

# Fuzz Sensoring

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## Abstract

Traffic congestion is a significant problem which affects smoothness in transportation in many cities around the world. It is unavoidable due to increasing numbers of vehicles and overuse of roads in large and growing metropolises. Although, there are several policies that are implemented to reduce traffic congestion, such as improvement of public transport, car and motorcycle restriction on several roads, and an even-odd license plate policy, the major problem involves getting data in order to predict and avoid traffic. Information can be collected from many sources such as: city sensors, GPS, as well as, from many application programming interfaces (API) provided by different companies. The project involves gathering sources and information about traffic congestion in order to create guidelines which can be essential in creating a traffic map of Vilanova i la Geltrú in the future. Eventually, the guidelines to the city of Vilanova i la Geltrú are provided, consisting of analysis of traffic inside the city, IoT management, choices of APIs, effective selection of sensors, and cost analysis to vastly improve traffic flow.

**Keywords:** traffic congestion, API, GPS, sensors, Data

## 1. Introduction

'Fuzz Sensoring' was carried out by five international students participating in the European Project Semester (EPS) 2021 from various study fields with different experiences. This project was a collaboration between Universitat politècnica de Catalunya EPSEVG and local company Neàpolis.

## 2. Project definition

The aim was to improve the current state of traffic management in Vilanova. Thus, it is essential to use traffic APIs and sensors to provide traffic data of the city. However, we are also going to work under the assumption we are limited to a set few. Once research has been conducted, guidelines will be set to support the choice of API's and what kind of set of sensors are needed to improve the city of Vilanova. A task also was to discover effective ways to achieve data where none is gained through APIs and sensor use.

To know the project's direction, it was critical to brainstorm about the most prominent challenges and questions we would encounter along with the project. The main queries are:

- How many API can we get traffic data? Are they free, or do they have a cost? To what extent IoT technologies (Internet of things) can help tackle traffic issues in cities?
- How many street-level sensors do we need to make a useful inference? How many of them are already set up? What kind of sensors would be the most suitable regarding the needs of the city? Where must the sensors be installed?
- What kind of traffic does the city of Vilanova have? Where are the most critical paths in Vilanova?
- How much would it cost to purchase Traffic Data from APIs? What would be the cost of implementing sensors in the city of Vilanova?

## 3. Study of traffic management

Traffic Management is the procedure designed to improve the state of traffic. It stems from improving safety, efficiency, security and the environment. It is a predominately complicated system with many sources of information to deal with and take into account. The issue is to make the best possible traffic management decisions to get the best outcomes in all aspects of improvement.

Analysing all traffic management in different cities, the most important aspect is focused on modern technology like sensors, cameras and advanced artificial intelligence software, in order to provide real time data. The aim is to apply smart cities solutions, involving adaptive traffic signals, pedestrian safety, ease of parking and air quality monitoring. These technologies will allow cities to respond faster to traffic conditions, cutting down on congestion and reducing costs.

### 3.1. Why is it so important?

To summarise the benefits of a good traffic management system the following are key areas of development. Firstly, improvement of traffic guidance and traffic flow, which will result in reduction of the risk of accidents. What is more, traffic can be cleared without any irregularities and should be managed smarter and savvier. Excess expenditure of the government on traffic police needs to be reduced. Time of the commuters on the road should be saved and traditional methods of traffic management systems replaced. All factors would influence the usage of the fuel, which can be saved up to 70% compared to normal timer-based traffic control.

#### 4. Traffic management of Vilanova i la Geltru

Firstly, it was necessary to study the current situation of the city, to know where and what kind of improvements should be implemented. One part of the studies was focused on sensors, what kind of the sensors are used for monitoring the traffic and where they are situated. What is more, it was essential to check the location of the main roads and mostly frequently used ones.

Vilanova, being a small and highly concentrated city. One of the consequences that the traffic management in Vilanova suffers nowadays is that many of its streets have gone from being two-way to just one, this is because the city council prioritizes the transfer on foot and by bicycle over the private vehicle. This has many benefits, such as improving the fitness of the people and reducing the number of cars on the road to reduce air pollution, however this may be their intention but as a result it has caused more traffic. Only a few roads or avenues are two-way such as: Carrer de l'Aigua, Av de Jaume Balmes, Rambla de l'Exposició, Av de Francesc Macià y entre otras. The distribution of the streets are presented in the figure 1 (fig.1.).

