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An Approach to Detection of Tampering in Water Meters

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Abstract

Meter tampering is defined as a fraudulent manipulation which implies a service that is not billed by a utility company. It is a lack of consumption control for the utility company and a main problem because they represent an important loss of income. We have developed a methodology consists of a set of three algorithms for the detection of meter tampering in the Emasesa Company (a water distribution company in Seville and one of the most important of the country). The algorithms were generated and programmed after a data mining process from the database of the company and they detect three type of consumption patterns: Progressive drops, sudden drops and abnormally low consumption. The methodology has been tested with in situ inspections of the customers of a village of the province of Seville. Once carried out the inspections by the utility, the inspectors confirmed a good success rate taking into account that the detection of this type of fraud is very difficult because it is a non-invasive technique. Besides, this type of detections is a topic that, if we take a look at the state of the art, there are few references or works.

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1. Introduction

Water is one of the most important resources of the world and, therefore, a water utility is one of the most important utilities because water is both essential for the survival of the human race and can act as an important energy resource. Governments invest a great quantity of money to ensure the distribution of potable water to the inhabitants of cities and towns; as a result, it is very important to establish a good infrastructure for water distribution, from the place in which it is stored and/or gathered to houses. This infrastructure is very expensive and, in some places, it is necessary to establish some means to control the consumption.

Meter tampering is defined as a fraudulent manipulation which implies a service that is not billed by a utility company. This type of losses represents a lack of consumption control for the utility company, as it does not allow for registering of the customer's consumption as well as a proper billing of the service [1]. Although the losses provoked by meter tampering are a major source of loss, the losses can be also due to leaks, meter malfunction or illegal water connection.

The utilities usually install a meter that registers the consumption of the customer in each house or place where the water needs exist. Thus, the utilization of new meter infrastructure, databases and information systems has provided the perfect scenario for the application of data mining and computational intelligence in the analysis of consumers' consumption for detection of meter tampering. Currently, some older water meters are in use, which are more vulnerable to different types of fraud or illegal manipulation. In addition, the new technologies related to smart grids [2], [3] will provide additional information, which will increase the amount of information regarding the consumption of customers.

Aided by the experience in power utilities [4][5], our research group has been working for the whole of 2013 and part of 2014 on the detection of meter tampering in water distribution. Thus, as a result of our work, a methodology for fraud detection in water consumption generated from a data mining process is proposed in this article. The methodology is composed of several algorithms based on the detection of customers with suspect drops in their consumption and abnormally low consumption. Besides, we have added a module of geographical location for the customers detected.

If we take a look at the state of the art, there are relatively few references regarding detection of meter tampering using data mining of the water distribution data. Thus, [6] proposed the utilization of remote systems to increase the control in the distribution network and to model the behaviour of the network from the demand and losses viewpoint; thus, the author used pressure and flow sensors. The proposed solution is applied in a real case in a water distribution network in Herzegovina (Bosnia and Herzegovina). In general, several references exist that are dedicated to water demand modelling, a good example of which is the model proposed by [7] in which the author describes a model of the different consumption levels (residential and non-residential) and the losses model, which includes well-defined examples and categories supported by statistical data from several countries. On the other hand, [8] proposed an application for fraud detection in water distribution based on a Supervisory Control And Data Acquisition (SCADA), which uses a data-driven Decision Support System (DSS), applying a water flow active control in the water distribution network.

2. Meter Tampering in Seville (Spain)

We worked with the Emasesa Company (Empresa Metropolitana de Abastecimiento y Saneamiento de Aguas de Sevilla), which is the most important water distribution company in Seville and one of the most important companies in Spain.

The problem of meter tampering in water distribution is a well-known fact to all companies in this sector. Thus, sometimes, this illegal manipulation of the meters can be applied in a very short period of time. There are various fraudulent methods as carrying out a direct connection, removing or bypassing the meter. But the main way that the customers have for the illegal manipulation occurs because the older water meters are based on an oscillating piston or disk, which relies on the water to physically displace the moving measuring element in direct proportion to the amount of water that passes through the meter. The piston or disk moves a magnet that drives the register. This type of meter can be manipulated using an external strong magnet to slow down and, even, stop the magnet that drives the register. The detection of this type of fraud is very difficult because it is a non-invasive technique.

Currently, there are additional modules for old meters to avoid this type of fraud based on the common magnets. They include a new fraud detection system based on the detection of magnetic fields. Thus, if the register detects one, it will enable an alarm. The thing is that the implantation of such modules is very expensive, and sometimes, the installation of a smart meter is cheaper than the installation of the methods to avoid the magnet fraud. Thus, Emasesa Company is progressively implementing this type of smart meters in homes, but it is an expensive process and even most customers have the older meters.

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