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Monitoring Rail Traffic Using Wireless Sensor Network (WSN)

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***Abstract*--- Due to the fact that most rail lines located in mountainous or desert having a monitoring system to check the safety of these lines is very important. According to performance of wireless sensor networks, it is very useful in monitoring system of rail lines. In this paper, an algorithm failure tolerant (FT) is provided for monitoring the rail lines. This algorithm is based on the simultaneous use of movable and fixed sensor network design that has the ability to send information as online-offline.**

***Keywords*--- Fault tolerant, rail lines, wireless sensor networks.**

I. INTRODUCTION

Rail Line is one of the safe and secure ways to carry goods and passengers, but there is some defects in railway system such as deterioration of line balance and old lines. So having a secure system for bridges and railway Line is required, particularly in finding defects. By using wireless sensor networks we can establish a system to monitor rail Line according to advantages of the sensor network, cost and time will be reduced And quickly identify the hazardous areas to prevent possible accidents. Wireless sensor network is composed of three main units: Sensor nodes, hardware and data collection, a visual way. Sensor nodes that are closely related to gathering information and sending them to the sink node.

II. WIRELESS SENSOR NETWORKS IN RAILWAY

Sensor techniques, helps to detect defects in railway lines and prevent accidents. The most interesting feature of the wireless sensor networks is being multi-layered that starts at the lowest layer and continues to the next higher layer. One of the important applications of wireless sensor network is monitoring the rail lines.

III. CARIES DETECTION AND FRACTURES METHODS IN THE RAILWAY

One of the most serious causes train derailment is fractures in rail line. To detect defects, ultrasonic will be Checked practically. In this technique, some high-energy electronic signs will be published in two directions at certain distance. Published Symptoms will be received by the receiver. The ultrasonic waves are sent to receivers in different times with the same frequency by transporters then; the receivers can find the path they have received. If there is no break in coverage area by the signals, received amplitude of wave will decrease.

IV. ALGORITHM

As we know Energy consumption of sensors and the error event are important challenges in wireless sensor networks. In this article an algorithm is presented that reduce fault tolerance and energy consumption in a network therefore network lifetime will increase.

Checking the algorithm: This Algorithm is divided into two parts:

A. Movable Algorithm
B. Fixed Algorithm

The fixed algorithm is related to sensor networks that are in places such as bridges, tunnels and special points. This algorithm collects information about seismic data and the bridge balance and Cracking in the foundations of bridges and Pressure on the bridge and investigates this information. Movable algorithm, will displayed that how to collect information of fixed sensor network by installed networks on the locomotive or monitoring cars Also it check the balance point line and register in a data position. In this system, GPS will detect coordinates of points that their data is registered. Next, algorithm of these two sections will be presented.

A. Movable Algorithm

This section, monitor surfaces of the Rail trains during the movement of train. By analyzing collected information by sensors it determine the points in rail lines that need to be fixed.

1) Message Types

Ordinary messages that contain raw data or process data.

Messages correspond to find errors such as sensors, server and the buffer to ensure they are functioning.

2) Data Structure

- Data received from sensors.
- Sensed position by each sensor.
- Data related to TCP protocol

Sensors should be active and remain in active mode while system moves. Sensors change to SLEEP mode when train stop(SET timer) or timer reaches to T.

Sensors transfer Sensed data to PC and it stores Sensed data with their position.

3) System Can Be Considered With Or Without Buffer

A. System With Buffer

1) Send Online

Data frames send by PC to buffer. PC, First checks connection if it was connected data online form sends to buffer after that buffer send data to server. Otherwise PC stores the data until the connection is established.

2) Send Offline

PC evacuates stored data when it lies in server radius.

B. System Without Buffer

If connection was established data will be sent online. Otherwise Data will be stored in PC until reach to next server radius. Suppose server always is normal but in optimal method before sending data it should be ensure that the server is enabled.

1) Sensor Check

If in a certain time, if the sensor do not sends data to PC therefore sensor is broken.

Note: Buffer can be placed inside PC In this case upon failure from buffer, this failure is detected by the PC.

B. Fixed Algorithm

This section is designed and implemented corresponds to important parts such as concrete and steel bridges, risky mountainous areas and also tunnels. Data collected in this network includes factors such as broken legs of bridges, pressure on the bridge and their subsidence, collapse tunnels and seismological data in mountainous area.

V. DETECT VARIETY OF MESSAGES

- Ordinary messages, which must include destination field.
- Warning message, this message is sent by CH to all sensors and for inform of Failure state of storage nodes.
- This message is sent by CH to all sensors and that means Storage nodes returned to normal work state and the network begin to work normally again.

A. **Algorithm**

The sensors do not need work all of the time. At first Sensors are in "Sleep state". In T1 period time they would "ACTIVE" and begin to sense data. After T2 seconds change to sleep state again.

Note: All of sensors are formed in clusters.

The S1 node sends its data to CH.

B. **The Method Of Sending Data From Ch To Sink**

- Online Method: in this method intermediate nodes or satellite system can be used for sending data to sink.
- Offline Method: in this method data are stored in CH memory while the train or a collector device would reach. When collector device located in board of CH node, this node then sends its data to collector and as collector reaches to station which sink is located in it, it sends data to sink.
- In addition all information, there is A field that called FAULT STATE In sent message, it notify the sink of the sensor Failure. If a node is Crashes this field will be set to one (1).

  (A copy of the latest relevant table can be sent).

C. **The Fault Tolerant Algorithm**

Fault tolerant is an important factor in WSN. This part of algorithm is designed to reduce the impact of Fault on the network.

CH IS CONTAINED IN THE FOLLOWING TABLE.

Sensor id	Sensor type	Fault state (f)
Position /id/name	Normal/storage	0 for 0 for fault free node 1 1 for faulty node

At T3, all nodes are in active mode. (During T2 this operation can be detected online by using failure detection algorithms). And the failure detection algorithm is implemented on nodes and the table is updated according to it.

- The table in CH will be Searched and a node founded that Fault state of it is equal to 1:

If the node is normal its status will be determined for troubleshooting in frames which is sent by CH.

- If the node is storage node:

S1 node is corrupted and S2 node is correct. In this case, CH, send its requests to s2 and received Data from it. Then S1 field will be sent by CH to troubleshooting.

S1 and s2 Nodes are damaged. Then CH sends warning message to all nodes. When Nodes receive it send their data to the CH directly. (For each node, a buffer or temporary memory can be specified to collect data temporarily). After troubleshooting, a normal message will be sent to all nodes by CH and network will work normally again.

S2 node is damaged in this case CH reports this status by sent data.

VI. CONCLUSION

Existence of rail lines and moving goods and passengers through it, requires constant monitoring of the security status of these lines, therefore using a wireless sensor network is one of the most accurate and safest way for it.

In this article a failure tolerant (ft) algorithm is presented that provide monitoring of rail lines. In this algorithm, the network is Divided into two parts, fixed and movable parts that has the ability to transfer information online or offline.

At present authors of this article are designing and manufacturing platform for the practical implementation of this algorithm and they are testing it on rail line to evaluate the performance of these algorithms in a real environment. Also in the future to increase efficiency, this algorithm can be implemented and be applied in the form of fuzzy logic.

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