Most cities use sensors to know the traffic in real-time. Vilanova i la Geltrú is not a highly advanced city in technology, as there is a shortage of sensors in the city. There are only three traffic sensors in the entire town, and these three do not use highly advanced technology because you cannot obtain real-time data with them. To use their data, a person has to physically extract data with a memory card and then connect it to the computer to see the data.

#### 5. Application Programming Interface (API)

Further researchers included contacting with API' companies, in order to understand the traffic management system, know the price of data and establish cooperation in future perspective. Table 1 (tab.1.) shows the comparison of API. The best option is to use the local service SCT, but at the moment they do not have much real-time data from Vilanova. In the future they had it, it would be the best option for Vilanova. We propose Waze as the Traffic API to seek. Mainly due to their specific niche to improve traffic in cities all over the world. This application can provide us a lot of information and the important thing is that we can use it for free, unlike the others. We have to bear in mind that Waze for Cities only provides their information to the authorities and not to ordinary people, therefore a person from the city council would have to contact them.

#### 6. Sensors

Despite many technological advances in APIs, momentum sensors are still among the best options to know the traffic in real-time. To locate these sensors in Vilanova i la Geltrú, the following factors must be taken into account.

- **Acoustic map**  
The acoustic map is one of the main factors to consider when placing the sensors, as it helps us know which streets have a higher acoustic level than allowed, and with this information, we can know which streets have more traffic.
- **Google Maps**  
Google Maps does not give us complete city traffic because we only can know the real-time traffic in some streets and main avenues. We could conclude that these streets are the busiest, as Google Maps needs active users to show the traffic. In addition, we can also counteract the information that Google provides us with the sensors since the sensors give us information in real-time. That is, with this data, we can assess Google if they give us 100% precise information or not.
- **Pacification plan for the centre**  
The objective of this plan is to reduce the traffic in the city centre. Therefore, taking this into account, we will not put many sensors within this area because they are not necessary.
- **Main roads**  
Four main roundabouts go into Vilanova i la Geltrú. Then these four rounds end in the main avenues, such as: Ronda Ibèrica, Carrer de Josep Coroleu, Av de Jaume Balmes and Rambla de Josep Antoni Vidal.
- **Personal experience**  
A colleague of ours works in emergency medical services of Catalonia and he has given us names of some streets where there are traffic accidents. For example, Carrer del Cardenal, Av. de l'Aragai, Carrer del Pare Garí, BV-2115, Plaça dels Ocells, Carrer de Josep Coroleu, Ronda iberica 141 and etc.

##### 6.1. Location proposition

Based on the council information from city sensors, historical record data and thanks to the map of acoustic, the proposition of location of the new sensors was made (fig.2).

Keeping in mind that we would certainly be limited in terms of budget and also regarding the town/government on traffic sensor policy, it is of course, without doubt, unrealistic to implement all these sensors. At the moment, we will only recommend covering the four main roundabouts of Vilanova since around 95% of city traffic passes through there. If we know how many cars enter and leave these roundabouts, we can determine how much traffic there will be in the city.

- The best option is to set up video sensors as long as it delivers us the traffic situation in real-time thanks to live video of the road. Immediate visual confirmation through a monitor is invaluable for operators or traffic managers, as it allows them to know exactly what is happening and what measures to take. This video sensor would cost 1,290€ (FLIR TrafiCam x-stream 2), knowing that we would set up a total of 8 sensors: the overall budget required would amount to 10,320€ (without installation).

We can also use other types of sensors, the good thing about these sensors that we are going to explain next is that we can use them within the city because that way we would avoid legal problems about video recording with sensors.

- Implementing some inductive loop sensors on the most critical roundabouts of the city of Vilanova i la G. As soon as a typical loop system – based on 40cm ducts, 3 chambers, traffic management, permits, loop cutting and cable would cost around 6500€ per approach, knowing that we would set up a total of 8 IDL sensors: the overall budget required would approach €52,000.
- Implementing some pneumatic road sensors on the most critical roundabouts of the city of Vilanova i la G. As seen previously, the overall cost of a pneumatic road sensor, including the installation and the maintenance, would reach 5,800€ so for a total of 8 sensors: around 47000€.

