

# **The automatic vehicles access control system of the historical centre of Rome**

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## **Abstract**

The continuous increase of vehicles inside cities leads to an unsustainable traffic flow that, in historical cities such as Rome, in Italy, leads to a congestion situation characterized by a high environmental pollution due to the vehicles emissions.

In this paper we illustrate an automatic vehicle access control system which is capable of controlling and reducing the traffic inside the historical centre.

## **1 Introduction**

The historical centre of Rome has been defined a limited traffic zone (LTZ), where access is allowed only to the vehicles of resident people, policemen, shop owners, ambulances, service vehicles, and to every kind of scooter.

The LTZ is a wide quasi-circular zone, with few entrances and exits, that were controlled directly by the policemen, that checked the presence of the proper authorization of the car, represented by two logos that must be exposed on the front and on the back of the vehicle, released by the proper city office.

This sight control of authorized vehicle need a lot of human resources, due to the high traffic flows, and can lead to various kind of mistakes.

For this reason a proper automatic system, called "Iride" (Italian translation of the term Iris) system, has been realized, so that all the check operations are executed by it, without any need of human controllers.

The system is composed by a proper number of lanes for each entrance, so that the vehicles slow down their velocity and follow a well defined path. Authorized vehicles are equipped with a proper low power microwave transponder, the so called on-board unit, that is equal for everybody, where the

driver must insert its own smart card that stores the so called “user category” informations. When the car enters the lane, the on-site transmitter ask the on-board transmitter to send it, in an encrypted way, the data that are stored inside the smart card: if the data are regular the vehicle can get in, otherwise a proper camera takes a picture of the vehicle and of its number plate to check if it is an authorized number. If the vehicle is unauthorized, a proper punitive procedure is activated, sending all the necessary information to the police office.

In this paper we want present the whole system and the procedures that automatically optimised the traffic situation inside the historical centre of Rome.

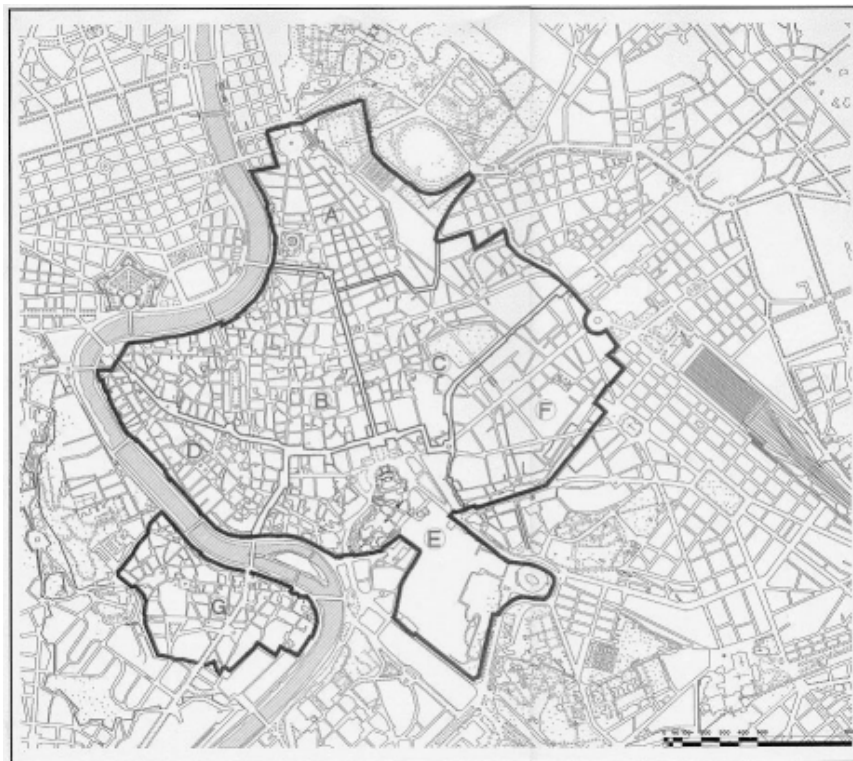


Figure 1: Map of the Limited Traffic Zone (LTZ) of Rome, Italy

## 2 The access control system

The limited traffic zone is controlled by means of 22 electronic entrances/exits. Each of them can be single, double or triple, depending of the number of lanes that must be controlled.

