Wireless Sensor Network for Secure Railway Operations
R.R.Shewale¹ Sumedh H. Pathak² Nimesh D. Pandè³ Snehal Niphade⁴ Nupur Shimpi⁵
¹Assistant Professor, 2,3,4,5NDMVP’sKBTOCE, Nashik

Abstract—In recent years, the range of sensing technologies is expanding rapidly, whereas sensor devices have become cheaper. This has led to a rapid expansion in condition monitoring systems, structures, vehicles, and machinery using sensors. Key factor is the recent advances in networking technologies such as wireless communication and mobile ad-hoc networking coupled with the technology to integrate devices. Wireless sensor networks (WSNs) can be used for monitoring the railway tracks. Condition monitoring reduces human inspection requirements through automated monitoring. This reduces heavy maintenance through detecting faults before they escalate. This is vital for development, up-gradation, and expansion of railway networks. This paper describes the implementation of various models which shows how the hazardous accidents occur on railway tracks, and how it can be prevented using GSM protocol, micro-controller (Atmega328) and various sensors.

Key words: Wireless sensor networks (WSNs)

I. INTRODUCTION

This paper provides an innovative approach in defining the new security standards in railway transport. This paper contains ways in which the railway transport at present can be made safer in comparison to present scenarios. Railways are considered as the safest means of transportation. But, lots of people suffer due to train accidents. According to research, Indian railways consist of almost 115,000km of tracks. A total of 28,360 cases of railway accidents are reported in the last decade in India; These railway accidents rendered 3,882 persons injured and 25,006 deaths during that year. Reasons for these accidents are human error, signal misinterpretation, system failures, improper maintenance of tracks and points. By controlling some of the parameters, many of such major accidents could have been prevented. To design an automated system to monitor tracks health is of utmost importance. Wireless Sensor Network for Secured Railway Operations so that hazardous accidents occurring on railway tracks in India can be prevented using GSM protocol, micro-controller (Atmega328) and various sensors.

II. SENSOR DESIGN

There are a number of sensors used in railway condition monitoring for analyzing different aspects of structures and infrastructure. The sensors that are implemented in this paper are capable of sensing five parameters. (1)Landslide on tracks or some physical intervention, (2) Flood sensing, (3) Earthquake near railway tracks, (4) Intervention in tracks route caused by a pole tilt. (5) Scenarios where in the railway track has been dislocated.

A. Landslide Detection Sensor.

A light dependent resistor is used in order to detect a landslide or some physical intervention on the tracks. This LDR is used in a circuit and a continuous laser is pointed at the LDR. A break in Laser light pointed at the LDR will result in different voltage across the circuit. This change in voltage will be detected by the arduino which will then trigger an alarm and send the warning message.

B. Flood Sensor.

Flood sensor will be basically used at locations where there is a possibility of floods like bridges or tracks surrounding river cliffs. The working of flood sensor is based on conduction of electricity through water. The sensor will have two endpoints connected at top of a column and one at the bottom considering the bridge scenario. In a situation of flood water will start reaching the topmost end of the column of the bridge. This will complete the circuit, hence triggering an alarm and sending of a warning message.

C. Earthquake Detection Sensor.

Earthquake detection is carried out by using a vibration sensor. This vibration sensor work on piezoelectric effect. A piezoelectric sensor is a device that uses the piezoelectric effect, to measure changes in pressure, acceleration, temperature, strain, or force by converting them to an electrical charge, whenever a dense vibration is sensed in areas nearby tracks the arduino can sense the change in vibrations and trigger an alarm.

D. Pole Tilt Sensor.

Pole tilting due to uneven pressure from the electric wires can be very harmful. In a scenarios where a pole falls on the route of track can be the cause of a harmful accident. This tilting of pole can be sensed using the accelerometer [5].

E. Track Break Sensor

Track break is a very important problem as it can cause derailing of trains. Track break detection sensor is formed by completing a circuit where in a track is an important part of it. In a scenario where a track is dislocated, will result in circuit breach which will trigger an alarm and warning message.

III. SCENARIO DESCRIPTION

A. Landslide Detection

Consider a tunnel on railway track, now consider a scenario where tunnel caves in and block the route. This can cause a big accident if undetected. To detect this type of infrastructure failures we will be focus a light i.e. (laser) onto a LDR (Light Dependent Resistor). This light will pass through the tunnel itself. In case of landslide or tunnel caving, the laser will be obstructed and cause a change in voltage levels. This change in voltage levels will be detected by the arduino which will then trigger an alarm and a warning message.

