1 The MEDES System

MEDES is an automatic inspection system for overhead wires that has been designed by DIE (Electronic Engineering Division, Polytechnic University of Madrid, Spain), funded by RENFE, and currently is installed and operative in laboratory coaches used by RENFE (Spain) and SNCF (France).

Catenary maintenance is a very important part of the total maintenance investment. The wear of overhead wire is an important parameter for the adequate preventive operation on the catenary. The continuous friction between the pantograph and the wire produces a wear that reduces the effective cross section of the wire. This means that the wire must be replaced in order to prevent spontaneous fracture.

The traditional method of maintenance of the overhead wires is performed manually, during breaks of circulation, and is not completely executed, the section that is going to be inspected is selected based on historical data. In order to avoid these disadvantages and to carry out a preventive maintenance an automatic inspection is necessary.

MEDES is based on an artificial vision system taking advantage of good reflecting characteristics of the wearing track of the overhead wire. The wearing track is illuminated using laser diodes of 810 nm and CCD lineal cameras capture the reflection. An image similar to the one in Figure 1 appears.

![Image obtained with a double overhead wire](image-url)
Under these conditions it is possible to measure the width of the wearing track. Starting from the width, the cross section and the thickness of the wire can be calculated.

1.1 Specifications

- Measures: 250 images per second.
- Type of wires:
  - Circular section of 107 mm², 120 mm², 150 mm².
  - Oval section of 107 mm², 150 mm².
- Accuracy: 5% of the section.
- Number of wires: 1 to 4.
- The system can be used by day and by night.
- Range of measure:
  - Height of overhead wire to top of rail: 4400 - 6400 mm (adaptable).
  - Stagger: ± 500 mm (adaptable).

2 Description

The system consists of several subsystems dedicated each one to a particular task.

There are two physical units: the optic table (see Figure 2) and the rack. The optic, the illumination and the images capture subsystems are on the optic table. The processing subsystem, the power supply system, control and PC are housed on the rack.
2.1 The Illumination subsystem

The illumination subsystem is made up of six equal units. Each one including a 1W- laser diode of 810 nm, with stabilised power supply, temperature regulation and power emission regulation. At that wavelength, the solar spectrum component is very small, this means that the system can be running in daylight. Besides, to reduce the effect of the skylight interference filters are used (Transmit centre wavelength = 810 nm, Transmit centre width = 10 nm).

Using these six laser diodes and special optics the wearing track is satisfactorily illuminated in the plane that is being viewed by the CCD linear cameras. At the minimum height of the overhead wire, guarantees an illuminated area of more than 1000mm in transversal aperture and a width of no more than 20mm.

2.2 CCD lineal cameras subsystem

The horizontal displacement of the contact wires either side of the track centre line is ±500 mm. The MEDES system uses five 2592 pixels CCD lineal cameras to cover the whole field of vision.
2.3 Optic and Focus subsystems

The height of the overhead wire may vary from 4400 mm to 6400 mm. The MEDES system uses conventional optics to achieve the necessary definition. Its advantages are its simplicity and low cost. However, it is necessary to use a focus system.

Based on the height of the overhead wire, the magnification is calculated. The focus system uses a servo with a PID controller to position the cameras with respect to the lenses.

2.4 The processing subsystem

The images captured by CCD cameras are processed by a system based on transputers. A transputer is a single VLSI device with processor, memory and communication links for direct connection to other transputers. Transputers are designed to allow parallel systems to be built from collections of processors operating concurrently and communicating through links.

The parallel processing is performed in four steps or levels (see Figure 3). In the first level what may be a wearing track and what not is detected. In the second level the width of the wearing track is measured. Each measure is associated with the camera that captured it. Data coming from the second level is packed forming an “image” in the third level. The fourth level of processing is carried out by one transputer. In this level the height of the wire and the kilometric point are added. This transputer is also dedicated to global management, data compression and communication with the host computer.

There is another transputer for hardware controlling and monitoring task.
The interface with the user is done via a PC and the resulting data is also stored on it for further analysis.

3 Results

MEDES system is installed and operative in laboratory coaches used by RENFE (Spain) and SNCF (France). The system is in full exploitation and the Spanish track network has been evaluated several times. Manual confirmations have shown the good behaviour of the measurement system.

The obtained information has been useful for deciding the strategy for the upkeep of the overhead line equipment on the electric railway. From these results, preventive replacements have been successfully carried out.

The results of measurement can be shown as statistical data or graphical output (see Figure 4). The width of the wearing track, the thickness or the useful surface of the wire can be obtained for a number of wires from one to four.
Results graphical output

The graphical output shows seven channels. The first column shows the contact wire height, the second one shows the stagger. The measured magnitude of each wire is drawn in the next four channels. In the last column appears the kilometric point.
4 **Benefits**

The main advantages of MEDES are:

- The automatic inspection is performed without breaks of circulation and at speed of ordinary locomotives. Currently, measures are obtained at speeds of 120 km/h, the system is capable of taking and processing 250 images per second, which means that the overhead wire is measured every 12 cm.
- Automatic inspection allows to evaluate the whole track network.
- Preventive maintenance.

5 **Conclusions**

An automatic system to measure the waste of the overhead wire of a railway has been presented.

This system has been a great improvement on the methods that were used and are still used today. For this reason RENFE has registered the system with the Spanish patent #9401633 and the European patent #96500022.7.