Analyzing of Electromagnetic Exposure from GSM Antennas Using Data Mining Techniques

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Abstract

Nowadays, overall the world the Electromagnetic Fields radiated from telecommunication antennas are main source of electromagnetic pollution in urban, especially when base antennas located adjacent the living areas such as homes, schools, hospitals in city. In this study, electromagnetic pollution measurements were analyzed with 3 different cluster for base stations which is placed at different locations in a city center. K-means algorithm is used for clustering. The data used are obtained from the Report named "Electromagnetic pollution 2012 study in Rize" which is published by the SEMAM (The electromagnetic research center of Sakarya University). Clustering option is determined by the parameters such as the distance from homes to base stations, measurements of electromagnetic field data's risk status.

Keywords: Data Mining, Open Source, Sample Application, electromagnetic pollution, GSM antennas

1. Introduction

Electromagnetic pollution occurs every time electricity is generated. We are surrounded by it whether from mobile communication towers, satellite GPS systems, wireless networks, radar, power lines. In recent years because of increasing number of GSM base stations around us, electromagnetic exposure has been increasing indoor and outdoor environments. People living near base stations, especially in indoor places, may be exposed to several times more electromagnetic field than those living farther away from base stations.

Intensity of electromagnetic radiation emitted from base station antennas changes according to parameters such as being in the main lobe of antenna, distance from the antenna and exposure duration [1]. Unnoticed continuous exposure situation occurs for a human being who lives against or near the base station antennas or spends a considerable time there. Therefore, monitoring the trend of increasing electromagnetic field in GSM frequencies by performing control measurements at indoor places in parallel with the evolution of base stations in cities are important to determine the involuntary exposure to electromagnetic radiation. Information derived from these studies is used to control the levels and estimate the future values of electromagnetic radiation in cities and specify the minimum electromagnetic exposure possibility [2].

Safety requirements for limiting exposure to time varying electric and magnetic fields are enforced by regulations. At international level, safety guidelines for electromagnetic exposure of workers/general public and controlled/uncontrolled environments have been issued by the International Commission on Non-Ionizing Radiation Protection (ICNIRP Guidelines). The

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ICNIRP guidance's for EMF exposure which GSM base stations must satisfy changes between 41 V/m and 61 V/m depending on the operating frequency. Some countries such as Switzerland, Italy and Poland have applied lower limits in sensitive areas from ICNIRP levels. The limits for the total EMF's from GSM base station antennas are 5 V/m in Switzerland and 7 V/m for Poland. The regulations for GSM frequency range have been generated with reference to the ICNIRP regulations by BTK (Information and Communication Technologies Authority) in Turkey. Total GSM exposure limits generated by BTK are equal to ICNIRP reference levels [3].

Maximum permissible exposure limits for single GSM and total environment at GSM frequencies presented in BTK guidelines are given in Table 1 Single GSM exposure limit for electric field is 1/4 of total GSM exposure limit of BTK and ICNIRP reference level.

Table 1. Single GSM and Total GSM exposure limit for electric field

Frequency	GSM Band Electric Field Strength (V/m) (Single GSM)	GSM Band Electric Field Strength (V/m) (Total GSM)
900 MHz	10.23	41.25
1800 MHz	14.47	58.34
2100 MHz	15	61

In this study, we are analyzed electromagnetic exposure living areas using the data mining techniques. Generally, data mining is the process of analyzing data from different perspectives and summarizing it into useful information. Data mining software is one of a number of analytical tools for analyzing data. It allows users to analyze data from many different dimensions or angles, categorize it, and summarize the relationships identified. Data mining is the use of automated data analysis techniques to uncover previously undetected relationships among data items. Data mining often involves the analysis of data stored in a data warehouse. Three of the major data mining techniques are regression, classification and clustering. In this research paper we are working only with the clustering because it is most important process, if we have a very large database [4]. The present paper has the following organization. Section 2 outlines the concepts of clustering and k means algorithm. Section 3 interprets the results of application with graphics. And the last section concludes this paper.

