A Preliminary study of vehicular traffic distribution in Great Mendoza area. Use of IoT tools.

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Abstract. This paper discusses the use of Radar Sensor Network at Great Mendoza area in order to register and to store vehicular traffic information. Both the network features and the software used in order to analyze and post process the captured information are provided. The main issues of vehicular traffic flow at Great Mendoza area are described from a qualitative point of view.
Preliminary results registered with a Radar Sensor Networks placed at Godoy Guaymallén department are discussed as well. Based on the obtained results it can be expected that this kind of tools be very useful in order to alleviate vehicular traffic bottlenecks and related problems.

Keywords: Vehicular Traffic, Radar Sensor Network, IoT, Great Mendoza Area.

1 Introduction.

The appearance of Internet of Things (IoT) [1] allow us to analyze different problems of practical interest. For instance, the vehicular traffic flow in large cities, a problem whose analysis and modeling is typical of the field of Smart Cities.

This paper presents and discusses the implementation of the radar sensor network, placed at Guaymallén department located in Great Mendoza zone.

This work is framed within the context of the research project "Studies on the contribution of technologies such as Blockchain, NFT and VPN to security in IOT platforms" [2,3].

The work is organized as follows: First, the qualitative description of some vehicular traffic problems in the area of Great Mendoza is provided. The radar sensor network installed at Guaymallén municipality is described in section 2. Some preliminary results obtained are discussed in section 3. Finally, the conclusions of the work and the corresponding bibliography are presented.

2 Great Mendoza area vehicular traffic issues

The Province of Mendoza, located in the west of the country, see figure 1, has around 2 million inhabitants. Approximately half of them inhabit the called Great Mendoza, see figure 1, which includes the departments of Capital, Guaymallén, Las Heras, Godoy Cruz, Maipú and Luján de Cuyo. The Capital (Mendoza City) and Godoy Cruz departments are the smallest in area and have the highest density housing. It is important to note that GreatMendoza is the fourth urban nucleus in Argentina, after AMBA, Great Córdoba and Great Rosario.

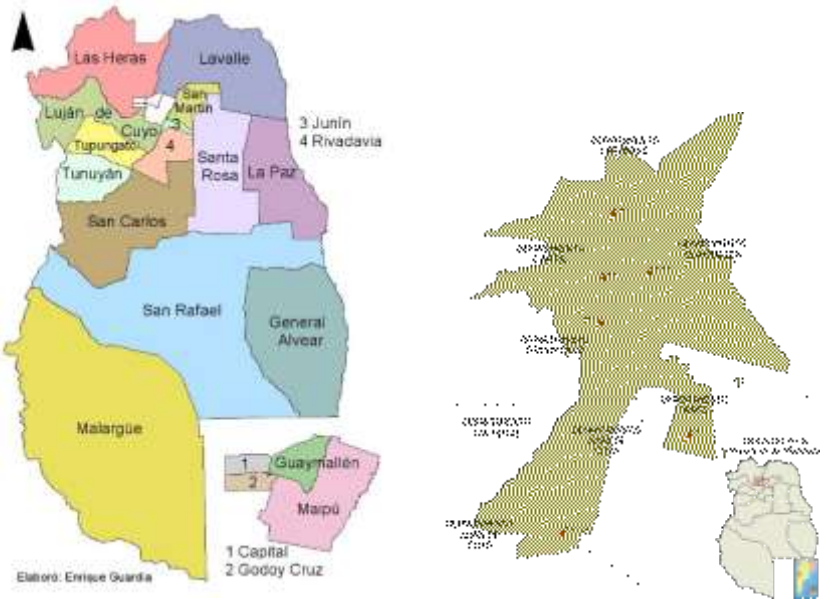

Fig. 1. Mendoza province and Great Mendoza area maps.

For different reasons: entry of employees to the public administration, opening of shops, beginning of the school day and in universities, among others, in the area of Great Mendoza, morning and afternoon traffic peaks occur. The incoming traffic flows to the Capital department, takes place between 7 A.M and 9 A.M., approximately. The flow of outgoing traffic starts at around 5 P.M.

3 Radar sensor network.

In this section the technical characteristics of Guaymallén Radar Sensor Network is provided. The Godoy Cruz infrastructure is quite similar to the Guaymallén one.

