A Paper on Landslide Monitoring System For Konkan Railway Using Wireless Sensor Networks

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***Abstract*— The power of wireless sensor network technology has provided the capability of developing large scale systems for real-time monitoring. This paper describes the efficient use of a wireless sensor network system for landslide detection in Konkan railways Ratnagiri district of Maharashtra, India, a region known for its heavy rainfall, steep slopes, and frequent landslides .When water level in the soil exceeds certain limits resistivity of the soil decreases. So potential gets developed across the electrodes of water potential sensor. The node station regularly with a configurable period measures water potential and temperature of the soil. After that, data are immediately sent to the gateway and a sleep mode is called what ensures energy savings. Since a sampling period will be around 15 min and active mode takes only couple of milliseconds, the end station is able to work more than a year on a two AA batteries. Use of WSN for this application increases efficiency of it. Maximum land slides which occurs in the hilly region of Kankan railway can be avoided by using this particular system**

Keywords: Wireless Sensor Network, Land slide detection, Heterogeneous Networks, Zigbee

I. INTRODUCTION

Konkan railway:

Konkan Railway is a railway line which runs along the Kankan coast of India. It was constructed and is operated by the Konkan Railway Corporation. It runs from Thokur, near Mangalore in Karnataka to Roha railway station in Maharashtra through Goa for a total distance of 741 km, along the west coast of India and Western Ghats.

Challenges in front of Konkan railway:

1) 2,000 bridges and 91 tunnels to be built through mountainous terrain containing many rivers, the project was the biggest and perhaps most difficult railway undertaking during this century, at least in this part of the world.

2) There are challenges posed by the terrain and the elements. Flash floods, landslides and tunnel collapses affected work at many places on the project. The region was also thickly forested, and construction sites were often plagued by wild animals. Despite these problems, work on the project continued, and an effective system of decentralization enabled better efficiency. The entire stretch of 740 kilometres (460 mi) was divided into seven sectors - Mahad, Ratnagiri north, Ratnagiri south, Kudal, Panaji, Karwar and Udupi - of approximately 100 km each, headed by a Chief Engineer.[4] Following the example. Some components, such as multi-leveled equations, graphics, and tables are not prescribed, although the various table text styles are provided. The formatter will need to create these components, incorporating the applicable criteria that follow.

II. PROPOSED SYSTEM:

The major issue of land sliding in the region of nearby 10 main tunnels is focused considering tunnel area as highly influenced area by the land sliding. Use of wireless sensors at certain locations can provide the necessary readings of the different parameters like water potential level, humidity, pressure to the gateway.These gateways acts as the mediators between the WSN and internet. These gateways connect WSN to the nearby station through Ethernet which stations are connected to each others through internet. The nearby station can take preventive action to avoid the disaster. As well as central station will have continuous monitoring of all stations.

<u>Tunnels at which land slide detection system is to be mounted are:</u>

- Natuwadi Tunnel (4 km)
- Chiplun Tunnel (2 km)
- Savarde Tunnel (3 km)
- Parchuri Tunnel (3 km)
- Karbude Tunnel (6 km)

- Tike Tunnel (4 km)
- Berdewadi Tunnel (4 km)
- Karwar Tunnel (3 km)
- Barcem Tunnel (3 km)
- Pernem Tunnel (1 km)

III. GENERAL DESCRIPTION OF THE PROPOSED SYSTEM:

Tunnel opening and closing will carry two sets of nodes to detect occurrence of land sliding. Total 4 nodes which cover the area of 1 kilometer each will be mounted at both the ends so that 4 kilometers at both the ends will undergo continuous monitoring of soils water content. Base station circuitry will be at nearby station which will continuously get the monitored data through wireless link. These all base stations will be connected through an internet and can be monitored through central station far away from the sight.The soil resistivity value is subject to great variation, due to moisture, temperature and chemical content.

