# Suraki Bhoomi: Landslide Early Warning System

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**Abstract**
**During past few years there were several types of Landslides Early Warning Systems developed in the world wide. Mainly Asian countries which effect by south-west and north-east monsoon rainfall are mindfulness for this objective. Due to weather changes landslides become more frequent and cause damage to people. In this situation people need complete landslide early warning system to protect their resources. The implementedsystem is capable of predicting a possible landslide in a given area and issuing warnings that would assist in risk management. This research project has a low-cost, sustainable early warning system to send warning alerts via Short Message Service (SMS) to monitor the landslides. The system uses data mining to identify what are the most dangerous areas for landslide. After that,the sensors are placed in the areas to detect landslides. System calculate values what are the probability for a landslide to happen be high. Then the system will generate a warning Alarm and warning message and it will send to people with using Siren and SMS or Android application. System administrator can handle this system using his Desktop application.**

*Keywords: Detect landslides, Warning System, SMS, Alarm, Android Application,Data Mining, Desktop Application, Siren, GSM*

## I. INTRODUCTION

"Suraki Bhoomi" Landslides Early Warning System which specify to the landslides areas. This is a warning system to alert the people in dangerous areas for landslide. The research team decided to add datamining system for identify landslide areas with using clustering method. Devices are placed at the risk area to get data to the system. System is very small and very light. Then it can be placed on anywhere any time and easy to move. This system has many components such as sensors, alarms, data mining system, android application, server, desktop application, SMS system. It can calculate the distance about earth crack and ground water level with using several types of sensors.

Send an alarm to the nearest area, send a SMS notification, android application identify landslide areas and online data can send to nearest server. National Building Research Organization in Sri Lanka is our main resources holder. Initially a data-mining modelused for get well prediction to searching most dangerous areas for landslide. Sensors are set in those areas. Module is based on several types of sensors using Arduino, GSM module. It is measured by getting a movement of ground displacement and ground water level.

Process of the ground water level sensor is soil moisture sensor calculates the water volume of a measured soil sample. Rain sensor calculates the water volume of a measured rain water sample and the value is display using a screen. If the water level is higher than the level in the moduleit is toodangerous,then system will indicate an alarm.

Data which were gathered out of Arduino sensor calculations are being transferred to the online database through the GSM module. Simultaneously data gathered and transferred to the database as warning alerts.

At the Earth displacement sensor, Earth displacement measured by moving two point of ground. This is calculate with using couple of Arduino sensors. When the ground is displacement sensors move a side. Module calculate the distance and the crack is too dangerous system will indicate an alarm.

In this manner the attainment data with using displacement sensors, to send the database through the GSM module like risk warning. Both two sensors can directly send SMS to users.

The SMS notification system notifies the warning message to the people in near area can attention about the alert and they can go to the safe area. SMS notification system is a useful method.

Warning system store data about landslides. Data can be send to a nearest server via GSM module.

The desktop application for system administrator named as "Suraki Bhoomi". Administrator handle the system data without came to the module and getting data. System administrator directly add rainfall data to server using desktop application which gathered from National Building Research Organization as CSV file format. Administrator add the geological details to server and view the details using pie charts and bar charts. Administrator can view the detail where coming from couple of sensors. System send the emails who staff members and peoples where in dangerous areas.

Landslides detecting is very important for the people. "Suraki Bhoomi" android application includes data of landslides area. This application includes three-year data of landslides. Landslide area are mapping online and update 04 months. In the map dangers areas arerepresented usingdifferent colors. It will help people to recognize the places of landslides.

## II. LITRETURE REVIEW

"SurakiBhoomi" Landslides Early Warning System research team studied numerous published research papers, articles and documents from various sources. National Building of Research Organization is the main resource center where the research group collect that information. Using that knowledge

above mentioned sources it assistance the research group to develop a unique and well-informed system.