2. Materials and Method

2.1. Data

Used data obtained from the Report named "Electromagnetic pollution 2012 study in Rize - Turkey" which is published by the SEMAM (The electromagnetic research center of Sakarya University). Clustering option is determined by the parameters such as the distance from homes to base stations, measurements of electromagnetic field data's indoor or outdoor environment and risk status.

2.2. Cluster Analysis

Cluster analysis or clustering is the task of assigning a set of objects into groups (called clusters) so that the objects in the same cluster are more similar (in some sense or another) to each other than to those in other clusters. Clustering is a main task of explorative data mining, and a common technique for statistical data analysis used in many fields, including machine learning, pattern recognition, image analysis, information retrieval, and bioinformatics.

The key input to a clustering algorithm is the distance measure. In Figure 1, the distance measure is distance in the two-dimensional (2D) plane. This measure suggests three different clusters in the figure. In our clustering study, the distance measure is often Euclidean distance. Different distance measures give rise to different clusterings.

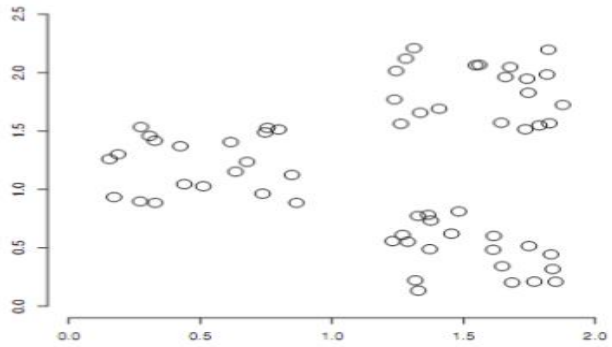

Figure 1. An example of a data set with a clear cluster structure.

Cluster analysis itself is not one specific algorithm, but the general task to be solved. It can be achieved by various algorithms that differ significantly in their notion of what constitutes a cluster and how to efficiently find them. Popular notions of clusters include groups with small distances among the cluster members, dense areas of the data space, intervals or particular statistical distributions [5].

2.3. K means Clustering

K-means is one of the simplest unsupervised learning algorithms that solve the well-known clustering problem. The procedure follows a simple and easy way to classify a given data set through a certain number of clusters (assume k clusters) fixed a priori. The main idea is to define k centroids, one for each cluster. These centroids should be placed in a cunning way because of different location causes different result. So, the better choice is to place them as much as possible far away from each other. The next step is to take each point belonging to a given data set and associate it to the nearest centroid. When no point is pending, the first step is completed and an early groupage is done. At this point we need to re-calculate k new centroids as bary centers of the clusters resulting from the previous step. After we have these k new centroids, a new binding has to be done between the same data set points and the nearest new centroid. A loop has been generated. As a result of this loop we may notice that the k centroids change their location step by step until no more changes are done. In other words centroids do not move any more [6].

3. Results

In this data mining analysis, the city of Rize's 105 measured electromagnetic fields values which is originated from base antennas were used. From the number of 105 electromagnetic fields levels were separated three different risk groups. Named ND (Normal Dose) which is contain $0<E<0.99$,KED (Acceptable dose) which is contain $1<E<2$, RD (Risky dose) $E>2$ .the dose's distributed by using different physical parameters like distance from the base station to measurement point of electromagnetic fields, and electromagnetic field's values. Obtained cluster's distributions are shown in Figure 1 and Figure 2.

