International Journal of Current Advanced Research
ISSN: O: 2319-6475, ISSN: P: 2319-6505, Impact Factor: 6.614
Available Online at www.journalijcar.org
Volume 10; Issue 07 (A); July 2021; Page No.24744-24748
DOI: http://dx.doi.org/10.24327/ijcar.2021.4931.24748

Research Article

DESIGN AND IMPLEMENTATION OF LANDSLIDE EARLY WARNING AND MONITORING SYSTEM

Santhosh S., Rohan Shetty., Roshni A B., Varun G Shetty and Yamunashree N

[1]Electronics and communication Department, Alvas Institute of Engineering and Technology Mijar, Moodbidri,
[2]Visvesvaraya Technologiacl University, Belagavi, Karnataka, India

A R T I C L E I N F O

Article History:

Received 6th April, 2021
Received in revised form 15th May, 2021
Accepted 12th June, 2021
Published online 28th July, 2021

A B S T R A C T

Landslides are one of the natural disasters that often occur in different parts of the world. It refers to several forms of mass wasting that may include a wide range of ground movements, such as rock falls, deep-seated slope failures, mudflows, and debris flows. This natural phenomenon cannot be abolished, but one can reduce the losses by an early warning system using wireless sensor networks. Early warning systems depend on a sensor node used to read different properties of slope and soil condition with particular parameters. The parameters that are received are used for the detection of downhill movement of soil, debris or rocks. However, one should replace the entire system due to the damage to the sensor node when a landslide occurs. Sensor node has IMU sensors to monitor the movement of particles and microprocessors, which are economical to manufacture and could be installed in a small space.

INTRODUCTION

Natural disasters are often unforeseeable and occur in a matter of minutes. As a result, technology to capture relevant signals must be created. Monitoring time is kept to a minimum. Wireless sensors are one of the most common types of sensors cutting-edge technologies that can react swiftly to changing conditions changes in data are sensed, and the data is sent to a data analysis programme Wireless sensor network (WSN) technology allows for the real-time capture, processing, and transfer of important data with high resolution[1]. Landslide mapping has traditionally relied on visual inspection of aerial pictures and extensive field surveys. However, those technologies are ineffective for mapping broad areas time-consuming, resulting in a void that remote sensing has been able to fill. Due to spatial resolution limitations, typical optical satellite images, such as that obtained by the Landsat Thematic Mapper (TM) is only useful for land-based applications researches on slides[2]. However, monitoring should not be limited to vibrational analysis in order to have a foolproof system. There are a variety of other factors that might be tracked. In a landslide, for example, the pore pressure might be monitored. Changes in the soil's shear strength as a result of the response The introduction of wireless technology aided in the monitoring of sites that were previously dangerous and inaccessible, such as active volcanoes and isolated locations.

Corresponding author:* **Rohan Shetty
Electronics and communication Department, Alvas Institute of Engineering and Technology Mijar, Moodbidri

Sensor that can be used wirelessly WSNs are increasingly being used for real-time monitoring landslides and other similar occurrences WSN was used in a trial project to detect landslides. This website is well-known for its frequent updates. In the past, there have been landslides. We sent out numerous Deep Earth Probes. DEP probes with a tiltmeters, MPU6050, and temperature sensor. The water level is detected using the dielectric moisture sensor. External geophones were installed and connected to DEP's wifi node. Our findings from the pilot. We discovered that geophones may be used throughout the deployment to minimise the system's power limits and costs in a cost-effective manner. The geophone can also be used to pinpoint the location of the slip which predict the motion's direction including all of these concepts a more efficient design. In the current proposed paper, the landslide monitoring system is designed using Siren, Raspberry Pi 3 Mode+, Sensors[3].