B. Flood Sensing

Consider a scenario where a railway track is on a bridge. Consider a river flowing below the bridge. Now consider a...
situation where heavy rains have occurred and the river is flooded. This flooding of river can lead to flooding on the railway tracks which can lead to derailing and various accidents. Flood sensing will consist of two points. The first point will be located at the bottom of the column and the other will be located at the top of it. In case of flood scenario the water will complete the circuit and this completion of circuit will trigger an alarm and a warning message to the base station. The responsible authorities can then advise the railway drivers to not go forward.

C. Earthquake Sensor
Earthquake near the tracks can damage the tracks and result in an accident this scenarios can be detected beforehand so that railway driver can be warned beforehand.

D. Pole Tilt Sensor
In railway there are poles which holds heavy metallic wires, which contains high voltage current, which is used by trains for there working. If these poles tilt towards the railway track and obstructs the moving train, then it will result in major accident. To avoid such accidents we have proposed sensing using accelerometer to measure the pole tiltness.

E. Track Break Sensor
Track breakage is the main cause for derailments in railway transport. Tracks can break due to various reasons like natural causes, Animals or even human involvement. Track break is sensed by passing a little current through the tracks. If a track is dislocated the circuit will break and this can be detected by arduino and an alarm will be triggered.

IV. COMMUNICATION
The communication between arduino and command center will be handled by GSM sim 900 module GPRS RS232 Modem from rhydoLABZ is built with SIMCOM Make SIM900 Quad-band GSM/GPRS engine, works on frequencies 850 MHz, 900 MHz, 1800 MHz and 1900 MHz’s It is very small in size and easy to use as plug in GSM Modem. The Modem is designed with RS232 Level converter circuitry, which allows you to directly interface PC Serial port [1].The baud rate can be configurable from 9600-115200 through AT command. Initially Modem is in Auto baud mode. This GSM/GPRS RS232 Modem is having internal TCP/IP stack to enable you to connect with internet via GPRS. It is suitable for SMS as well as DATA transfer application in M2M interface.

V. ARDUINO
The sensor values will be processed using an arduino card. It has 14 digital input/output pins .6 analog inputs, a 16 MHz crystal oscillator, a USB connection, an ICSP, an power jack, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.

VI. ALGORITHM
In this proposed system continuous monitoring is of utmost importance. As per the working of this system sensors should continuously scan for their respective parameters. Hence we propose a Sequence step algorithm.

VII. WORKING OF SENSORS
A. Landslide Sensor
In landslide sensor we will be using a light dependent resistor. Light dependent resistor changes its resistance as per the presence of light. In order to check landslide a circuit consisting of this resistor will be placed at a mountainside cliff or in a cave. A light will be focused on this resistor continuously. If a landslide occurs in this situation then it
will obstruct the light hence changing the output voltage from the circuit.

The change in Vout will be an indicator that landslide has occurred.

1) Earthquake Sensor

To detect earthquake in earthquake prone areas a digital sensor like vibration sensor running on piezoelectric principle.

This sensor can be placed at areas which frequently experience earthquakes. In case of earthquake the vibration sensor will pick up the seismic activities in the ground, depending on the set limits arduino can alarm the responsible personnel [2].

2) Pole Tilt Sensor

To detect pole tiltness accelerometer can be mounted on poles that are close to railway tracks [2].

Accelerometers contain mercury and can detect slight change in pole position.

3) Flood Sensor

Flood sensing can be done by creating a circuit that has two endpoints dipped in water completing the circuit.

To create a flood sensing circuit one end of the circuit in water and the second end can be placed at the danger point. In a flood condition water the first endpoint will be submerged in the water, when water touches the second wire it will complete the circuit.

This completed circuit will indicate a flood.

4) Track Break Sensor

To detect track break on a railway track a small current can be passed through the tracks. This can be made into a circuit.

In case of track break the circuit is going to break this will result in stoppage of current in the circuit. The Vout will change and track break will be detected.

VIII. GOALS AND SCOPE

This system will be a better alternative to the current security scenarios. The technology advancements that the world is seeing requires modern thinking and approach to create a safe and secure travelling to each and every person.

The proposed system will help railway officials to stop various accidents and also maintain the railway networks efficiently.

Various scope for this system considering the parameters that it senses. In future the vibration sensor can be used to denote the speed of the train by detecting the vibrations on the track.

Using web API many alerts can be sent at a time and unlike current scenario alerts can be sent to various control stations.

IX. CONCLUSIONS

Manual Monitoring and maintenance is very difficult and takes more time. To avoid accidents or delays, our proposed system will immediately notify and inform the authorities and current train driver coming on the track through wireless medium. Hence it is expected that, major train mishaps can be prevented and human life can be saved if this system is implemented.

Various human errors can be avoided as system will have major control over the sensing of railway tracks.