1. INTRODUCTION
The last decade has witnessed unprecedented interactions between technological developments in computing and communications, which have led to the design and implementation of robotic and automation systems consisting of networked vehicles, sensors, and actuator systems. These developments enable researchers and engineers not only to design new robotic systems but also to develop visions for systems that could not have been imagined before. There is a need now for a unifying paradigm within the computing, robotics, and control communities to address the design of these networked systems.
A concrete example is the interaction of intelligent sensors and pervasive networking technology which gives wireless sensor networks a new kind of scope that can be applied to a wide range of uses: environmental and habitat monitoring, precision agriculture, indoor climate control, surveillance, treaty verification, and intelligent alarms [1].

This poster addresses the experimental plans and the deployment of a system for wildfire detection based on wireless sensor nodes capable of measuring specific environmental parameters (temperature, humidity and light).

2. NEED FOR EARLY FIRE DETECTION
Experienced heat waves in Europe in the last years were one of the major causes of the unprecedented magnitude of forest fires that devastated the southern countries and, in particular, Portugal. Preliminary estimates indicate that over 10% of the Portuguese forest was devastated in only 3 weeks in the summer of 2003. In Italy, in 2002, 22 outbreaks in the same day damaged 1,000 hectares of forest. And in Sweden, in 1997, a 10-day outbreak consumed 450 hectares of forest and costs €350,000.

Several studies were conducted at the European level (see [2]) and from all the lessons learnt the most important was that “the best way to fight a forest fire is to prevent it”. Moreover, study of typical forest fires determined that there are three important events in the evolution of a fire: initiate fire (IF); detect fire (DF); and fight fire (FF). The time to detection (TD) is the time elapsed between IF and DF. The time to intervention (TI) is the time elapsed between DF and FF. The reduction of both TI and TD may be crucial to prevent the propagation of the fire and to limit its action. The factors affecting TD are: Time of the day; Location; Type of terrain. The factors affecting TI are: Time of the day; Location and accessibility; Distance from sources of water.

By reducing the time to detection, the early warning fire detection systems will contribute to restrict the propagation of forest fires. Moreover, associated with autonomous fire fighting capabilities (see [5]) may be able to reduce fire propagation and to prevent the occurrence of situations where a fire may run unattended for hours, especially in the case of remote locations.

3. SYSTEM ARCHITECTURE
The purposed architecture is based in a network of tiny wireless sensors. The wireless sensor nodes are composed of environmental sensors collecting temperature, relative humidity, and light attached to a wireless, networked MOTE. The motes communicate with each other forming an ad-hoc wireless sensor network capable of monitoring the evolution of these parameters on a pre-determined forest area. The network communicates with a base station which stores, processes and relays collected information. This information is locally available at the base station or can be accessed through any wireless device (laptop, PDA) if the base station is equipped with standard wireless communication.

The base station relays the collected data and analysis results to services running on a web server through a GSM/GPRS uplink. This web server makes the information available to authorized users, which can view and manipulate the data with a browser through a specific web application. Web publishing through Web services and other interfaces gives researchers and civil protection authorities seamless access to information.

When the level of threat, defined in terms of environment parameters, reaches a pre-defined level the base station sends a warning message to the forest guard or directly to the local fire department.

Remote operators can diagnose network node failures and react accordingly by changing the network setup.

Further details can be found in [4].

4. PILOT EXPERIMENT
Several pilot experimentations of the system were run at Peneda-Gerês National Park [5] in the north region of Portugal this semester. The first experiment was deployed over an area of 7 hectares, using only 7 nodes. The last experiment had already 32 wireless nodes, covering an area of more than 20 hectares. These experiments helped us studying the aspects of each deployment which lead to specific solutions namely in what concerns routing,
optimal sensor placing and efficient retrieval of the deployed nodes. A new application, called MonSense, was created to receive and collect the data from the wireless sensor network and has evolved according to the new requirements found during each experiment. The existent version helps an inexperienced user to deploy a WSN and after this task, allows him to monitor the network state, view the current and past gathered data.

Each node contains a Tmote Sky [6] device, a battery pack and a 5 dBi antenna, all protected by a weather resistant plastic container. By default, the nodes contain sensors for measuring temperature, relative humidity and luminosity, but other types of sensors can be added like wind direction and speed sensor, barometric pressure sensor, rainfall sensor, etc...

5. REFERENCES