LITERATURE SURVEY

1. The proposed project based on Wireless Sensor Network (WSN) technologies. Wireless sensor networks are one of the emerging areas which have equipped scientists with the capability of developing real-time monitoring systems. This paper discusses the development of a WSN to detect landslides, which includes the design, development and implementation of a WSN for real time monitoring, the development of the algorithms needed that will enable efficient data collection and data aggregation, and the network

requirements of the deployed landslide detection system. The actual deployment of the test bed is in the Idukki district of the Southern state of Kerala, India, a region known for its heavy rainfall, steep slopes, and frequent landslides.

2. The project based on real-time wireless sensor network for landslide detection, in one of the landslide prone areas in India. This research work proposes to incorporate wireless geophones to detect and analyze ground vibrations that may arise before, during and after the landslide. A nested wireless geophone methodology is designed to collect and analyze the relevant signals. The proposed system incorporates a novel signal processing algorithm, to detect landslides. Pilot deployment has been performed with one axis geophone, and the new design of nested 3C geophone will be implemented and validated in our existing system. The newly developed Wireless Geophone Network captures the slope instability vibrations. This data is analyzed and used for disseminating landslide warnings.
3. The project based on image analysis using criteria based on shape, color, texture, and, in particular, contextual information and process knowledge, candidate segments must be delineated properly. This has proved challenging in the past, since segments are mainly created using spectral and size criteria that are not consistent for landslides. This paper presents an approach to select objectively parameters for a region growing segmentation technique to outline landslides as individual segments and also addresses the scale dependence of landslides and false positives occurring in a natural landscape.
4. The proposed project based on wireless sensor technology for the detection of landslides but for analysis it make use of MEMS. The wireless sensor network in the laboratory trial follows a two-layer hierarchy: i) lower layer wireless sensor nodes, ii) the upper layer wireless node. The present paper discusses the experiments performed in laboratory with the eco nodes and independent IRIS mote integrated with different digital sensors. The output of digital sensor is connected with the es9200 interface board in case of eco nodes. Experiments with micro-electro mechanical system (MEMS) based Inclinometer with signal output 4-20 mA and linear range ± 50 has been carried out and described below in detail. MEMS inclinometer can measure incline and decline that is positive and negative slopes, respectively.
5. Landslide hazard mapping published in recent years. The advanced multivariate techniques are proved to beeffective in spatial prediction of landslides with high degree of accuracy. Multi-criteria decision- making approach also play significant role in determining relative importance of landslide causative factors in slope instability process. Remote Sensing and Geographical Information System (GIS) are powerful tools to assess landslide hazards and are being used extensively in land slide researches since last decade. Aerial photographs and high- resolution satellite data are useful in detection, mapping and monitoring landslide processes.
6. The project based on chemical paper LITMUS. Since physical sensors designed for specific disasters are insufficient for multi- hazards. We describe LITMUS - a landslide detection service based on a multiservice composition approach that combines data from both physical and social information services by filtering and then joining the information flow from those services based on their spatiotemporal features. Our results show that with such approach LITMUS detects 25 out of 27 landslides reported by USGS in December and 40 more landslides unreported by USGS. Also, LITMUS provides a live demonstration that displays results on a web map.
7. The proposed project based on numerical assessment of landslide detection methodology based upon the change of scattering power between multi-temporal fully Polarimetric Synthetic Aperture Radar (POLSAR) data, they have tried to detect sediment disaster including landslide, slope failure, debris flow, from POLSAR data. The scattering process of the microwave comes to the surface scattering from the volume scattering. Therefore, we select a mountainous area stricken by a large earthquake. The four-component scattering model decomposition was applied to the polsar data over the area. Compared sediment disasters interpreted from aerial photographs with the scattering power decomposition images.
8. The proposed project based on radar interferometry technique for the monitoring of an ancient landslide detected. Aperture Radar interferometry technique carried between March, 25th and 26th. Displacement maps have been geo located and overlaid to a Digital Elevation Model (DEM) of the scene. It has been observed that the once area is almost stable except two portions located at the foot of the ancient landslide and at the center of the town, respectively. In both cases, a maximum displacement of about 0.5 mm has been measured. A further campaign is needed to confirm this displacement.
9. Automatic method for detecting landslides by using an integrated approach comprising Object-Oriented Image Analysis (OOIA), a Genetic Algorithm (GA), and a Case-Based Reasoning (CBR) technique. It consists of three main phases: (1) image processing and multi-image segmentation (2) feature optimization and (3) detecting landslides. The experimental results indicated that the proposed OOIA-GA-CBR 0.87 demonstrates higher classification performance than the stand-alone OOIA 0.75 method for detecting landslides. The results of this study thus facilitate fast generation of accurate landslide inventory maps, which will eventually extend our understanding of the evolution of landscapes shaped by landslide processes.
10. The proposed project based on high spatial resolution multispectral optical imagery and a Digital Elevation Model (DEM) with an object- oriented analysis technique to develop a scheme for the recognition of landslides using multilevel segmentation and a hierarchical semantic network. Three kinds of remote sensing imagery, namely pan-sharpened FORMOSAT-2 satellite images, aerial digital images from Z/I digital mapping camera, and images acquired by a digital single lens reflex camera mounted on a fixed-wing

