FACULDADE DE ENGENHARIA DA UNIVERSIDADE DO PORTO

Influence of outliers in a railway remote monitoring system

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DRAFT VERSION

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Symbols

kbps	Kilobit per second (often used kbit/s or kb/s) - bit rate
Mbps	Megabit per second (often used Mbit/s or Mb/s) - bit rate
Gbps	Gigabit per second (often used Gbit/s or Gb/s) - bit rate
dB	Decibel - Gain/Attenuation
kHz	Kilohertz - Frequency
MHz	Megahertz - Frequency
GHz	Gigahertz - Frequency
km	Kilometer - Distance
min	Minute - Time

Chapter 1

Introduction

This chapter presents the context, motivation and document structure of a study of outlier detection in a railways WSN-based smart grid.

1.1 Context and motivation

Smart grids are conceived as electric grids that deliver electricity from generation points to consumers, having the feature of controlling the entire process.

In railways...

Outliers are bla bla,..,.

The study of outliers is relevant due to it's influence in ....

With this work it is expected to raise the awareness of outliers detection in the phd study

1.2 Document structure

This document is divided in 4 chapters, each of them incorporate the relevant subsections to present the subjects mentioned

Table 1.1: Document structure

Chapter	Title
1	Introduction
2	Railways Remote Monitoring Systems
3	Outliers Detection
4	Future Research
5	Conclusions

Chapter 2

Railways Remote Monitoring Systems

In this chapter it is an overview of the railway system where the outliers detection is expected to be studied.

2.1 Smart Meters

2.2 Synthesis

Chapter 3

Outliers Detection

In this chapter it is made the study of the state of the art of outliers and it's relevance in railways.

3.1 Definition of outlier detection

Outlier detection is a computational task to detect and retrieve information from erroneous data values. The definition is usually close to anomaly detection or deviation detection.

3.2 Outlier detection in WSNs

Wireless sensor networks (WSNs) has been widely used in several applications in several domains such as industrial, scientific, medical and others. Those applications has been supported by the advances in wireless technologies as well as in the evolution of microcontroller technologies, with enhanced processing capabilities associated with reduced energy consumption.

3.2.1 Motivation

"In sensor networks, the majority of the energy is consumed in radio communication rather than computation" ... in the particular case of Sensoria sensors and Berkeley motes, the ratio of energy consumption between computation and communication modes is between 1000 and 10000 <rajasegarar2007>. Thus, an research opportunity is raised to reduce the communication usage of μCs by adding processing features towards the redution of energy consumption.

The motivation of detecting outliers in data acquired from WSNs has been extensivelly presented in the literature. The need for acquire data from harsh or "highly dynamic" environments as well as the need to validate and extract knowledge from the acquired data are one of the main points in the motivation to study the outlier detection in WSNs. <zang2010> <chandola2009> <ghorbel2015> <martins2015>

3.2.2 Research areas

Zhang et al. <zhang2010> identifies the outlier detection research areas in three domains:

- Intrusion detection: Situation caused by malicious attacks, where the detection techniques are query-driven techniques;
- Fault detection: Situation where the data suffer from noise and errors and where the detection techniques are data-driven ones;
- Event detection: Situation caused by the occurrence of one atomic or multiple events and where the majority of the research has been developed due to the complexity of detecting and extracting information on ?? upper layers ??

Based on the division of this three domains, the upcoming research is intended to be focused on the event detection techniques. ?? The railway environment requires closed subsystems that meets specific standards. Despite the intrusion detection should be considered, this must be took into consideration accordingly to the development and implementation of the wireless smart metering system for the railways. ?? The fault detection should and must be taken into consideration and the data outcome must be, preferably, a null value with a warning raised. ???

3.2.3 Challenges

The challenges of outlier detection in WSNs are related to the quality of the acquisition of the sensors, the fiability of the modules in terms of energy or environmental susceptibility, and the communication requirements and restrictions.

Zhang et al. <zhang2010> lists the challenges as the following:

- Resource constraints;
- High communication costs;
- Distributed streaming data;
- Dynamic network topology,
  frequent communication failures,
  mobility and heterogeneity of nodes;
- Large-scale deployment;
- Identifier outlier sources;

Thus, the main challenge faced by outlier detection techniques for WSNs is to satisfy the mining accuracy requirements while maintaining the resource consumption of WSNs to a minimum [21]. In other words, the main question is how to process as much data as possible in a decentralized and online fashion while keeping the communication overhead, memory and computational cost low [1].

Table 3.1: My caption

Zhang et al.			
Input sensor data	attributes	univariate/multivariate	Nature of i
	correlations	dependencies among the attributes sensor nodes	
		dependency of sensor node readings on history and neighboring node readings	

3.3 Classification of outlier

Zhang et al. <zhang2010> presents aspects to be used as metrics to compare characteristics of different outlier detection techniques. In parallel, Chandola et al. <chandola2009> presents a similar approach for the classification of outlier detection. In the following table is present a comparison between the

3.4 Taxonomies

Chapter 4

Future Research

In this chapter there are presented the future steps in research on outliers detection on railways WSN-based smart grid.

4.1 Outliers detection definition

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4.2 Synthesis

Chapter 5

Conclusion

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