Typical values are:

- Usual values: from 10 up to 1000 (Ωm)
- Exceptional values: from 1 up to 10000 (Ωm)

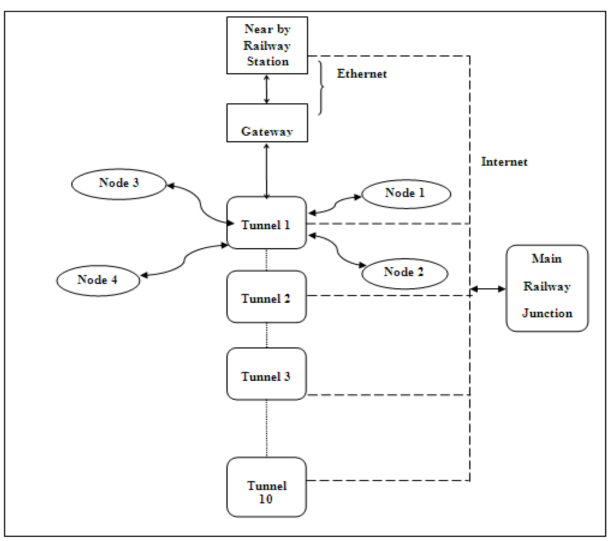

Fig. 1.Generalised Block Diagram of proposed system

IV. BLOCK DIAGRAM:

End Station:

A typical WSN node consists of a microcontroller, a transceiver, sensors and a power source. Design is usually focused on low power consumption, a long range, autonomy and reliability. The hardware concept for both stations is shown in Figure 1 and 2.

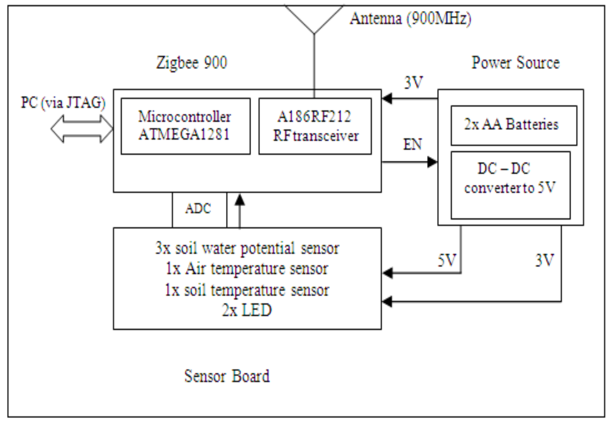

Fig. 2.Block diagram of end station

The end station contains a set of sensors and a flash memory allowing over-the-air firmware upgrade. The power state of the sensors is controlled by the enable input of the DC-DC converter. The voltage value of water potential sensor output is measured by ADCs of the ZigBit module. To compensate temperature dependence of the soil water potential, the sensor set is supplemented by a soil temperature sensor working on I2C.The node station regularly with a configurable period measures water potential and temperature of the soil. After that, data are immediately sent to the gateway and a sleep mode is called what ensures energy savings. Since a sampling period will be around 15 min and active mode takes only couple of milliseconds, the end station is able to work more than a year on a two AA batteries. This time depends on the number of sensors because in a primary stage the each end station will have three water potential sensors to handle inconsistent values. If any remote configuration wants to be made, coordinator must wait until the end device wakes up and then sends an indication message about changes, e.g. a new sampling frequency, to the end device.

Base Station:

The WSN is built on an embedded software stack Bit Cloud, which implements base core of the Zig-bee PRO standard. The transceiver range built in ZigBit900 is limited within 6 km from the base station under optimal conditions in plain land.
Between other special features of this system belongs a firmware upgrade over the air, an user button, which triggers the data sending and a two-stage valve controller for the irrigation scheduling. To improve flexibility and workability

without a computer, a graphic display and SD memory card are implemented. After pressing the user button 1 on the base station, the actual values and settings are shown on the display. The user button 2 is used to plot the latest history. The data transfer and the configuration can be done in both ways, through the SD memory card or directly through the USB port and FTDI converter. The whole application is supported by java program, which visualizes data and performs new settings of the remote end nodes.