unmanned aerial vehicle are used. The results demonstrate the feasibility and accuracy of the proposed landslide recognition scheme even when different optical sensors are utilized.

11. Based on regional scale warning system for landslides that relies on a decisional algorithm based on the comparison between rainfall recordings and statistically defined thresholds. The latter were based on the total amount of rainfall, which was cumulated considering different time intervals: 1, 2 and 3day cumulates took into account the critical rainfall influencing shallow movements, whilst a variable time interval cumulate up to 240 days was used to consider the triggering of deep-seated landslides in low permeability terrains. The proposed methodology could be easily implemented in other similar regions and countries where a sufficiently organized meteorological network is present.
12. The MATLAB code for data processing a highly accurate, effective and efficient landslide detection system has been proposed which can be used along the Konkan railway line to monitor tracks for landslide using image processing. The coding has been done using MATLAB and a low resolution webcam was used for acquiring sample video frames. Various techniques like Hamming distance, Entropy, Euclidean Distance, Correlation, Block processing etc. were used for event detection. The proposed technique gave a threshold margin of 80.24 percentage and the average efficiency of the system was found to be 86.6for the considered set of images. Using proposed technique, False Acceptance Ratio (FAR) of 0.067 and False Rejection Ratio (FRR) of 0.933 were achieved.
13. Based on the usage of LIDAR technology for landslide detection. This research proposes an efficient framework by combining three object-based classifiers using the DST method. Consequently, an existing supervised approach that is fuzzy-based segmentation parameter optimizer was adopted to optimize multiresolution segmentation parameters such as scale, shape, and compactness. Subsequently, a Correlation-based Feature Selection (CFS) algorithm was employed to select the relevant features. Two study sites were selected to implement the method of landslide detection and evaluation of the proposed method subset A for implementation and subset B for the transferrable. The DST method performed well in detecting landslide locations in tropical regions such as Malaysia, with potential applications in other similarly vegetated regions.
14. The proposed project based on results of the project 196 B Development and applications of a multi-sensor drone for geohazards monitoring and mapping. The objective of the project is to test the applicability of a multi-sensor drone for the mapping and monitoring of different types of geohazards. The aerial images were combined and analyzed using Structure-from-Motion (SfM) software. The collected data allowed an accurate reconstruction and mapping of the detected landslides. Comparative analysis of the obtained DTMs also permitted the detection of some slope portions being prone to failure and to evaluate the area and volume of the involvedmass.
15. Based on SAR images to read the data obtained in prior of landslide occur, Discrete and temporarily stable natural reflectors or Permanent Scatterers (PS) can be identified from long temporal series of interferometric SAR images even with baselines larger than the so-called critical baseline. This subset of image pixels can be exploited successfully for high accuracy differential measurements. A new approach to the estimation of the atmospheric phase contributions, and the local displacement field is proposed based on simple statistical assumptions. New solutions are presented in order to cope with nonlinear motion of the targets.
16. The proposed project based on Recurrent Neural Networks (RNN) and Multi-Layer Perceptron Neural Networks (MLP-NN) in landscape detection. These efficient neural architectures require little or no prior knowledge compared with traditional classification methods. The proposed methods were tested in the Cameron Highlands, Malaysia. Segmentation parameters and feature selection were respectively optimized using a supervised approach and correlation-based feature selection. The hyper-parameters of network architecture were defined based on a systematic grid search. The accuracies of the RNN and MLP-NN models in the analysis area were 83.33 percentage and 78.38 percentage, respectively. The accuracies of the RNN and MLP-NN models in the test area were 81.11 percentage, and 74.56 percentage, respectively.
17. A project based on using remote sensing satellite for landslide detection. The experimental analysis of the characteristic changes of PALSAR- 2 signals showed that quad-polarization parameters indicating signal depolarization properties revealed noticeable la nds l ide -induced temporal changes for all local incidenc angle ranges. The accuracy assessment results showed that the depolarization parameters, such as the co-pol coherence and polarizing contribution, can identify areas affected by landslides with a detection rate of 60 percentage, and a false-alarm rate of 5 percentage. On the other hand, the single- or dual-pol parameters can only be expected to provide half the accuracy with significant false-alarms in areas.
18. Based on land sat images and Digital Elevation Model (DEM) for land slide detection. DEM is useful in removing flat areas, where landslides are less likely to occur. The framework consists of three sections: image enhancement, landslide proposal extraction, and detection model setup. Bare land, including landslides, is enhanced using vegetation index after haze/cloud re-movement. Later, calculate connective contours and propose them as potential regions that may contain landslides. For each proposal, calculate texture feature and build detection model using one of the Landsat8 images, which is further applied on other images to check its applicability and robustness. This data analysis can save millions of people life and their properties.
19. The proposed project based on Wi-Sun acceleration sensors, which can detect the acceleration of the nearby environment in 3D domain, and the sensors are linked with the router act as 'sink' node via Wi-Sun transmission that is IEEE802.15.4g. The details of the detection system are explained and the landslide detection mechanism with low computational