At the moment the Iride system is operative in the sector pointed out with letters A,B,C,D,E,F in figure 1, while the sector G in not operative due to the high number of entrances that ought to be controlled. This last sector is still controlled directly by the policemen.

Each lane is equipped with a control unit composed by a microwave transmitter/receiver, that is called microwave buoy, and a proper camera.

Under each lane is placed a proper coil used to reveal the passage of a vehicle. When a vehicle passes on the coil the microwave buoy emits a signal that tries to invite the on-board vehicle to emit the information stored in the smart card.



Figure 2: On-board unit with the personal smart-card inserted

If the “user category” informations stored in the smart card, transmitted by the on board unit and received by the control unit using the microwave buoy are correct, the vehicle can pass without any further check. This recognizing phase is called transponder revealing.

If the local unit does not receive any information by the on-board unit during the transponder revealing, it means that it is not present on the vehicle or it is not working. In this case the local unit gets into the so called optical revealing, taking a picture of the vehicle using a proper position camera, in a way that the number plate is well visible. The picture is sent to the central control system where a proper unit decodes the number plate using a proper OCR (Optical Character Recognition) engine and compares it with the number plates contained in the data base. If the number plates is not authorized a last check is made, that consists in controlling if the vehicle carries some goods, if it is an institutional vehicle, an emergency vehicle or any other authorized vehicle, and last if the number plate has been authorized directly by the policeman at the entrance for particular or urgent needs. In this last case the number is properly stored and given at the central unit personnel at the end of the working time to be inserted in the central unit, in the authorized number plates database.