"AsaniWasi" is a landslide early warning system, in this system the focus is on measuring of distance between two points of the slope and the ground water level [1]. Sensors are placed in the risk area to get data to the system. Critical limitations of the factors for landslides to occur are stored in the system. When the system detects that it is exceeding the limits, warning messages are automatically sent to the relevant people via SMS. However, "AsaniWasi" have an issue, in this research project have not use any Data mining system. "SurakiBhoomi" will allow using Data mining.

"Landslide Early Warning System for Rural Community as an Application of Sensor Asia" is an early warning system for landslides was developed and deployed in Banjarnegara Region of Indonesia as a part of Asian Joint Research Project and Sensor Asia Initiative [2]. A Field Server was used to collect data from several sensors and display them in a web page in real time. Other advantage is, a graphical interface is also provided at the local site for community people to see the movement and the warning level. There are some disadvantages in this project, the system used only Linux system to store data and have not SMS. "SurakiBhoomi" will allow to use any operating system platforms and send massages with using via SMS.

"Development of Landslide Early Warning System Using Macro-Bending Loss Based Optical Fiber Sensor" [3]. This research using fiber optic sensors were made by wrapping a polymer optical fiber. Through the research paper mainly consists of a displacement fiber sensor, mechanical displacement converter, and Short Messaging Service (SMS) gateway equipped with a siren. Research did not develop data mining part to detect landslide areas.

"Design and implementation of a landslide early warning system" was down by Emanuele interior, Giovanni Gigli, Francesco Mugnai, Riccardo Fanti, and Nicola Casagli [4]. It is the early warning system for the rock slide including the geological knowledge, the risk scenarios, kinematic characterization of the landslide, the choice and installation of the monitoring system, the setting of appropriate alarm levels and the definition of plans of civil protection. It did not provide ground displacement detecting sensor or SMS.

"Automated Statistical Data Mining of a Real World Landslide Detection System" is presents an architecture which have developed for automatic data mining of landslide data which will ultimately help in issuing an early warning for occurrence of landslides [5]. This work has been partially funded by "Monitoring and Detection of Rainfall Induced Landslide using an Integrated Wireless Network System" project funded by Department of Science and Technology (DST), India and also by "Advanced Integrated Wireless Sensor Networks for Real-time Monitoring and Detection of Disasters" project funded by Ministry of Earth Science, Government of India.

Y.Srinivas, K. Raghava Rao indicated "Landslide Warning System Using Zigbee. And Global Positioning System (GPS) is design combines of GSM wireless communication technology and Wireless Sensor Network" [6]. This research implements SMS and landslide monitoring system. Zigbee used three sensors of Angle sensor which gives the readings of slope angle if there is any movement in landslide and we have Liquid level sensor it collects the depth of water at the mountains. Temperature sensor gives the changes in the temperature. SurakiBhoomi" will allow to use several sensors to detecting ground displacement and warning alerts.

"GSM Based Real-Time Wireless Sensor Network for Landslide Detection" is a one of system with using Wireless Sensor Network (WSN) and Global System for Mobile Communication (GSM) to a remote data center [7]. System monitors the changing geo-technical condition using various geo-technical sensors. This system has not contained any ground displacement detecting sensor or warning alarm. "SurakiBhoomi" will allow to use several sensors to detecting ground displacement and warning alerts.

## III. METHODOLOGY

This project used the prototype methodology because the target was the end user's satisfaction, which was accomplished in a lot of implementations of updated versions of the previous systems that were created. By prototype methodology developers show the user phase by phase their system development.

### A. Planning

Main issues that came into consideration were financial problems, Database issues, Interface integration issues and Time management.

After a thorough look a final conclusion took place about the above mentioned economical and technical problems. To ensure that the project goes smoothly, techniques such as a Gantt chart and a work Break Down structure has been used to ease out the workload so that the application manages time, resources (Human Resources, Hardware etc.) and have a smoother control over the project.