complexity is proposed. A traffic reduction method is proposed thereafter to help reduce the data needed for transmission by exploring the intra-correlations of the sensor data. This method can save the energy consumption without degrading the detection performance. Field test is conducted and the results show that the landslide can be detected and amount of data to be transmitted can be reduced, which verifies the system's effectivity.

20. The techniques and the effectiveness of their synergic use is explored in the field of landslide analysis by analyzing various case studies, characterized by different slope instability processes, spatial scales and risk management phases. Although these spaceborne platforms have revisiting times of few days they still cannot match the spatial detail or time resolution achievable by means of Unmanned Aerial Vehicles (UAV) Digital Photogrammetry (DP), and ground-based devices, such as Ground-Based Interferometric SAR (GB-InSAR), Terrestrial Laser Scanning (TLS) and InfraRed Thermography (IRT), which in the recent years have undergone a significant increase of usage.

Design and Construction of Sensor Node Architecture

The system mainly concentrates on monitoring the soil parameters to avoid landslide which can be installed in any landslide prone area. In this system Raspberry Pi 3 Model B+, powerful micro-computer is interfaced with different sensors to monitor the soil parameters. There are very few systems are available in the market where it costs high with the expensive sensors. The replacement of the damaged sensors will also cost high and hence the maintenance of those systems are expensive. But the proposed system is easy to install and possesses high precision with low-cost sensor and lesser power consumption.