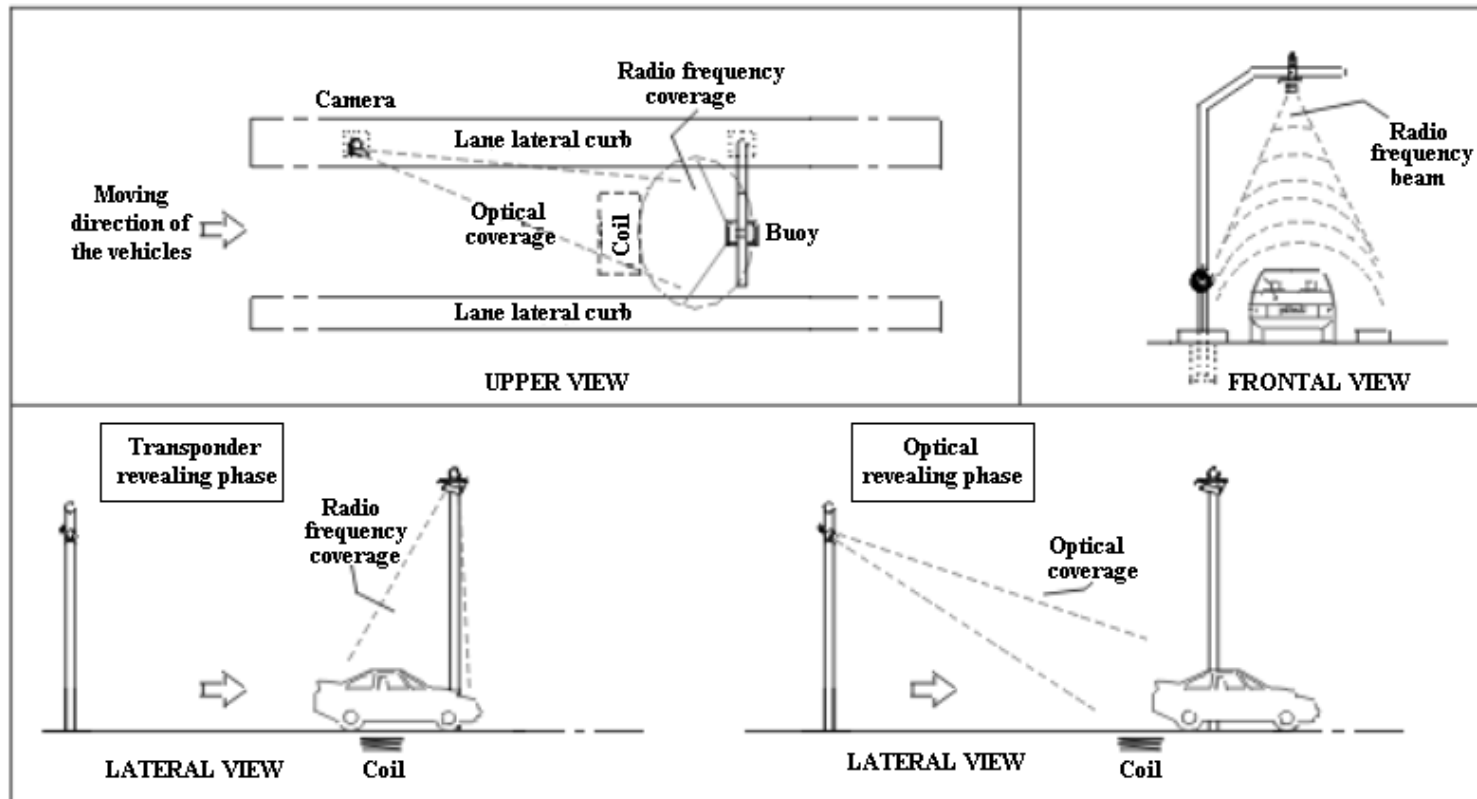


Figure 3: Disposition of the components of a control unit on a lane

The central unit communicates with the local units using optical fibres.  
 Each microwave buoy is placed at a height of no less than 5,4 metres, according to the scheme shown in figure 4.

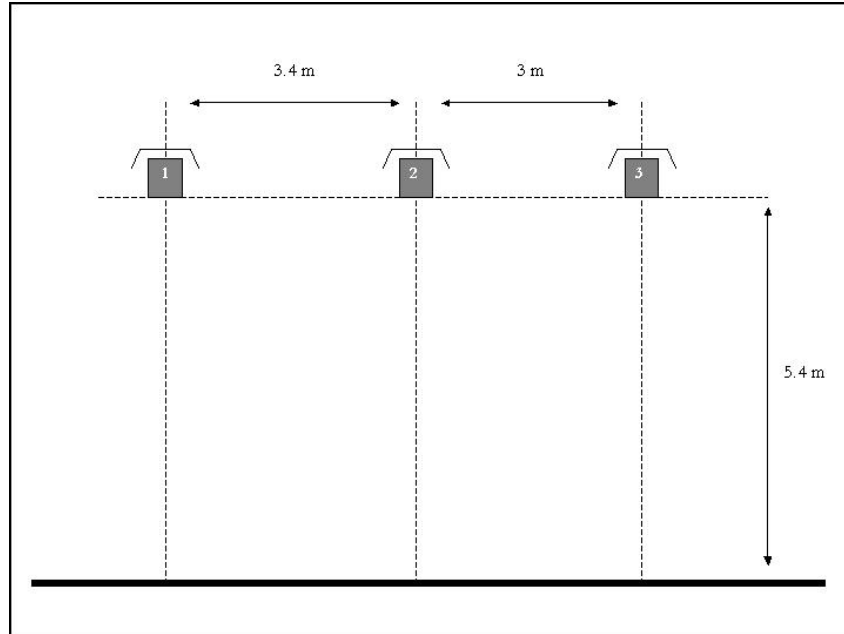


Figure 4: Positioning of the buoys for a 3 lanes configuration

Each buoy emits its microwave signal according to a well defined beam whose inclination, with respect to the vertical is of about  $15^\circ$  in the entrance direction, to allow the local unit to query the on-board unit and, in the case of no answer, to allow of taking a valid and recognizable picture of the vehicle and of the relative number plate.