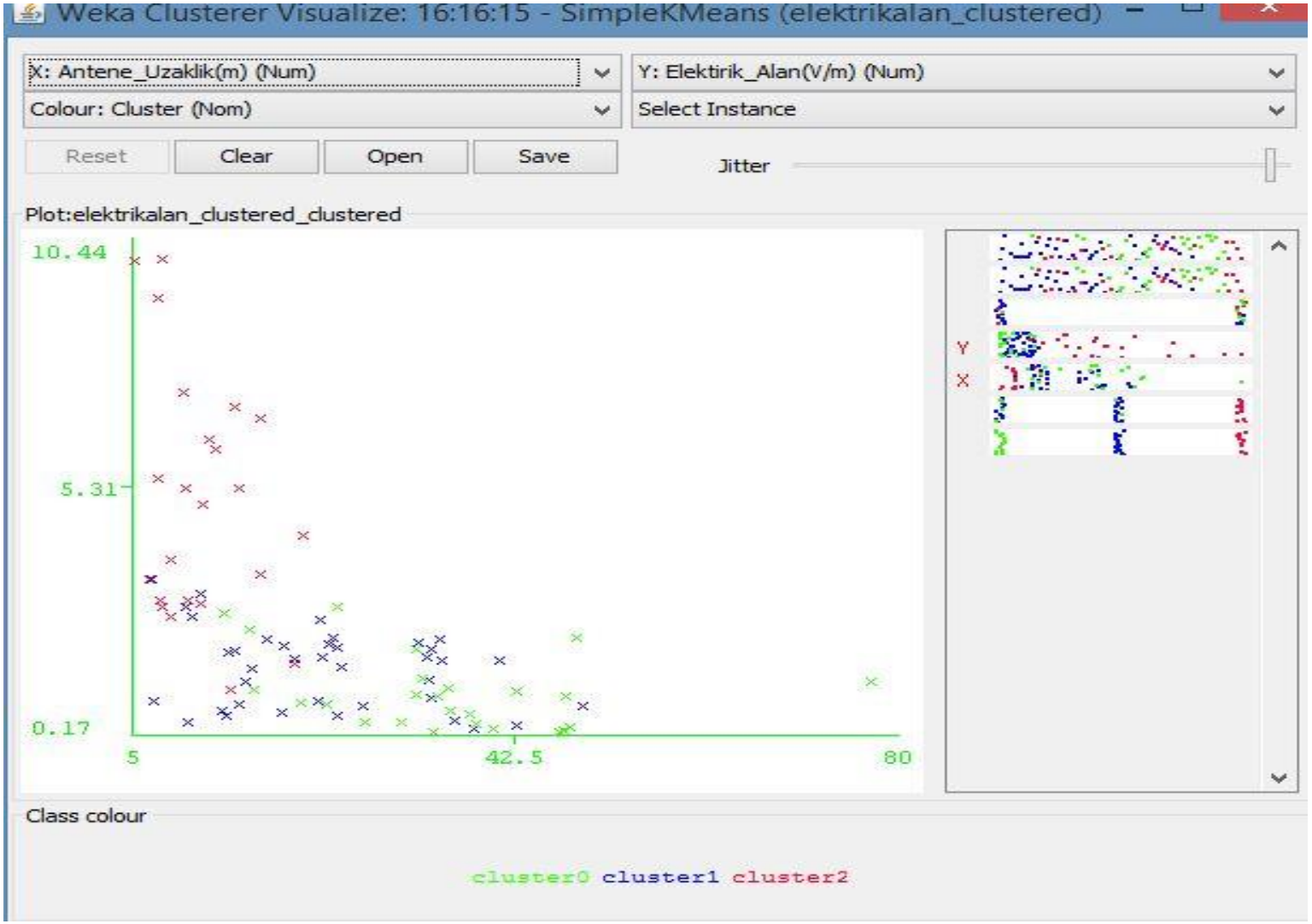

Figure 1. Cluster of Electric field values with reference to the distance of antenna

Figure 2. The distribution of clusters according to risk situations

Conclusions

In this study an application of clustering was realized by using measurement of electromagnetic field values radiated from base stations, in the a Turkey's pilot city. Measurement values were analyzed by three different clusters and obtained results were shown with clustering distribution in graphics. Figure 1 shows the clustering results as electromagnetic values with GSM antennas distance. Accordingly, in places which are close to the GSM antennas, electric field values are seen scattered especially in the Cluster 2 set.

Also, every at 3 different clusters in which composed of electromagnetic field exposure, appeared risk situations. First one is Cluster 0 have ND (Normal Dose)'s risk status, second is Cluster 1 have both ND (Normal Dose) and KED (Acceptable dose) risk status, and finally Cluster 2 only have RD (Risky dose) risk status which electromagnetic values are higher than 2V/m.

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