### B. Requirement Gathering and Analysis

Information and data required to the new system has been gathered through techniques such as research papers, interviews with visitors, questionnaires, analyzing reports and by conducting meetings with supervisors etc. The Documents related to research was collected and has been evaluated thoroughly. Questioning people on different levels who are currently involved with the system helped in finding requirements to build the new system. Simple questionnaire has been given out to visitors from different areas to obtain visitors opinions from them.

Finally, analyzing took place only after getting enough prospective on the problem thoroughly before the design

phase. The team was able to recognize user expectations in this phase.
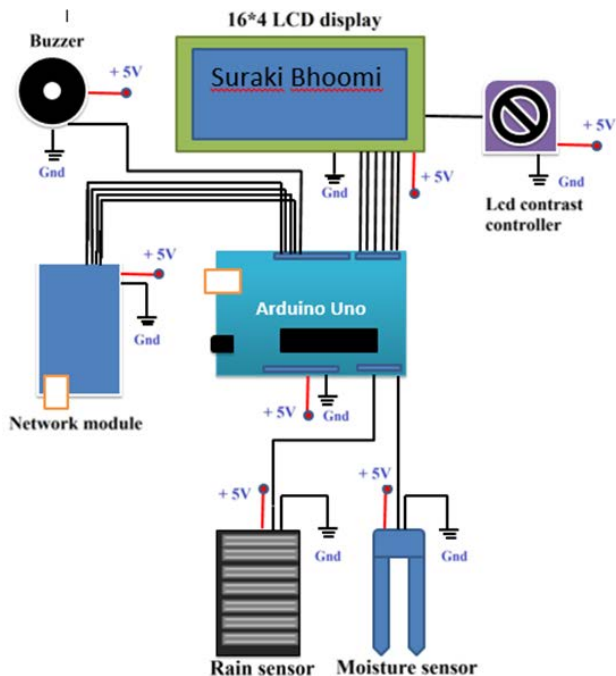
### C. Design



Fig.1.1illustrates the circuit diagram of ground water level detecting sensor.

Circuit diagram of ground water level detecting sensor as Fig.1   point out how to append couple of sensors, GSM module and Buzzer.
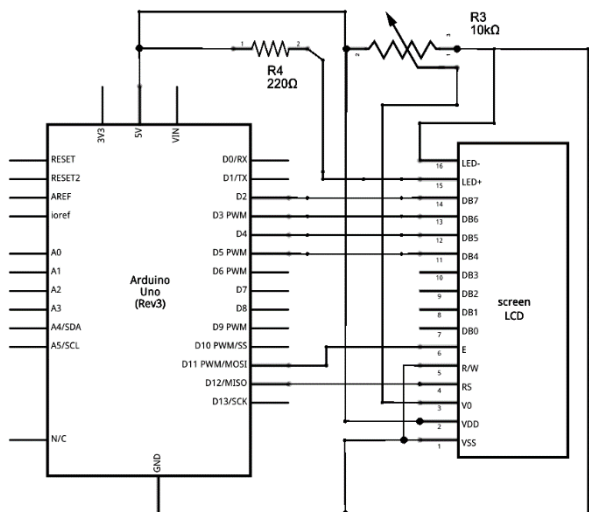