The different radars nodes are connected using a proper network in order in order to download the registered information as well as to do maintenance tasks.

In this case, for each radar node available in the network a 4G link connect them to a server that stores the information. Previously as can be seen in Figure 2, a 3G link was used. This link is set up by means of a Huawei model E173 USB modem equipped with a SIM card with an active line and available mobile data.

A TP-Link router model TL-MR3020 version 3.20 manages the connection for each radar sensor node. The original factory router operating system has been replaced by OpenWrt version 22.03.2 [4]. This alternartive operating system allows the connection as a client to an OpenVPN network as well as Internet link through the aforementioned 4G modem, in addition to other useful features for this application.

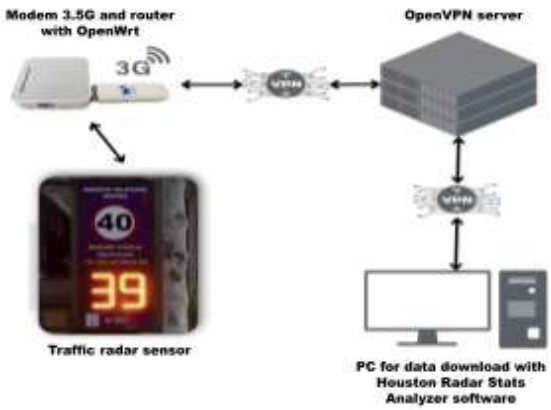

Fig. 2. Radar Sensor Network scheme.

The sensor module is a Doppler effect radar, brand Houston RADAR, Model SS400, whose operating frequency is 24.125 GHz +/- 50MHz. The antenna power is 5mW or higher and the polarization is linear. The operating temperature is in the range between -20ºC and 85ºC. It has a measurement range: 2.1Km/H – 161Km/h, which can be configured and a resolution of +/- 0.1 Km/h, with an accuracy:+/- 0.5% of the read value. The maximum detection distance covers a range from 90m (small vehicles) to 150m (large vehicles) traveling at speeds between between 20Km/h and 88Km/h.

The connection to the OpenVPN server will allow the radar to have a known fixed IP with which it can be accessed to download the desired information using the Houston Radar Stats Analyzer Software [5].

4 Preliminary results.

This section presents the results of the traffic measurement carried out between 07/20/22 and 08/04/22, on Avellaneda street in the Department of Guaymallén. During the registered period, 46,782 vehicles circulated, with a daily average of about 3,000 vehicles. In particular, 2,902 vehicles per day if 5 days are considered and 3,016 vehicles per day if 7 days are taken into account.

The graph of Figure 3 shows the hourly distribution of the vehicles for the 07/25/22 week. In 01/08/2022. The x-axis represents the considered time in hours and the y-axis accounts for the number of registered vehicles. This information is presented for each day in between Monday 7/25/2022 until Sunday 31/7/2022.