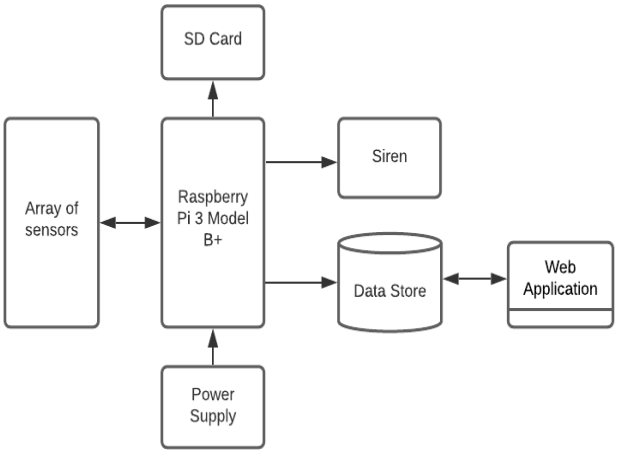

Fig 1 Workflow of the system

The system consists of a central component raspberry pi, a powerful microcomputer which controls all the operation of the system. The micro-computer can be powered by 2.5A micro-USB power supply for configuration when the implementation of the system is nearer to a supply source. It can also be operated with a solar power and battery configuration for implementation of the system with no nearby supply source. A siren can be configured with the raspberry pi to give alert for the near by area. The data can be uploaded into the webapp using the Wi-Fi connection depending upon the availability. In case of remote location, an external GSM module is interfaced to upload the data along with this one can use SD card to store the data collected from the sensors node which will be useful if there is a failure in transferring the data. The system contains multiple sensors to monitor the soil parameters in real time. Each node includes MPU6050, Tilt Sensor, Strain Gauge and DHT22. The sensors are configured and calibrated using Python IDE tool. Getting the data in real time from each sensor will be helpful in monitoring the soil parameters and it will be useful to take required actions before the incident happens. Which can also be useful for research purposes. The data which is geo tagged and time tagged collected from multiple sensors are independently logged.

Along with storing data in a database a SD card is used to store the data locally. The data can be stored in the form of Comm-Separated Values (CSV) file of JavaScript Object Notation (JSON) file depending upon the requirement and desired output.

The log files are generally found in /var/log folder and most of the files in there can only be read by the root user. One can analyse the data collected from each node using the data analysis tools to give more insights about the soil parameters. The data collected from each sensor should be analysed to get a precise result to take necessary action. Presenting this result on a webpage will be helpful for the people to see the data at anytime in one click. To build a web app, expo framework is used which is a set of tools and services built around React Native and native platforms that helps to develop, build, deploy, and quickly iterate on iOS, Android, and web apps from the same JavaScript/TypeScript codebase. React Native is an open-source framework with one of the largest support communities. Unlike typical hybrid applications, this new framework targets mobile platforms. It's based on the JavaScript library, React Native allows you to create a single JavaScript codebase that will work on different mobile devices. The user interface is the part of the web application which a user interacts with. In simple terms, it's everything a user can see and touch, such as buttons, colours, fonts, navigation, etc. The user interface is used to display real-time data from the sensors and also the data is visualized by plotting the graph. The data stored in the local SD card can be accessed/imported in the web app, for research purpose.

CONCLUSION

In the field of geophysical research, real-time monitoring of landslides is one of the most complex study fields available today. The development of this paper is discussed of a real-world wireless sensor network deployment landslide detection system that is based on the internet. For efficient distribution of real-time data, this system employs a heterogeneous network of wireless sensor nodes, Wi-Fi, and satellite terminals data to the data management centre in real time to enable advanced data analysis and to deliver landslide warnings the residents of the area with warnings and risk assessments region. This effort will be expanded to a complete deployment in the future. Utilising the knowledge gained from the existing network. The network will be utilised to have a better knowledge of the capability. The suitability of a wireless sensor network for mission-critical applications.

In order to overcome and accomplish the required results the following points are taken into consideration.

- Based on the field of application the type and quality of sensors are selected.

- For landslide detection near locality a siren is deployed for warning.
- For landslide detection in remote areas solar power supply with a battery backupis ideal.
- For landslide detection near locality wireless fidelity would be the best option.
- For landslide detection in remote areas Global System for Mobile communication (GSM) or General Packet Radio Service (GPRS) would be the best option.

