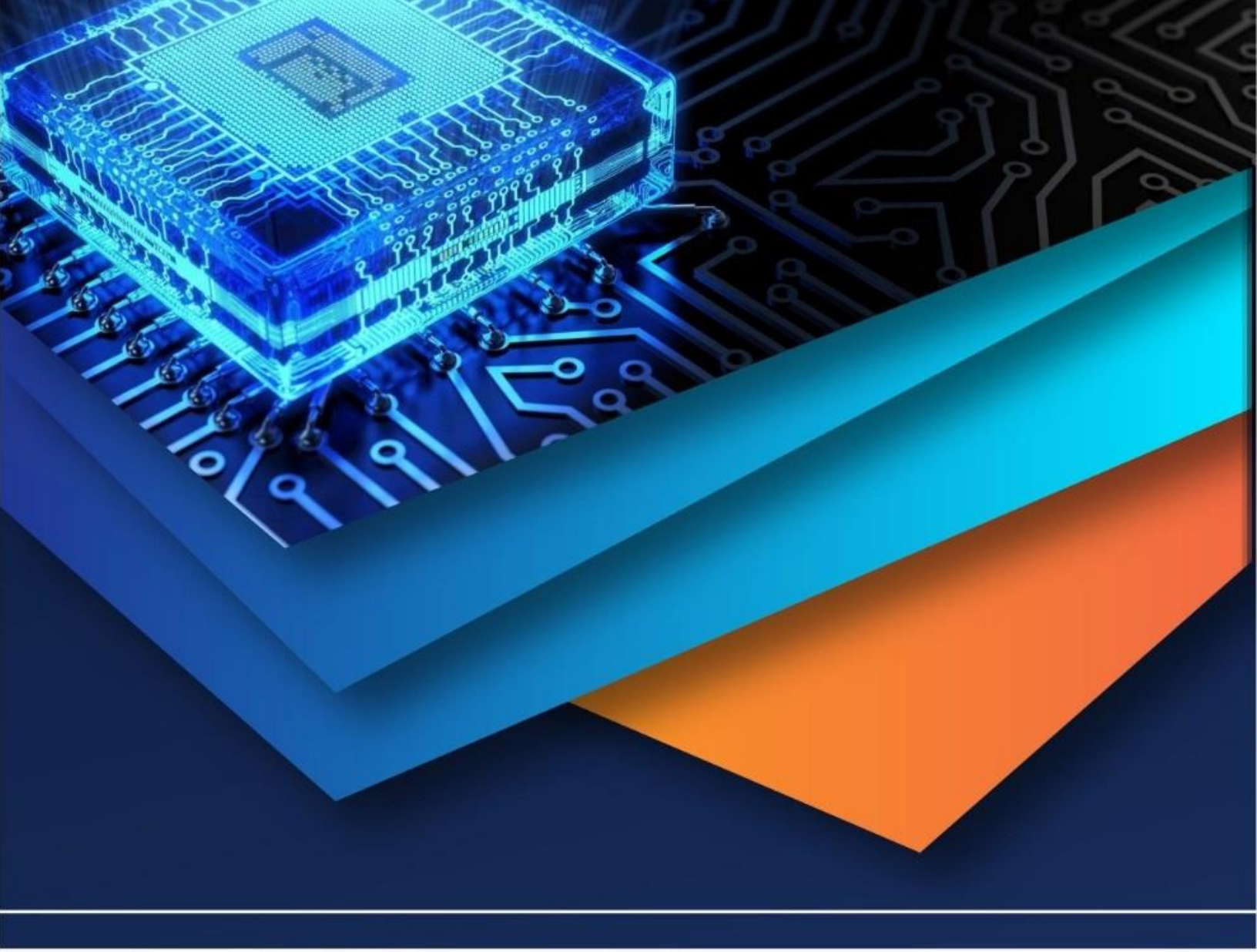

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