SYSTEM FOR MEASURING SPEED ON ROAD SECTIONS

A SERIES OF TESTS WAS RECENTLY CARRIED OUT TO VERIFY THE RELIABILITY OF A NEW SYSTEM FOR MEASURING SPEED ON ROAD SECTIONS BY AUTOMATICALLY READING NUMBER PLATES WITH THE HELP OF OPTICAL CHARACTER RECOGNITION TECHNIQUES.
THIS TECHNOLOGY MAKES IT POSSIBLE TO GATHER A LARGE VOLUME OF TRAFFIC DATA WITHOUT THE NEED FOR OTHER COUNTING OR ACTIVATION DEVICES.
IT IS BASED ON DATA DETECTION AND ACQUISITION SYSTEMS THAT ARE ERECTED ON THE ROAD NETWORK AND EQUIPMENT THAT CENTRALISES, PROCESSES, AND CONTROLS THE DATA OBTAINED IN THIS WAY.

by
Jesus DIEZ DE ULZURRUN,
Chairman, ITS Spain, Chairman of ATC, PIARC Spanish National Committee

DEVELOPMENT OF THE TESTS

The aim of the tests was to verify the possibilities offered by a system for measuring speed on road sections. The test procedure was therefore organised in such a way as to provide the maximum amount of detailed information on the way the system works.
Because the system seeks to measure speed on a particular road section, two measurement points were defined. A complete detection procedure was conducted at each of the two points.

This procedure is divided into two stages:

- Firstly, the system must detect the vehicle as it passes the measurement point and take a utilisable photo of the vehicle. Each measurement point has a percentage of errors that depends on a variety of factors. A detection rate (a value between 0 and 1) is calculated for every measurement point.
- Secondly, the system must read the vehicle's number plate correctly. This is not always possible (soiled number plates, blurred photographs etc.). This parameter introduces another factor (read rate), which when multiplied by the factor above, determines the possibility of correctly detecting and reading a vehicle's number plate as it passes each measurement point.

As two measurement points are defined in order to obtain the speed of traffic on the road section in question, the probability of finding out the speed of a vehicle is equal to the product of the detection and read rates at the two measurement points.

Finally, given that this system is not a closed system, but that there are instead intermediary points of entry and exit, the influence of vehicle entries and exits at intermediary points of the road section must be taken into account.

Consequently, the reliability of the entire system (probability of determining the speed of a vehicle travelling along the road section in question) is equal to the product of all indicated environmental factors:

- the detection rate at the first measurement point;
- the read rate at the first measurement point;
- the detection rate at the second measurement point;
- the read rate at the second measurement point;
- the correction factor linked to the entry and exit of vehicles at intermediary points along the road section.

$$f = 1 + \frac{e}{N_1} - \frac{s}{N_2}$$

Where:

N1: vehicles at the entry point
N2: vehicles at the exit point
e: intermediate entry points
s: intermediate exit points

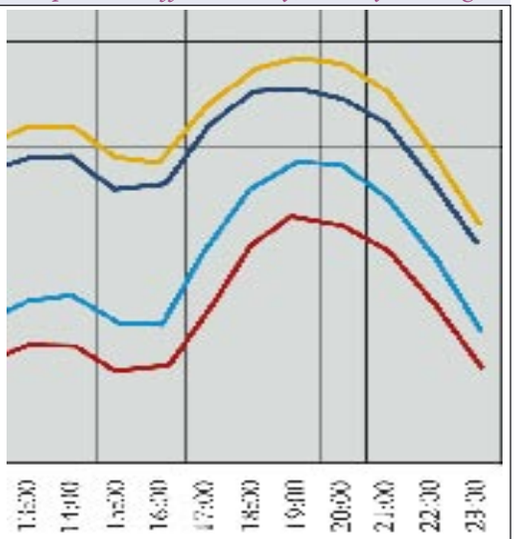
In the case of a closed system with neither intermediary entry or exit points, this factor would be 1 and total reliability would be equal to the product of the reliability at each gantry, because N1 = N2.