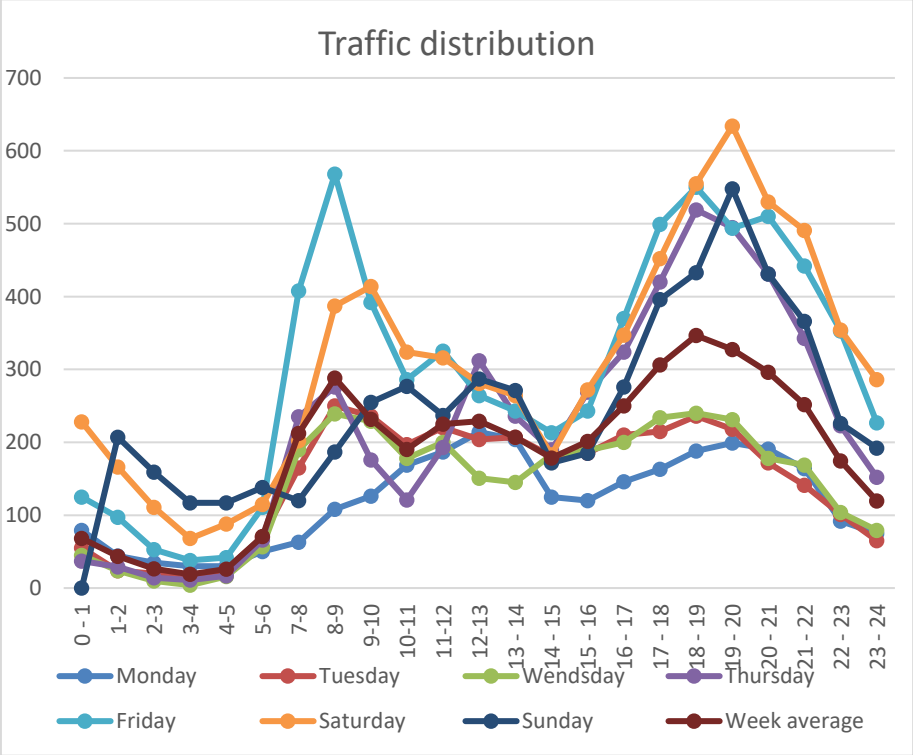

Fig. 3. Traffic hourly distribution for incoming vehicles.

In the graph of Figure 3 two different peaks can be clearly seen. One at early hours, in between 7 am and 9 am, and the other at the evening and night, from 5 pm until 9 pm. It is important to point out that the vehicular traffic increase at night during Friday and Saturday. Even at Saturday evening a larger amount of vehicles in comparison with working days can be observed. There is also a valley with a very low vehicular flow in the early morning hours. On the other hand, a marked decrease in registered traffic

between 11 a.m. and 3 pm it is shown in the graphic. In this sense, it is important to say that business and school operation hours at Great Mendoza is not continuous.

In the graph of Figure 5 the week average 85% speed hourly distribution is shown. The 85% metric considers only the 85% of the total registers. The 15% not considered values belongs to the extreme upper and lower speed values. As can be observed in the graph the average speed values are larger at early hours. The limit speed is 45 km/h that is keep mainly at working hours.

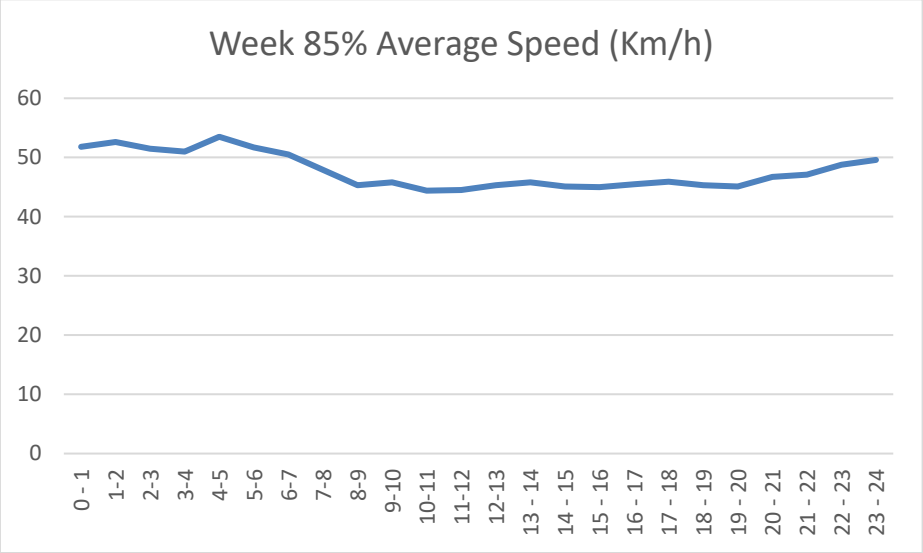

Fig. 5. Week 85% Average speed hourly distribution

5. Conclusion.

A radar sensor network and its implementation has been discussed in this paper. Their hardware, communications and software characteristics has been provided as well. Both functional prototypes are currently functional in two different departments at Great Mendoza area. The informed results belongs to a radar network available at Guaymallen department.

The preliminary results obtained are useful in order to model and estimate vehicular traffic flow. In this sense, the implemented radar sensor networks can be considered as a promising proof of concept.

Among other possibilities, Big Data analysis [6] of registered traffic can be a very useful tool in order to model and predict vehicular traffic flow.

6. Acknowledgments.

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