## **7. Guideline for Vilanova i la Geltru**

To determine which applications would be the most suitable for small cities, we've analyzed them by the volume of investments, required infrastructure, pay-off period, the visibility of benefits for citizens and came up with the following table (tab.2.).

Finally, based on all gathered information and research, the guidelines for Vilanova i la Geltrú were created. They would enable the city to manage their traffic using IoT technologies and could help in reducing traffic by implementation of described solutions. The plan consists of 6 stages: basic IoT-based smart city platform, monitoring and basic analytics, deep analytics, smart control, instant interaction with citizens via user applications and Integrating several solutions.

The first stage is focused on designing the basic architecture for future enhancements of the smart city. It involves four components like: the network of smart things, gateway, data lake and big data warehouse. Simply it is focused on collecting, storing and extracting data in order to manage traffic.

The second and third stage is to monitor and analyze the data from sensors. Whereas the fourth one is about controlling what ensures better automation of smart cities. Next stage allows citizens to connect to the central management platform to monitor and control IoT devices, as well as receive notifications and alerts. The last step is integration of the solutions.

What is more, it consists of further recommendations for Vilanova i la Geltrú considering: free public transport, encouraging biking, heavy traffic ban and the old town policy. For reducing the traffic, optimisation of the road network is recommended. Solutions consist of: widening streets, adding on/off ramps, squeezing in roundabouts and designing new interchanges.

## **8. Future prospect**

What is the future of this project?

1. Build a relationship with the Traffic Api company. Prioritise Waze then respectively if needed proceed to seek and build a relationship with the following, Google Traffic, TomTom, Servei Català de Trànsit & Ontonomo.
2. Build and Design a Programmable System to display useful traffic information to make traffic management decisions with the support of Waze and Fuzzy Traffic Sensors.
3. After testing the system on Vilanova, analyse and discover what are the most cost effective traffic management decisions that can be made to improve traffic under different circumstances, scenarios and events in Vilanova.