The microwave buoy uses a communication channel at the frequency of 5.8 GHz, that is a normalized European frequency, used for telecommunication applications in the transport field. This kind of device is similar to the one used for highway paying (the so called TELEPASS system). The microwave buoy emits with an antenna power equal to +22.5 dBm (dBm is the decibel referred to the milliwatt. Given a certain power P expressed in watt, it can be converted in dBm using the formula  $10\log\frac{P}{10^{-3}}$ ) and a maximum antenna gain G equal to 16.5 dB.

It has been used an antenna that is very directive to generate an electromagnetic beam that is restricted to a well define zone that corresponds to a proper area of the lane, concentrating around the main axis of the irradiation lobe.

Particular care was adopted to reduce as more as possible the exposition of the peoples to the electromagnetic field, to respect the limit imposed by the law.

Considering a 3 buoys configuration as the one shown in figure 4, the power density has been calculated to be distributed according to the diagram shown in the following figure.

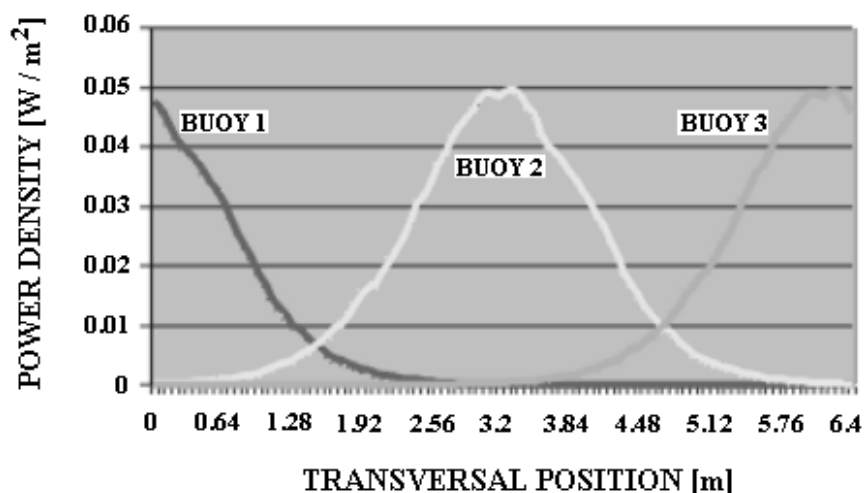


Figure 5: Power density of the electromagnetic field produced by the buoys of a 3 lanes configuration

It has been considered a 3 lanes configuration since it represents the worst case because three electromagnetic sources are present.

It is possible to see from the diagram that the curves are only partially overlapped, and therefore they add their effects only partially, never overcoming the maximum intensity of the electromagnetic field located on the main direction of emission of each antenna.

The Iride system has therefore been designed to respect the electromagnetic emission level limit fixed by the Italian law, guaranteeing the safety of the people that is interested by the emission of the buoys.

The automatic control of the entrances of the LTZ of the historical centre has totally allowed of reducing of 70 units the number of policemen devoted to the direct control of the vehicles, letting them available for other important duties.

### 3 Further developments of the system

The Iride system can be further developed to become an automatic fare device. In fact it is possible to let a well defined number of vehicles get into the historical centre paying a proper hourly fare. In this case the system checks the entrance and the exit time of the vehicles, properly recognizing the number plate, and calculates the total fare that can be detracted from a prepaid amount.

The Iride system can obviously be used to calculate properly the traffic flows, elaborating all the statistic parameters of the vehicles movement in the controlled zone of the historical centre, that can be properly used to manage the traffic in a context of city habitability.