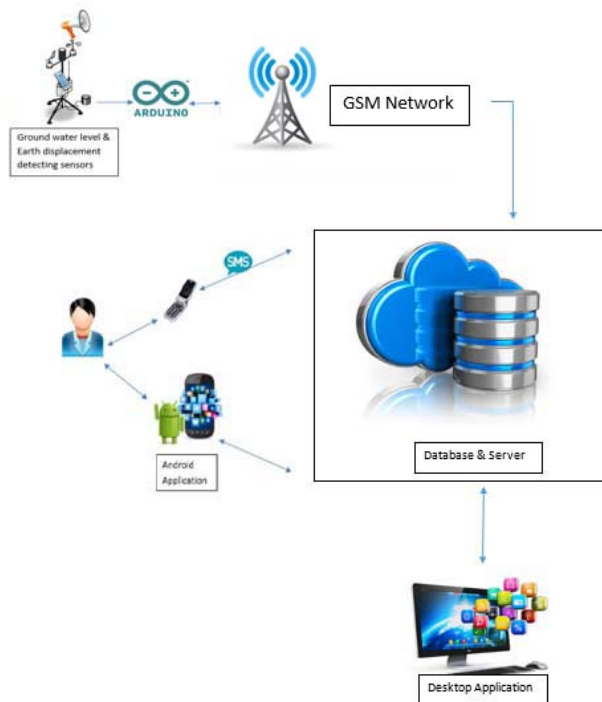Fig.2. illustrates the circuit diagram of ground Displacement sensor.

Circuit diagram of ground Displacement sensor describe how to calculate displacement of the crack.



Fig.3. High-level Diagram

Architecture Design as Fig.3 is describe what are the main components and flow of the system.

### D. Implementation

Since the system has five main components, Data Mining, Sensors, Server, Android application and the Desktop Application, for implementation of the system has wanted different platforms. Android studio will be used to develop the application with the aid of XML, JAVA and other android related languages and equipment. Data Mining system developed based on MS SQL and MS business intelligent R2 Version.
NetBeans will be used to develop the Desktop application with JAVA.Sensors are developed by using Arduino. Server will be developed based on languages that fulfill the requirements of the server that system wanted and it will be easy to make changes if there are problems on implementing the system because of using prototype model.

After completed the implementation of the system the data comes to server from sensors with using GSM module. Desktop application and android application are connected to the server using web services. Local host will be use to testing process.

Web server and the android application,both of systems need to be install on relevant devices like the android application need to be installed on an android smart device and the web server need to be hosted in a public server.

*E. Testing*

Integration of the modules and testing are done in this phase. This must be done in a well-planned manner in order to inter-relate each module correctly.

The system testing part of a testing methodology involves examining the entire system for errors and bugs. This test is carried out by checking the hardware and software components of the entire system (that have been previously unit tested and integration tested), and then testing it as a whole. Load testing was also used.

Security was tested after the implementation.Applications, which connect to the servers, can be faced on Cyber-crimes and irregularities. Some security measure need to designed and developed at the same time as the desired business functionality.

Security testing has inspected the software for integrity, confidentiality, availability, non-repudiation and authentication. Individual tests have been conducted to prevent any unauthorized access to the software code.

IV. RESULT AND DISCUSSIONS

This chapter covers the results that were achieved from the research project and what were the new approaches found to address further research in the undergraduate context.
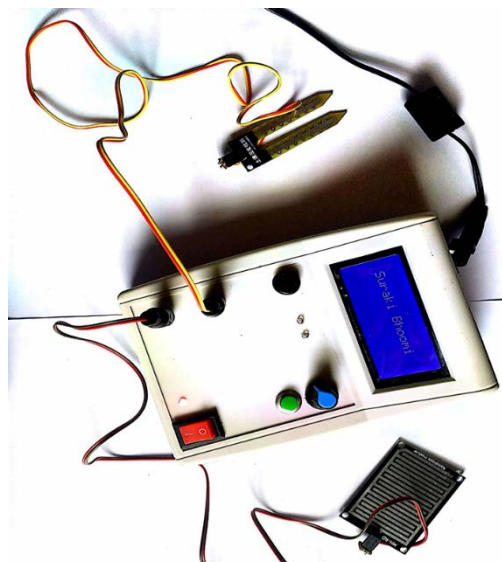


