Estimation of Wireless Coverage in Complex Cave Environments for Speleology Applications

Tomás Laborra[1], Leire Azpilicueta[1], Peio Lopez Iturri[1], Erik Aguirre[1], and Francisco Falcone* [1]

(1) Electrical and Electronic Engineering Dept., UPNA, Navarre, Spain

Wireless communication systems can be found in a wide variety of environments such as industrial, scientific, home and building automation, vehicles and outdoor environments, mainly due to the development of smaller and cheaper devices and the increasing operational lifetime. In this paper, the feasibility of the deployment of a wireless communication system inside caves is presented. Specifically, a Wireless Sensor Network (WSN) at 868 MHz, 2.4 GHz and 5 GHz bands is studied. WSN in cave environments have great potential because communication systems for speleology and potholing are wired, including the systems used by emergency and rescue teams such as firefighters. In order to perform the radio propagation analysis, an in-house 3D Ray Launching simulation code has been employed, which provides accurate estimations of received power level for full complex indoor scenarios, as it takes into account the topology and the morphology of the scenario, including material properties. Fig. 1a shows the schematic representation of the considered scenario for this work, which corresponds to the dimensions of a real cave placed in Navarre. The estimated received power level for a height of 1.5m inside the cave is represented in Fig. 1b. Results confirm that there is a great dependence of network performance with the topology of the scenario. Therefore, an overall increase system efficiency can be achieved with the aid of this deterministic simulation method.
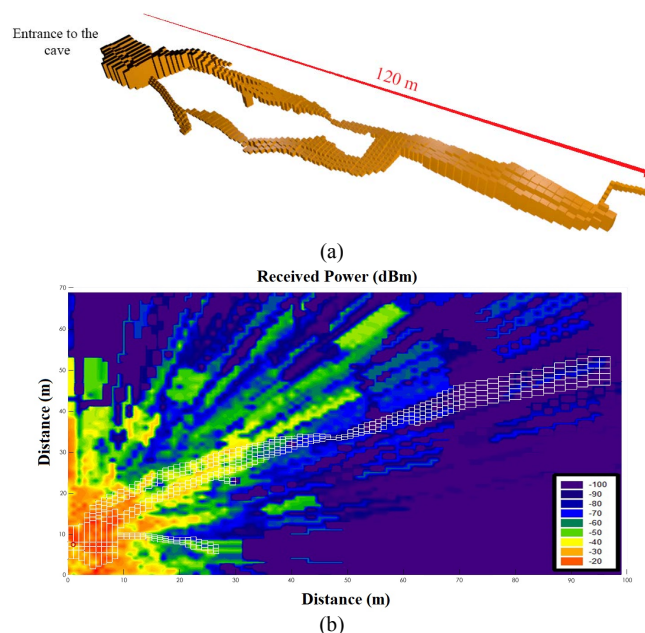

(a)

(b)

Figure 1. (a) Schematic representation of the cave implemented for the 3D Ray Launching simulation (b) Bi-dimensional plane with the Estimated Received Power (dBm) for a height of 1.5m, for a transmitter placed at the cave entrance.