INFORMATION SYSTEMS FOR URBAN MOBILITY.

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Urban traffic is one of the main problems that affect the life quality of residents in cities and metropolitan areas in developed countries, due to the city model, widely distributed, and the raising of urban population. Both factors are coupled, and amplify each other, contributing to increased displacement and length, in an expansive process that has placed the urban environment in a difficult situation in terms of sustainability. Pollution, traffic congestion and accidents are negative externalities producing a strong impact on both the health and the economy of citizens. All these problems suggest the development of new global strategies for sustainable urban transport. Strategies that address not only a wide range of mitigation measures, but also *the use of innovative technologies and infrastructures*. The concept of efficient, effective and safe transport must prevail today in new transport policies.

Our Research Group is involved in the design, development and implementation of a wireless smart sensors to acquire information about traffic and the environment, as well as to communicate with each other and with the outside, resulting in traffic reports available by the user in real time.

We have developed a series of nodes that receive sensory information from the environment:

- Bluetooth Node.
- Ultrasound Node.
- Laser Node
- Gases Node.
- Environmental Node.

All these nodes send the information gathered periodically to a manager node, also called coordinator node.

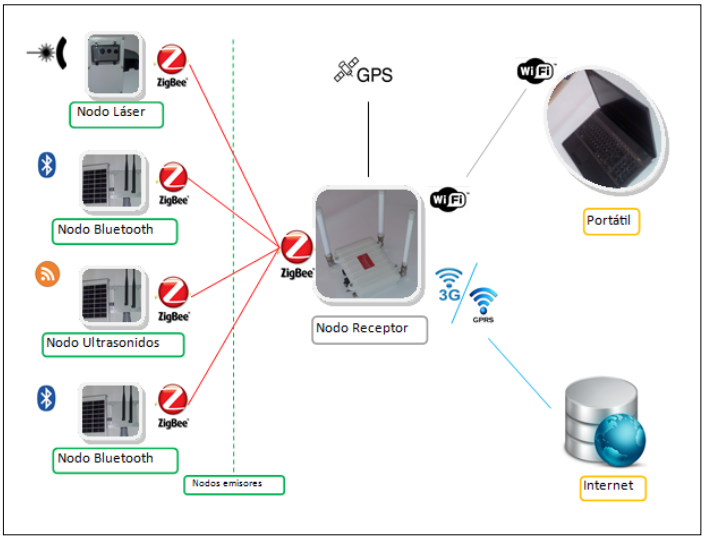


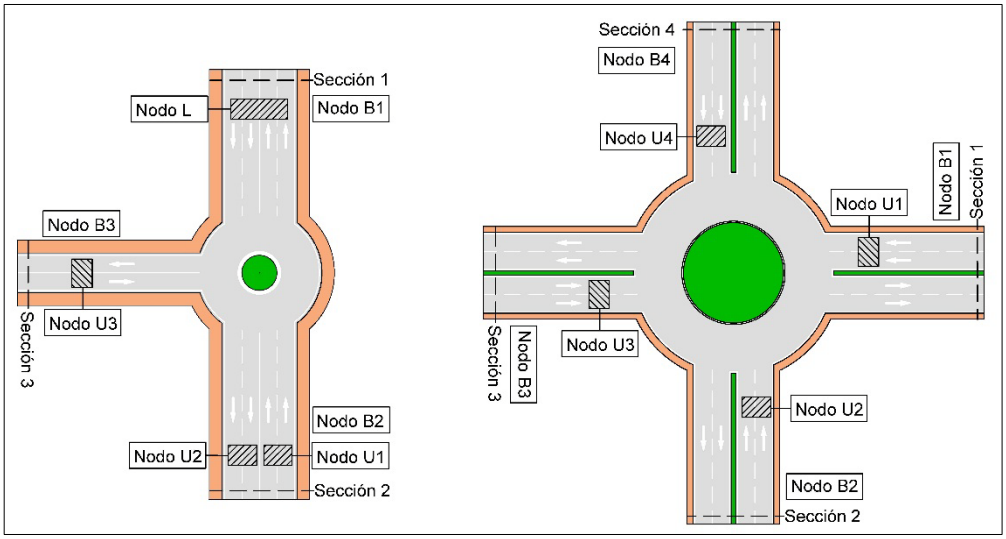
Diagram of the wireless sensor network.

Ultrasound and laser nodes are vehicles counters. The first type detect vehicles crossing the sensors beam, and the second ones sweep the driveway analyzing the existence, and characteristics of vehicles.