In order to be able to measure the speed of a high percentage of vehicles travelling between two measurement points, it is important that each of the rates mentioned is as close as possible to 1. This means that it is necessary to reduce detection and read errors as much as possible at each measurement point.

TESTS CARRIED OUT

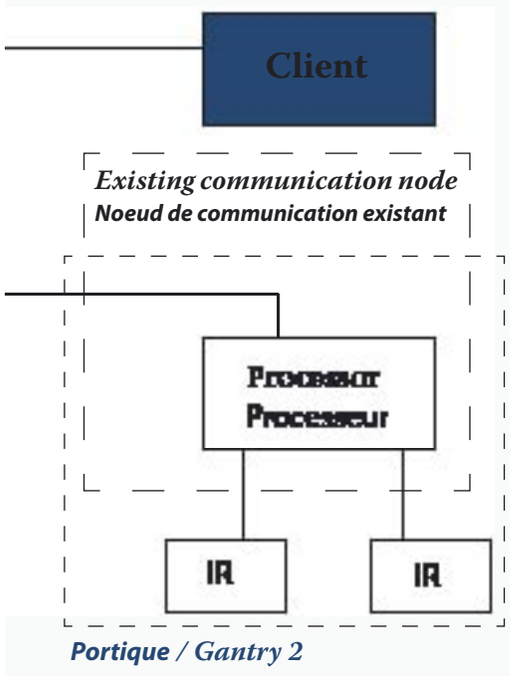
For every day on which tests were carried out, test periods were specified according to the parameters of traffic density and

Graph 1: Traffic density, hourly average ▾



Legend of the graph 1
- Inside lane: starting point
- Outside lane: starting point
- Inside lane: finishing point
- Outside lane: finishing point

Figure 2: System description ▾



Source: Road Bureau, MLI

light conditions in order to obtain a varied sample of conditions.

The specified test periods were:

- 5.00-6.00 a.m.: off-peak period and night-time traffic;
- 8.00-9.00 a.m.: change in light conditions as the sun rises;
- 1.00-2.00 p.m.: average traffic under day-time conditions;
- 6.00-7.00 p.m.: change in light conditions as night falls, and peak period;
- 9.00-10.00 p.m.: average traffic under night-time conditions;

The graph 1 illustrates the average hourly traffic density, which served as the basis for the selection of the aforementioned test periods.

Equipment

The basic system components are described below:

- Infrared camera

This camera has a 950-nm infrared light source and is used to record number plates. It is housed in a weatherproof IP67 case and is fitted with a large anti-dazzle canopy.
It is mounted on gantries using supports that were specially designed for this purpose.

- Processor

The processor can receive signals from a maximum of four infrared cameras and is equipped with Ethernet outputs, RS232 and RS485. It is powered by 110/220 V and is installed on the communication node that is closest to the gantry in question. It is equipped with number plate recognition software.

- Server

The control centre that manages the system has a server that gathers all the data transmitted by the equipment in the field. An application that allows the operator to access the data received and the functions developed on the basis of this data is installed on this server or on other PCs connected to the network.

System architecture

The figure 2 illustrates the system architecture.
The detection system is based on the data gathered by the cameras mounted on existing gantries at the start and end of each road section being monitored. These cameras are linked to a processor that transmits via a fibre optic network the data that will subsequently be used.
Every camera is positioned in such a way as to allow it to centre on the zone where most vehicles will pass in a particular lane. Traffic being what it is¾vehicles do not all travel along the same part of the lane¾it is not possible to detect all vehicles.
For every gantry, a processor gathers the signals from a maximum of four cameras and transmits the data for processing virtually in real time. In concrete terms, the processor provides a photograph in the form of a .jpg file. The name of this file indicates the day and the time when the vehicle was detected to within one-hundredth of a second (format ddmmyyyy, hhmmsshh), the readout of the number plate, and the reliability rate of the data read. These files are stored in a database on a server where they can be processed by the software according to the required application.