## 9. Figures and Tables

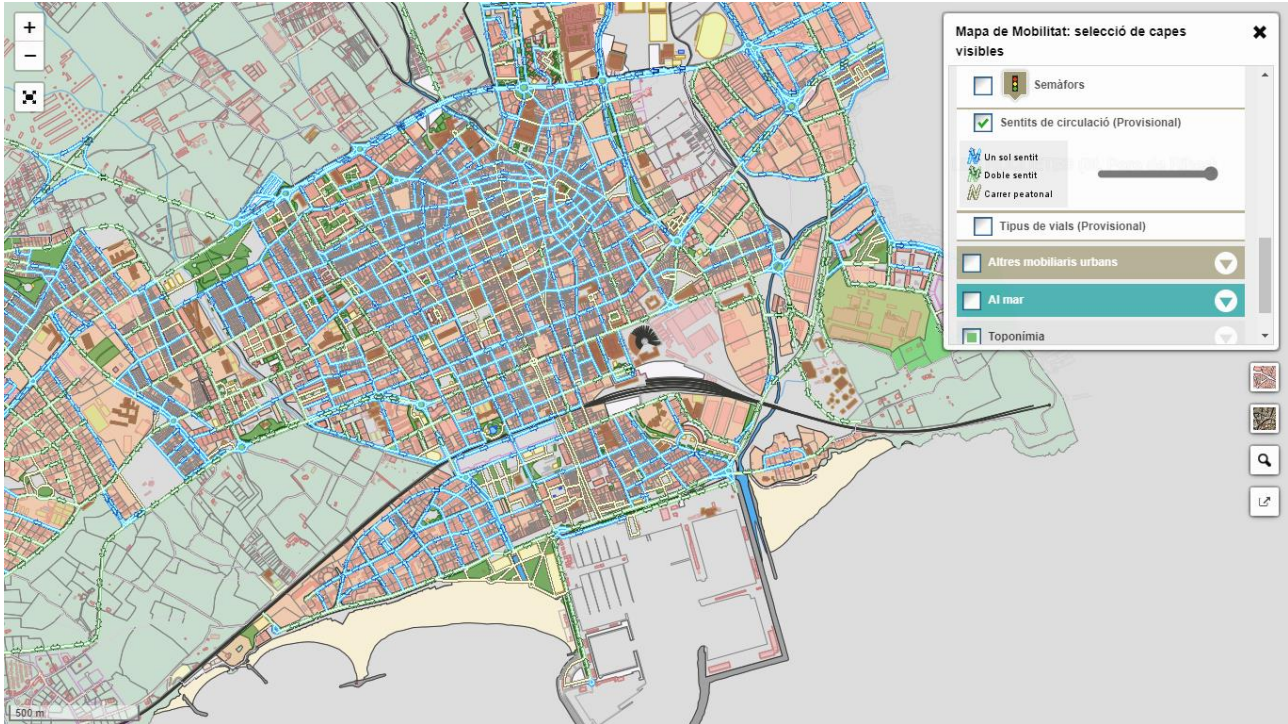


Fig.1. Map of Vilanova i la Geltrú- streets distribution.

Tab.1. Comparison table of different API.

API	It is free?	Are they available in Vilanova?	Do they have real-time data for Vilanova?	Can we use their real-time data?
Google Maps	200\$ free	Yes	Yes	Yes
Waze	Yes	Yes	Yes	Yes
Tomtom	No	Yes	Yes	No *
Ontonomo	No	Yes	Yes	Yes
SCT	Yes	Yes	No	---



Fig.2. Sensors locations proposition.

Tab.6. The relevance of IoT applications for smaller smart cities.

THE RELEVANCE OF IOT APPLICATIONS FOR SMALLER SMART CITIES			
	Highly relevant	Can be implemented with certain restrictions	The value is questionable
Traffic management			✓
Parking	✓		
Public transport		✓	
Utilities			✓
Street lightning	✓		
Waste management	✓		
Environment		✓	
Public safety		✓	

## 10. Discussion and conclusions

The aim of the project was to perform deep research about traffic management systems and gather all necessary information related to the topic, in order to create the guideline for Vilanova i la Geltrú.

Firstly, it was necessary to study the current situation of the city, to know where and what kind of improvements should be implemented. One part of the studies was focused on sensors, what kind of the sensors are used for monitoring the traffic and where they are situated. What is more, it was essential to check the location of the main roads and mostly frequently used ones.

Another factor considered is local public transportation, bus lines and trains. Based on the council information from city sensors, historical record data and thanks to the map of acoustic, the proposition of location of the new sensors was made. For that reason the budget plan had to be taken into consideration.

Collecting and displaying real time data of traffic and related factors which can influence it, is essential for improvement of traffic management systems. Hence, further researchers included contacting with API' companies, whose services allow the users to display real time data of traffic congestion in the area of interest, in order to understand the traffic management system, know the price of data and establish cooperation in future perspective.

Moreover, to propose the final plan of improvement in Vilanova i la Geltrú, traffic management systems in different countries and cities were analysed and compared. Depending on the size of the population and the stage of the development different systems are applied. Although, in each case, style of management is aimed to make the city smarter, safer and more eco friendly.

Finally, based on all gathered information and research, the guidelines for Vilanova i la Geltrú were created. They would enable the city to manage their traffic using IoT technologies and could help in reducing traffic by implementation of described solutions. The plan consists of 6 stages: basic IoT-based smart city platform, monitoring and basic analytics, deep analytics, smart control, instant interaction with citizens via user applications and Integrating several solutions.

IoT helps cities connect and manage multiple infrastructure and public services. From smart lighting and road traffic to connected public transport – the range of use cases is highly diverse. What they have in common is the outcomes. Applying IoT solutions leads to reduced costs for energy, optimized use of natural resources, safer cities, and a healthier environment. However, to enjoy these benefits, municipalities like Vilanova y la Geltrú should take a consistent approach to design a functional and scalable smart city architecture. Well-designed, it will allow to reduce investments in IoT development and hasten the implementation of smart city solutions, still leaving space for expansion.

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