An Automated System to Mitigate Loss of Life at Unmanned Level Crossings

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Overview

1. First Section

Problem Statement

To develop an automated system that provides an early-warning about an approaching train at unmanned railway level crossings using the Internet of Things (IoT).

Need for this work

- In India, 61% of railway related fatalities are attributed to accidents at Unmanned Level Crossings as shown in this figure.
- Nearly two thirds of the total number of Level crossing accidents occur at unmanned Level Crossings and this proportion has been increasing ever since.
- The proposed prototype is a cost-effective solution and much easier-to-implement with lower time and financial overheads than the traditional methods.

Figure: A chart showing the Loss of lives in train accidents (in percentage)

Proposed Solution

- Provide an audio-visual indication to the people when there is an approaching train.
- Create a log file for the administrator that records the values at various nodes periodically via Internet.
- Visualize the acquired information as graphs to identify areas where speed limit can be imposed to avoid catastrophe.

Data Flow in the system

- Data is collected by the end devices is uploaded to the cloud server on beagle bone black.
- Data processing is done using a python script which appends the received data to a local data base and to a comma separated value (csv) file.
- The graphs are generated using the Google charts API and a csv file which can be accessed from the cloud server by the administrator to monitor the devices.
- The data extracted from the csv file contains the details of the sensor reading from all the sensors along with a timestamp, each in separate columns.

Hierarchical Flow of Data in the System

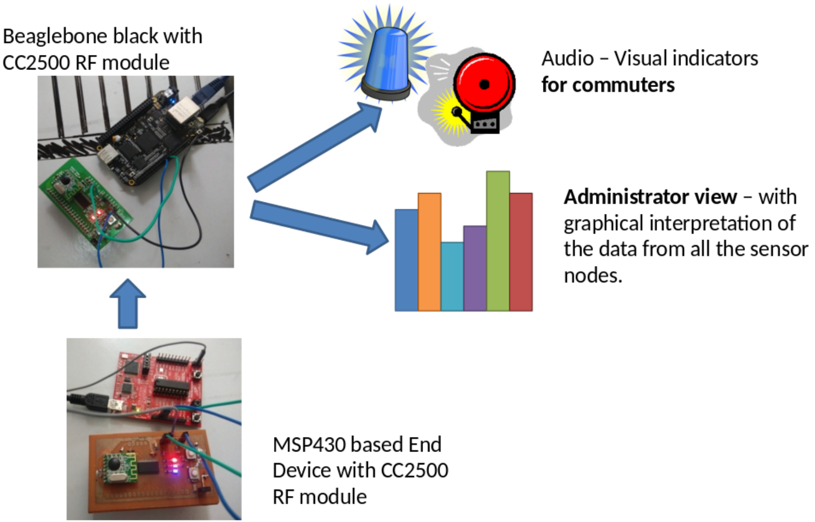


Figure: The hierarchical flow of data between devices in a large-scale deployment

Implementation

- The proposed solution has two devices namely the
  1. base system (placed at the rail-road crossing)
  2. end device (multiple device placed along the track)

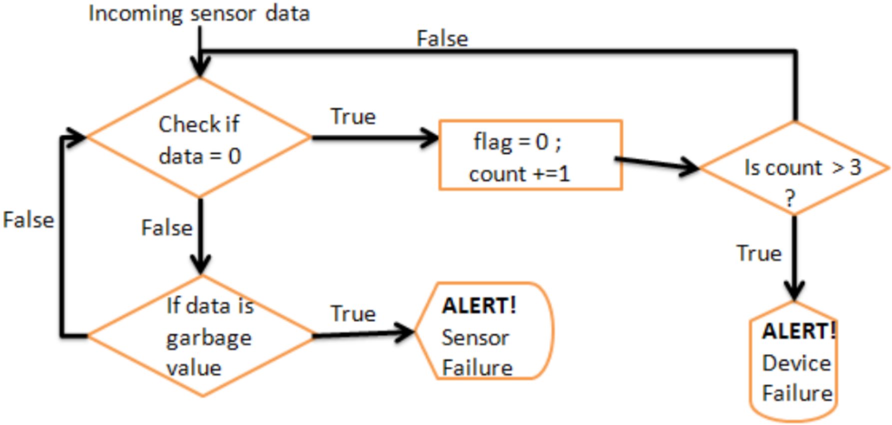
- The proposed model of the warning system uses sensors as inputs from various points across a fixed distance and sounds an alarm and a visual indication with LED strips in case a train approaches.

- The sensors are controlled by MSP430. The Beagle Bone is the master controller.

- The communication between the Beagle Bone and MSP430 is wireless and is encrypted with XXTEA to ensure reliability of the data.

Hardware Health Monitoring

The scenarios which indicate that the system is not functioning and when the administrator is needed to take the decision are as follows:



Results

Securing data communications between sensor nodes and access points

Data at the sensor Nodes (Sender)		Data at BeagleBone Black (Receiver)	
Actual Data	Sent Data	Received Data	Actual Data
*4@61$126 %307^1017#	Ik(ƒ(”r+ Ý Ïk(ƒ(”r+	Ik(ƒ(”r+ Ý Ïk(ƒ(”r+	*4@61$126 %307^1017#
*1@237$304 %426^691#	Z‡R¯□ Wûř^Xš U Ž‡R¯□ Wûř^Xš	Z‡R¯□ Wûř^Xš U Ž‡R¯□ Wûř^Xš	*1@237$304 %426^691#
*3@563$513 %580^114#	¿íE1ǒ[”‹r ‹å ¿íÉ1ǒ[”‹r ‹	¿íE1ǒ[”‹r ‹å ¿íÉ1ǒ[”‹r ‹	*3@563$513 %580^114#

The csv file maintained by Beaglebone black with data from the sensor nodes

	A	B	C	D	E	F
1	timestamp	deviceid	pressure	vibration	magnetic	proximity
2	10/25/2015 11:24:30	4	61	126	307	1017
3	10/25/2015 11:24:31	1	237	304	426	691
4	10/25/2015 11:24:32	3	563	513	580	114
5	10/25/2015 11:24:33	4	793	981	937	274
6	10/25/2015 11:24:34	1	1021	978	925	219
7	10/25/2015 11:24:35	3	381	389	238	670
8	10/25/2015 11:24:36	4	660	762	808	314
9	10/25/2015 11:24:37	2	993	985	912	37
10	10/25/2015 11:24:38	1	59	89	356	896
11	10/25/2015 11:24:39	3	443	337	357	701
12	10/25/2015 11:24:41	3	217	84	263	763
13	10/25/2015 11:24:42	1	791	944	785	244
14	10/25/2015 11:24:43	1	622	344	457	1001
15	10/25/2015 11:24:44	3	856	750	846	343
16	10/25/2015 11:24:45	3	632	919	932	153
17	10/25/2015 11:24:46	2	825	969	869	397
18	10/25/2015 11:24:47	2	92	370	89	1014

Outcome of this research work

- We have created an IoT-based platform to build an early warning system for unmanned railway crossings.
- The data thus collected in the csv file will be used to model a prediction algorithm that can understand traffic patterns and suggest suitable alterations to the running time and establish block-section limits to prevent accidents.

Conclusion and Future Work

- We introduced an automated early warning system prototype for unmanned level crossings that uses IoT.
- Our implementation the system works perfectly & consumes minimal energy.
- The system will be modified to sense the presence of any animal on the track, and a caution signal will be broadcasted to the trains in the vicinity.
- An effective communication standard is being identified to minimize the delay in communication between the sensor nodes and the decision hub.

Thank You!

Video Demo: https://www.youtube.com/watch?v=tp3ERH4CHD4