A GPS positioning mechanism installed on a joint server is used to synchronise the equipment. This mechanism is linked to the equipment in the field using an SNTP (Simple Network Time Protocol). This system synchronises all equipment within the network with a margin of error of less than 500 milliseconds.

The server software monitors the vehicle number plates detected at the gantry at the start of the road section

being monitored and searches for them again among the vehicle number plates read at the gantry at the end of the road section. Once the number plate is found, the available data allows the operator to calculate the average speed of the vehicle in that road section.

The picture 1 on the left page is a sample photo.

The objective is to detect a large number of vehicles at the gantries at both the start and end of the road section in order to determine the speed of traffic on that particular road section.

These elements are connected to the processor or to the recording mechanism installed on the communication node.

Application

An application was developed especially for this system: it displays on screen all data relating to the passage of vehicles as well as the photos taken by the cameras on the gantries at the two measurement points.

This gives rapid access to the following data:

- the photo taken as a vehicle passes the first measurement point indicating the day, hour, minute, second, and hundredth of a second at which the photograph was taken;
- the photo taken as a vehicle passes the second measurement point indicating in the same detail the exact moment at which the photograph was taken;
- the speed of the vehicle between the two measurement points;
- the travel time on the road section;
- the number plate of the vehicle read at both measurement points;
- the lane on which the vehicle was travelling as it passed both gantries.

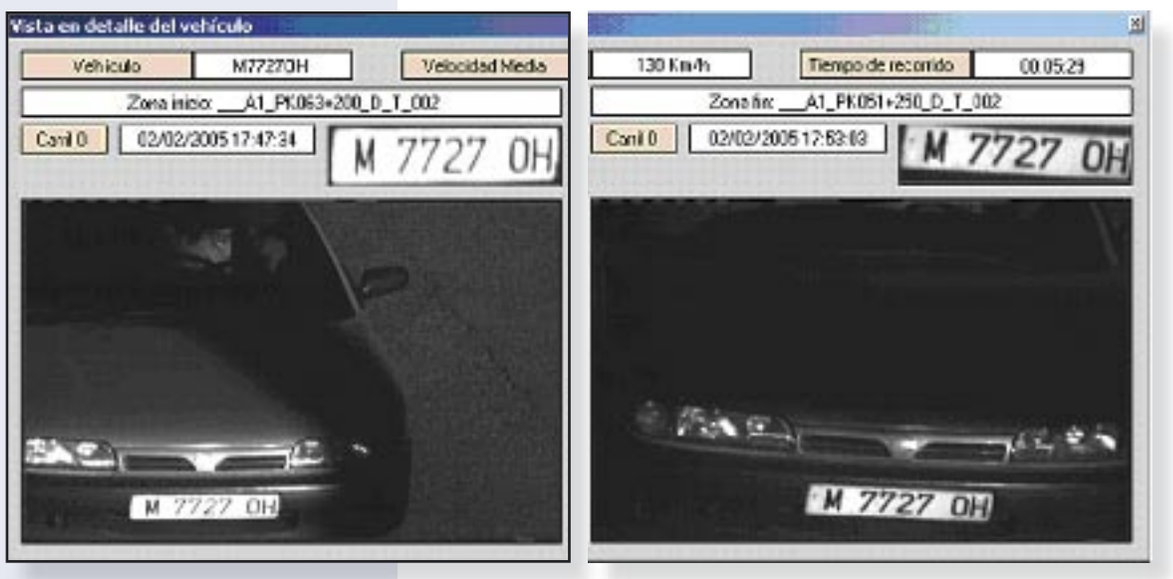
Apart from this vehicle-specific data, it is possible to use the information stored in the database of detected vehicles to obtain more information such as the average speed of traffic on the road section or the distribution of speeds in percentiles.

The *picture 2* below shows the detailed data relating to a photo of a vehicle. This data is accompanied by data relating to the trip.