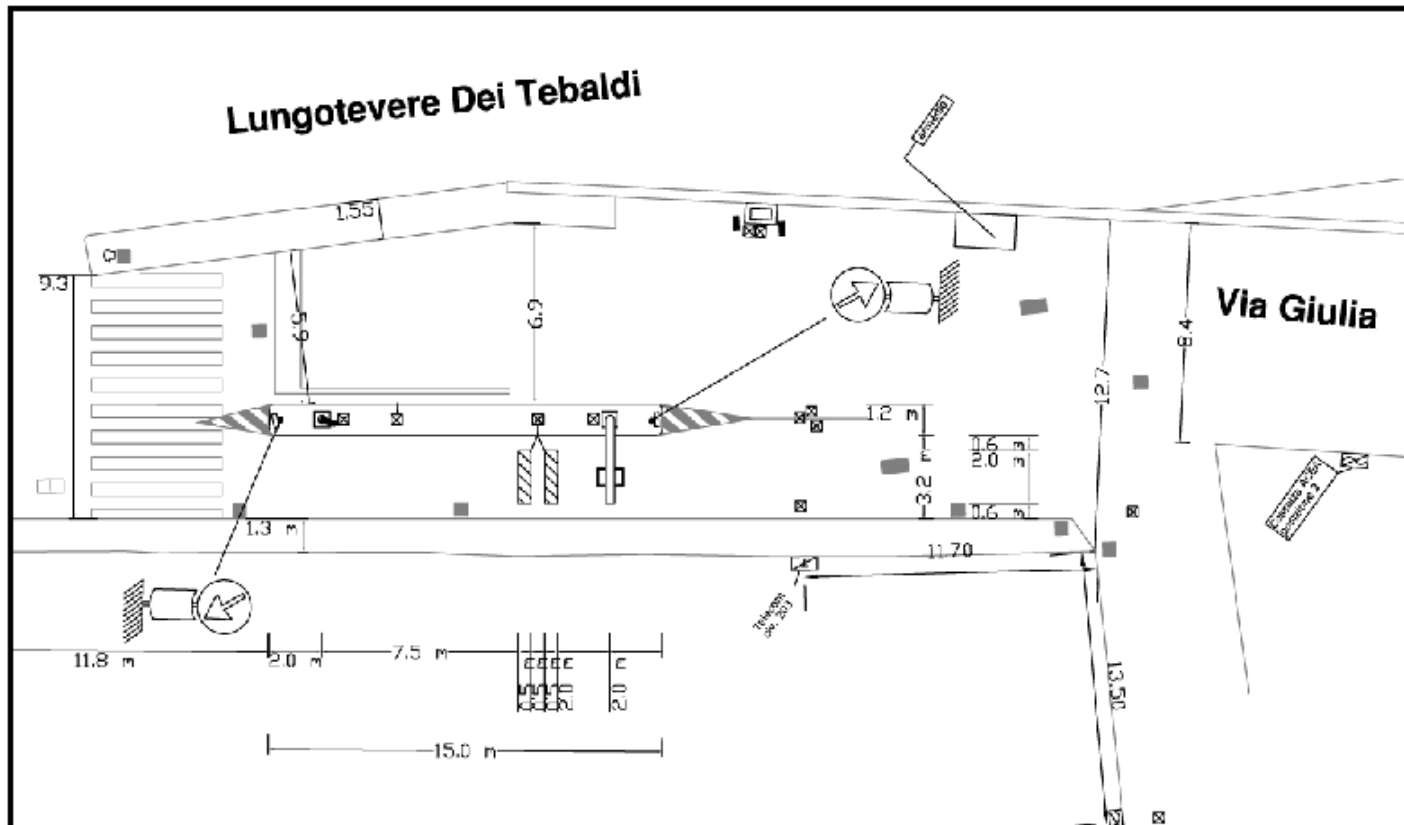


Fig.6 Upper view of 1 lane configuration

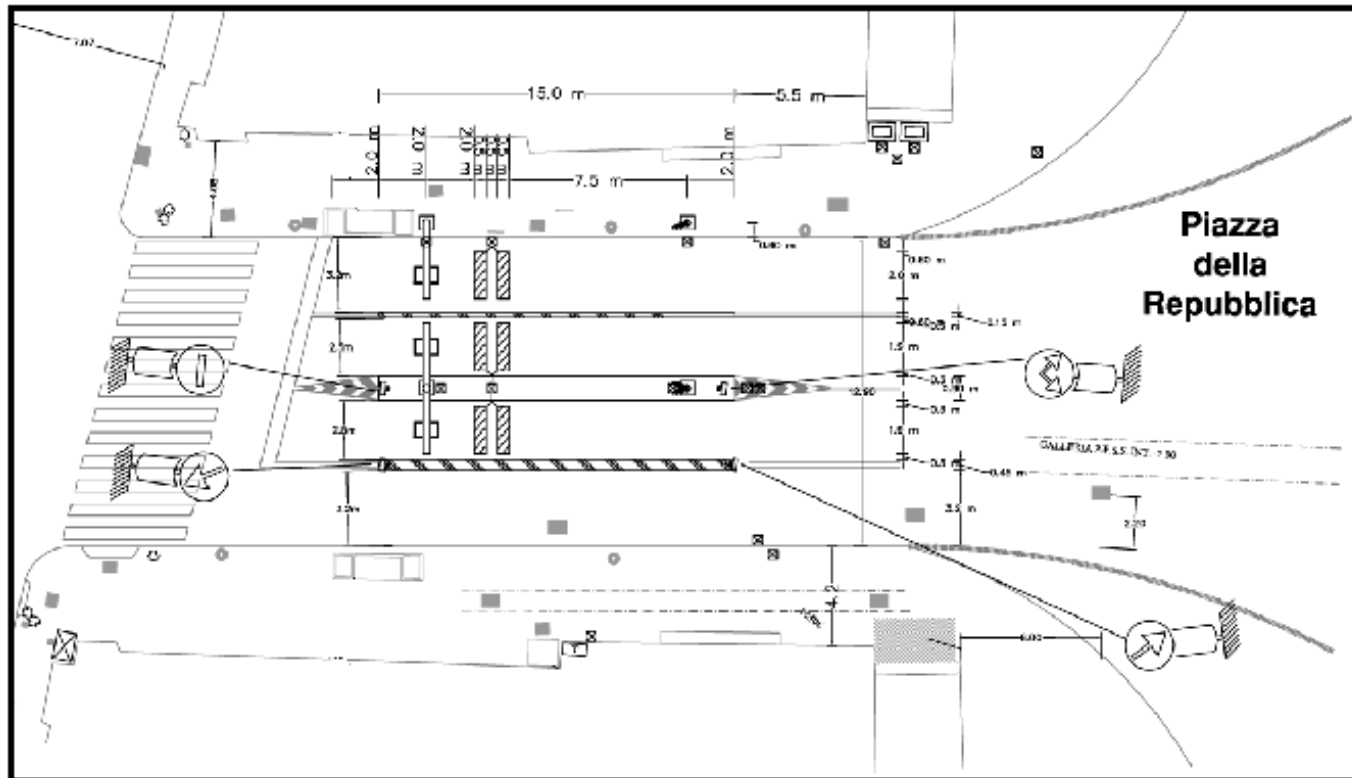


Fig.7 Upper view of 3 lanes configuration



## **4 Conclusion**

The Iride system of the Limited Traffic Zone of the city of Rome represents a very useful system to increase the life quality of a big city. It reduces not only the number of unauthorized vehicles that enter in the historical centre but it even reduces the number of human resources necessary to control the access to the mentioned zone, that can therefore be directed towards other important duties.

## **Acknowledgments**

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## **References**

- [1] F.Garzia, *IMPIANTI E SISTEMI DI SICUREZZA: antifurto, antintrusione, controllo accessi, videosorveglianza TV*, Carocci Editore: Roma, 2001.