Gases and Environmental nodes gather information from the environment. The first type of sensors gets information about the concentration of various gases such as O2, CO, CO2 and volatile gases, among others, and the second type gets information concerning noise, dust and brightness.

The information collected by the coordinator node is always available by using two protocols: Wi-Fi and 3G.

Depending of the study area, various settings can be chosen for a wireless sensor network distribution:



Different configurations for wireless sensor network based on the area to be studied.

The information gathered by the sensors is processed by an algorithm designed to obtain the Origin-Destination matrix of the study area. Therefore, it can obtain information about traffic flow in each of the lanes, trips made by vehicles (origin and destination), control sections that are more likely to receive vehicles as their destination, or those lanes that are more likely to be the origin of travel. All information before can be classified according to the hour, weekdays and weekends.

Experimental Results.

The experimental results correspond to the Project “Portable Information System applied to urban mobility” of the “Programa operativo FEDER de Andalucía 2007-2013” in collaboration with the Agency of Public Works of Andalusia Regional Government.

Several tests have been carried out, which can be classified into four groups:

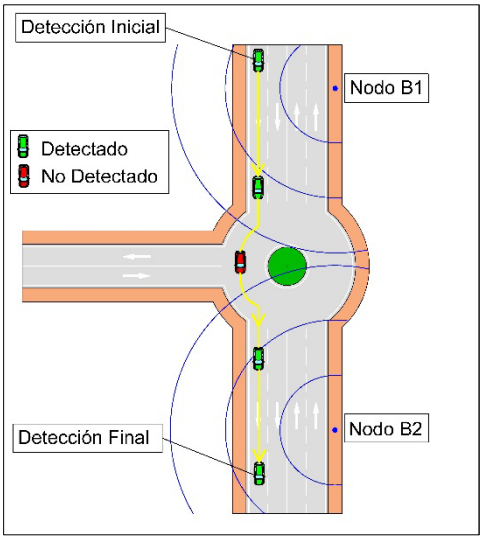
- Calibration tests of the system.
- Testing analysis of visible Bluetooth devices in the system.
- Mobile node testing, including all types of sensors.
- Crossings / urban intersections testing.

About the evidence concerning the analysis of Bluetooth devices detected by the system, the number of Bluetooth devices that the system is able to detect was processed. Consequently, the rate of vehicles has been detected with respect to all vehicles that have passed through the control area of the test. Results show that about 10% of the vehicles counts with some Bluetooth device recognizable by the system.

In addition, wireless sensors have been installed in a vehicle (mobile node) in order to provide information about traffic conditions and environment of the roads. As a result, a maps can be obtained with the information gathered by the mobile node in which citizens and mobility areas staff can observe the traffic situation at any time.

Maps created with the mobile node. Light colors represent low traffic intensities and dark colors high traffic intensities.

The whole system has been tested in two similar intersections, as shown previously. The first is used to validate the system qualitatively, while the second has been used to validate the system quantitatively. Both tests were performed in real urban environments with normal traffic conditions.



Detection process for Bluetooth device.

The results obtained by manual counting and through the sensor network in the above intersection can be observed in the table:

Origen \ Destino	1	2	3	*4*
1	72	249	125	125
2	39	52	256	1.611
3	170	537	0	59
4	72	872	118	20

Origen \ Destino	1	2	3	*4*
1	0	484	114	110
2	58	0	294	1280
3	316	772	0	42
4	91	592	111	0

Left: Real traffic counted manually during the experiment. Right: Results obtained using wireless sensor network.

The origin and destination classification algorithm uses a statistical process, so that increasing the number of vehicles taking a trip between a given origin and a certain destination, more confidence can be expected from the results. According to the rate of Bluetooth devices in vehicles, it will require 200 trips to obtain a confidence value of 95%.

After analysing the results, the main conclusion is that it is possible to make consistent, useful traffic studies with the intelligent sensors network. Among the advantages that the Mobile Information System Applied to Urban Mobility can be enumerated:

- Cheaper traffic Studies and real time results, including useful tools like Origin-Destination matrix algorithm.
- Installing sensors without road closures.
- Possibility to apply dynamic algorithms in traffic control elements (information signs, traffic lights, reversible lanes, etc.) depending on the traffic conditions.
- Increasing knowledge of drivers habits in urban and interurban areas.
- Real-time status of roads in a city using mobile nodes.
- Planning more accurate and efficient road projects.