TEST RATES

Different system tests were carried out in advance to find out how the elements behaved and to investigate how the system works in a variety of traffic and light conditions.
The tests were organised as follows:

- Data detection and collection per lane: a separate study of each camera was carried out first to gather information on the particulars of the situation, the influence of the camera position, the type of lane, and other factors relating to the measurement point.
- Data detection and collection per gantry: the data from all cameras mounted on a gantry (one for each lane) were then integrated to find out the rate of vehicle detection at the point in question because, a priori, a vehicle can travel on any lane.
- Data detection and collection according to light conditions: the tests were carried out during different time periods to evaluate the effect of varying light conditions on results.
- Data detection and collection according to traffic density: the tests were carried out at peak and off-



▲*Photo 2 / Picture 2*▲

peak times to find out, by sorting the results according to traffic density, the influence of this variable on the system.

- Analysis of the type of errors encountered when reading data: with the help of a photographic database of detected vehicles, the errors encountered when reading data were classified in order to establish the causes of the errors.
- Calculation of the effects of intermediate entry and exit points between the measurement points at the start and finish of the road section: a theoretical study and a real a posteriori verification using counting instruments was carried out in order to establish the influence of such access points on results.

POSSIBLE APPLICATIONS

- Measurement of the speed of vehicles on a specific road section
- Mapping of roads according to speed per section
- Mapping of black spots according to speed
- Studies conducted prior to the installation of radars
- Origin/destination matrices
- Access control
- Monitoring of white and black lists
- Travel time.

CONCLUSIONS

The tests conducted and a study of the data obtained allowed the following conclusions to be drawn.

1. It was empirically verified that it was possible to detect the speed of at least 68 per cent of the vehicles entering the road section being examined.
2. The study was conducted under real-life conditions, which necessarily give rise to factors that have a negative influence on results: e.g. vehicles with foreign number plates, intermediary entry and exit points, or the difficulty of attaching cameras to gantries.
3. Even though all of the vehicles travelling between the two gantries on the road section were not detected, the percentage of number plates that were correctly read provided enough data to measure the speed of traffic on the road section.
4. The reliability of the system does not depend on light conditions because no significant difference was noted between the various time periods examined, whether during the day or the night. This result was expected because the system in question is an infrared system.
5. The read rate for number plates (the number of number plates read correctly compared with the total number of vehicles detected) remained constant at slightly under 90 per cent. The incorrect reading of number plates was due in 50 per cent of cases to a confusion between two letters (e.g. C instead of G; Y instead of V etc.) In other cases, the number plates were either foreign, incomplete, or blurred.
6. The vehicle detection rate (number of vehicles photographed compared with the total number of vehicles travelling) was variable. The values were between 80 and 90 per cent according to the state of the pavement, the trajectory of the vehicles, and the position of the camera.
The influence of this parameter on the reliability of the system is very important. It is therefore essential to position the camera according to the lane in order to centre on the zone in which most vehicles travel.
7. Significant differences in the type of traffic on the inside and outside lanes were noted. The fact that the traffic on the inside lane was more spread out across the width of the lane influences the rate of detection because it was not possible to position the camera in such a way as to centre on the entire width of the lane.
8. It was shown that the probability of detecting a vehicle does not depend on the speed of traffic, which means that it is possible to draw up profiles of speed distribution for the road section and to identify vehicles that are travelling too fast.
9. In the case of open road sections, the relationship between entries and exits is very important. If the number of entries and exits remains similar and slightly less than that of the main traffic, their influence on the result is minimal. Reliability decreases if the number of entries is higher. It increases if the number of entries is lower. These variations grow with the number of entries and/or exits as a percentage of the total traffic.
10. One can therefore say that the quality of the system depends on the controls made at every measurement point.

The total reliability of the system depends on the design of the sites selected for the demarcation of the road section, according to the number of intermediate entries and exits compared to the total traffic on the section.#

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