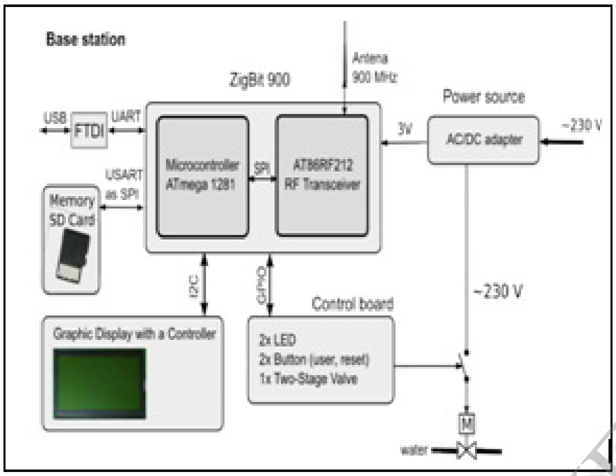

Fig.3. Block Diagram of Base station

V. SYSTEM GATEWAY:

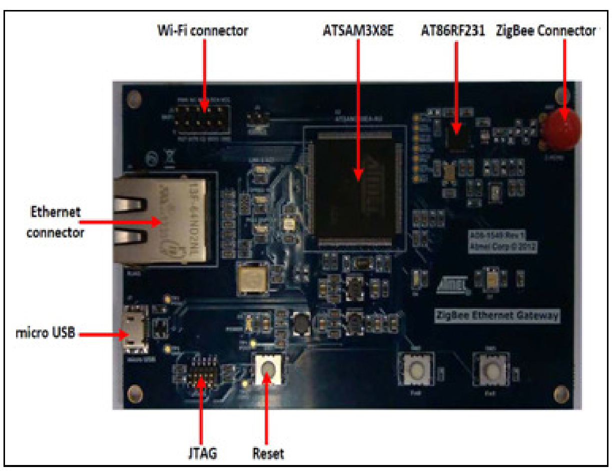

Fig.4. ZigBee to Ethernet and Wi-Fi Gateway with SAM3X

The Atmel ZigBee to Ethernet and Wi-Fi Gateway with SAM3X is a hardware platform to demonstrate built-in functions with ZigBee and Ethernet/Wi-Fi. It is a bridge between wireless network (ZigBee) and wired network (Ethernet), and also a bridge between wireless (ZigBee) and wireless (Wi-Fi). For this reference design, the hardware design files (schematic, BoM and PCB Gerber) and software source code can be downloaded from Atmel website. The provided hardware documentation can be used with not limitations to manufacture the reference hardware solution for the design.

VI. APPROXIMATE SYSTEM COST PER NODE:

- Ziggbit module (Atmel)- Rs.3827.24/-
- AC DC Adaptor- Rs.1420/-
- Ethernet gateway (Atmel)- Rs.4000/-

FUTURE SCOPE:

This system concentrates on detection of land sliding only across tunnel areas as possibility of land sliding is more in these regions as well as blocking of the tunnel affects whole track. With a small modification of VSAT technology or Wi-Fi all hilly areas in the India can be monitored by using this type of system. With a lesser cost than cost required for disaster management after occurrence of it.

CONCLUSION :

Wireless sensor network for landslide detection is one of the challenging research areas available today in the field of geophysical research. This paper describes about an actual field deployment of a wireless sensor network for landslide detection in konkan region. This system uses a heterogeneous network composed of wireless sensor nodes, ziggbee,e Ethernet and internet for efficient delivery of real time data to the data management center. The data management center is equipped with software's and hardware needed for sophisticated analysis of the data. The results of the analysis in the form of landslide warnings and risk assessments will be provided to the inhabitants of the region.

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