Fig. 4. Ground water level sensor

This is the ground water level detecting sensor asFig. 4.This have two sensors, soil moisture sensor and rain sensor. Sensor values are a displayed as a percentage value in a display. This

value can pass to the server via GSM module. If the value is shown in the display is high the buzzer will active and sound an alarm.
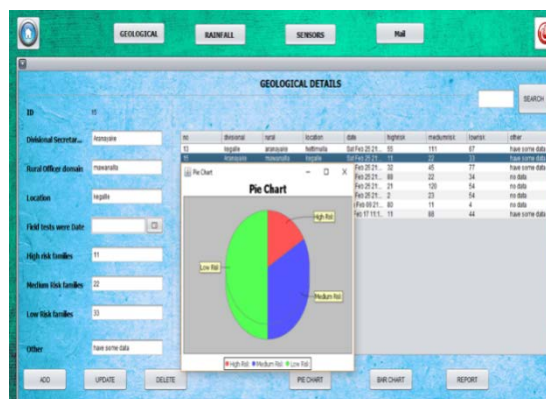


Fig.5. Geological data

Admin can input hard copy of NBRO geological data to the system as Fig.5.
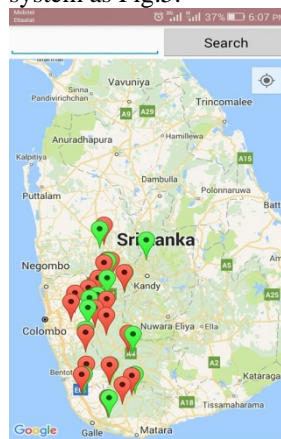


Fig.6. Map Page

In Map page, user can use search the place that landslides were happened and also navigate to current location where the user is in.
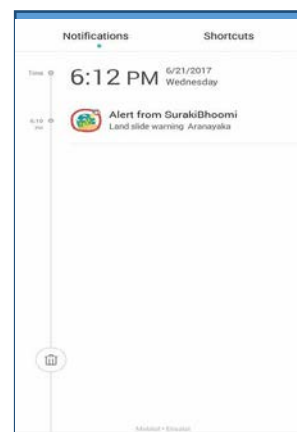


Fig.7.Alert

Alert message will receive to the user when user is in online as Fig.7. The message will be receiving from the database server.
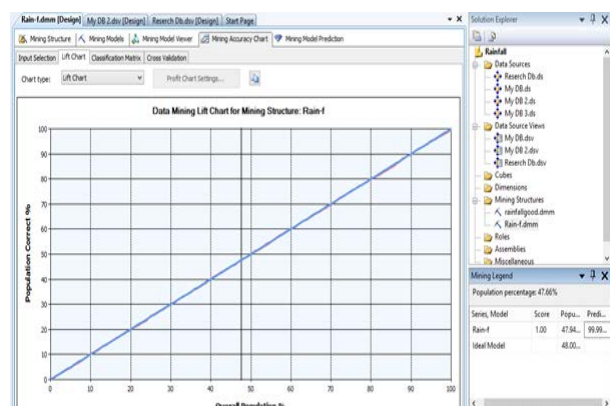


Fig.8.Mining Structure

Data mining list chart for mining structure using rainfall details asFig.8.After refering quite a few methodologies of data mining predictions the research team could identfied the most effected months for landslides. According to rainfall data in kegalle regionperiod from March to May is the most dangerous months for landslides.

## V. FUTURE WORKS AND CONCLUSION

Implemented system presented an efficient and affordable method for real time problem solve system. The method consisted of two categorize the problem and give the best solution for the problem.

There is a limitation to be highlighted in "Suraki Bhoomi" system. In order to use this system research group, have not enough data to data mining to get good prediction. Though the data for data mining is a limitation.

Recommendation to those who willing to develop this system further as follows;

- System can setup all over the Sri Lanka where landslides will happen.
- Add more data and do the data mining to get good result.
- Develop the system to get more accurate result.

As the research was limited to a specific area focus on Kegalle District Aranayake area. In the future the group is willing to do more data mining and setup the system where the landslide happens other districts in Sri Lanka.

## VI. ACKNOWLEDGEMENT

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