CSN-503

PROJECT REPORT ON

WIRELESS SENSOR NETWORK FOR LANDSLIDE DETECTION

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Abstract

Wireless Sensor Network (WSN) has found its prominent utility in a wide variety of applications including the monitoring systems leading to many advantageous revolutions. One such system in the following report is a landslide detection system for real-time monitoring and understanding the network requirements for the design of such a system. The data from the sensor network is aggregated first, then analysed and the client gets warning for a forthcoming landslide.

Contents

1 Introduction

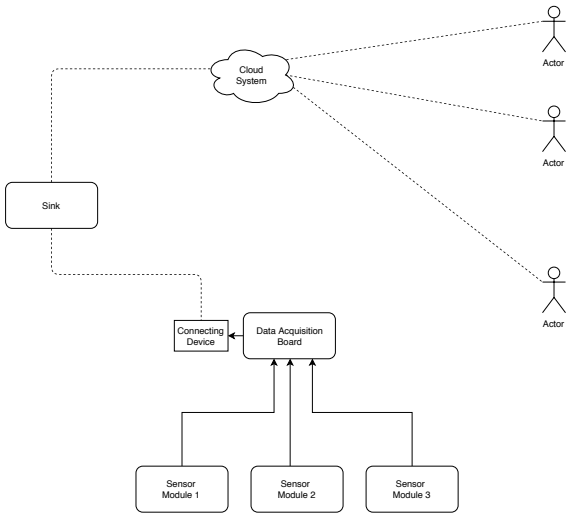
Natural calamities are highly unpredictable and spontaneous that lead to serious mankind and monetary losses, thus it needs serious attention that prior to the mishap, people are made aware about it through an early warning detection system. In the tropical hilly regions that suffer with too heavy rainfall makes the region prone to landslides. In such a prediction model, wireless sensors can provide the best efforts for quickly responding to any changes in its environment.

Despite the fact that a wireless sensor network is a low powered, low storage capacity system, it has the capability to capture, process and transmit critical data of a real-time scenario with high precisions. Also, a wireless sensor network system is a system that needs low-cost investment and requires lower maintenance making it easy to deploy in hostile and remote areas where continuous physical monitoring of the deployed sensors is not feasible.

The main goal in the project is to learn and implement the networking requirements for the development of a system that detects a rainfall-induced landslide which is common in such tropical hilly areas in India. The architectural framework used in the completion of this project is adapted from [1]. The remaining sections include the basic architecture design, implementation according to the architecture and its working.

2 Architecture

The networking architecture of the entire system that depicts the flow of data and associated alarms after aggregating data is shown below:-



The system follows a two-tier architecture and the major steps carried are broadly stated beneath:-

1. Firstly, the sensors are deployed on a lower level where they really sense for the abrupt changes happened.
2. Next, it transfers the sensed data to the upper layer module (such as an Arduino module) that performs data aggregation.
3. Next, the data is then transferred to the sink node for collection via a wireless connectivity module (such as a bluetooth module).
4. Next, the aggregated data from the sink is then transferred to a cloud system where it processes the data based on some threshold parameters.
5. In the event of an alarming situation, the cloud sends alert to the clients.

3 Implementation

3.1 Components

For the fulfilment of the design and implementation, following modules have been used:-

1. **Raindrop Module :-** It is an easy tool for rainfall detection which can be used as a switch when raindrop falls through the raining board and also for measuring the rainfall intensity. [2]

   The intensity is measured by the number of copper strips of positive and negative sides forming a closed circuit when water droplets get sprinkled on its surface.

2. **Soil moisture Sensor :-** The soil moisture sensor consists of two probes which are used to measure the volumetric content of water. The two probes allow the current to pass through the soil and then it gets the resistance value to measure the moisture value [3].

   When there is more water, the soil will conduct more electricity which means that there will be less resistance. Therefore, the moisture level will be higher. This sensor can be connected in two modes - analog mode and digital mode. We set threshold parameters using the analog output.

3. **Accelerometer-cum-Gyrometer Sensor Module :-** This combined sensor module (MPU-6050 or GY-521) is a six-axis motion tracking device that combines a three-axis accelerometer and three-axis gyroscope and a digital motion processor (DMP) into a 4 X 4 X 0.9 mm package acts like a device to measure the speed at which the soil slides by recording the speed and intensity of the tilt happening in the soil [4].

This module gives us the records of the x, y and z movements that can be used to mark the threshold parameters. It uses the I2C protocol for connecting to the data acquisition board.

4. **Arduino Uno Chipset Module :-** An Arduino-Uno chipset module is used as a data acquisition board that collects the data coming from the sensors.

5. **Bluetooth Module :-** An HC-05 chipset is used to transfer the aggregated data from the Arduino-Uno board to the sink node via bluetooth connectivity.

6. **Laptop :-** Three laptops are used to make sink node, cloud system and client.

3.2 Circuit Design

The following is the circuitry to depict the one complete module:-

3.3 Working

Following are the steps carried out to build the entire system :-

1. In the first phase, whole of the circuitry is built for the entire Wireless Sensor Network based on the above circuit design as mentioned above. Following connections for each sensor to the arduino chip are done:-
   - Soil Moisture Sensor is connected to a 5V supply as its analog data is recorded on A2 analog pin of the arduino chip.
   - Raindrop Module Sensor is connected to a 5V supply as its analog data is recorded on A3 analog pin of the arduino chip.
   - Accelerometer cum Gyrometer Sensor is connected to a 5V supply as its analog data is recorded on A4 analog pin of the arduino chip and its clock pin is connected to A5 analog pin of arduino chip.
2. In the next phase, sensors are provided with proper environments where they can trigger a landslide alert.
3. Next, all of the data - values of soil moisture module, raindrop module and accelerometer is collected by the data acquisition unit for which Arduino-Uno Chipset is used.
4. In the next phase, the data collected by the Arduino-Uno module is transferred to a sink node (a Laptop) using a bluetooth module which is connected to the Transmitter-Receiver pins of the arduino chip in a vice-versa fashion and provided with 5V supply.

   The sensor data from Arduino chip is sent to the sink only when some event triggers i.e. change in values of any module is encountered. Once the data has started getting transferred to the sink node, it keeps on sending until it encounters no change in the values for 15 seconds. This working is done to cater data distillation functionalities.

5. This data collected at the sink node is transferred to the cloud system through internet using client-server architecture through socket programming.
6. Next, the data received at the cloud system is further analyzed based on the threshold parameters set. It sends an alert if the requisite parameters are matched according to the intensity of the values to the

client. The client receives the alert through a third party API notify-run [5] for which the client priorly has to subscribe to the notification system. Following parameters were taken into consideration for making an alert for landslide :-

- Soil Moisture sensor outputs value lesser than 300.
- Raindrop Module sensor outputs value lesser than 600.
- Accelerometerś or Gyrometerś respective x, y or z values change by a factor of 2000 from previous values.

7. Finally, if all the above three criteria are met, an alert is sent by the cloud system to the client(s).

4 Conclusion

The real-time monitoring of heavy-loss causing calamities like landslides is a very important area to look forward upto because it causes heavy monetary and mankind losses. Hence, the model developed in this report can be deployed in an actual field to monitor the issues in a real-time scenario. The system uses a heterogeneous network comprising of Bluetooth, Internet for efficient delivery of the data infused in real-time to let the nearby people of the prone area about the warnings/alerts.

Bibliography

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