References

1. M.V. Ramesh, Real-time wireless sensor network for landslide detection, in: Proceedings of the Third International Conference on Sensor Technologies and Applications, Sensorcomm 2009, IEEEDigital Library, 2009.
2. Abishek Thekkeyil Kunnath, Huan Xia, Vineeth Nair, "Wireless Networks and Applications", Amrita Vishwa Vidyapeetham (AMRITA University). 2010 First International Conference on Sensor Device Technologies and Applications.
3. Tapas Ranjan Martha, Norman Kerle, Cees J van Westen, Victor Jetten, IEEE Transactions on Geoscience and Remote Sensing, VOL. 49, NO. 12, DECEMBER 2011.
4. Anup Mishral, J Gray, J Harju, Walter K "MEMS for landslide detection, Landslides and Engineered Slopes: Protecting Society" through Improved Understanding 2012.
5. Sudhakar D Pardeshi, Sumant E Autade Suchitra S Pardeshi, Landslide hazard assessment: recent trends and techniques. Department of Geography, University of Pune, Ganeshkhind, Pune 411007, India.
6. H. Liu, Z Meng, S Cho, "A Wireless Sensor Network Prototype for Environmental Monitoring in Greenhouses", IEEE Xplore, 2007.
7. L Yamaguchi, S Wang, S D Kallash "Wireless Sensor Networks with Self- Organization Capabilities for Critical and Emergency Applications".
8. Fang Chen, Bo Yu Nico, Bin Li "A practical trial of landslide detection from single-temporal Landsat images" using contour-based proposals and random forest: a case study of national.
9. Jie Dou, Kuan Tsung Chang, Shuisen Chen, Jin-King Liu, Zhongfan Zhu Department of Natural Environmental Studies, The University of Tokyo, Kashiwa 277-8568.
10. A V Rau, N Vasudevan, A Niemeyer "The deep-earth sensor probes for landslide detection".
11. G. Martelloni, S Segoni, R Fanti, F Catani "Rainfall thresholds for the forecasting of landslide occurrence at regional scale".
12. Satishkumar Chavan, Shobha Pangotra, Sneha Nair, Vinayak More, Department of Electronics and Telecommunication Engineering Don Bosco Institute of Tchnology, Kurla(W) - 400070 Mumbai, Maharashtra, India.
13. S Barbarossa, Rizie Astana, G Scutari decentralized maximum-likelihood estimation for sensor networks composed of nonlinearly coupled dynamics system.
14. M V Ramesh, P Ushakumari, Faisal Fathani threshold based data aggregation algorithm to detect rainfall induced landslides, in Proceedings of the 2008 International Conference on Wireless Networks (ICWN'08),vol. 1, 2008, pp. 255–261.
15. Alessandro Ferretti, Claudio Prati, Fabio Rocca, Nonlinear Subsidence Rate Estimation Using, Permanent Scatterers in Differential SAR Interferometry.
16. Marechal, J Pierrot, J Gorce, fine synchronization for wireless sensor networks using gossip averaging algorithms, in: Proceedings ICC 2008, 2008.
17. S Lindsey Park, C Raghavendra, K Sivalingam, data gathering in sensor networks using the energy delay metric, in Proceedings of the15th International Parallel and Distributed Processing Symposium, IEEE, 2005.
18. A.Chydzinski, Binli R. Wojcicki, G. Hryn, on the number of losses in an MMPP queue, in: Y Koucheryavy, A Sayenko, NEW2AN 2007, LNC.
19. K. Akkaya, M Younis, Casagalli M. Youssef, Efficient Aggregation of Delay-Constrained Data in Wireless Sensor Networks, Department of Computer Science and Electrical Engineering, University of Maryland 2005, 904-909.
20. A.Iserles Asch, S.P. Norsett, XU Dongsheng Linear ODE's in Lie Groups. Numerical, Analysis Report, University of Cambridge, 1997.

How to cite this article:

Rohan Shetty *et al* (2021) 'Designing and Implementation of Landslide Early Warning and Monitoring System', *International Journal of Current Advanced Research,* 10(07), pp. 24744-24748. DOI: http://dx.doi.org/10.24327/ijcar.2021.4931.24748

****