Electromagnetic Communication Solution for Scuba-Diving

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Data exchange in many underwater applications such as oceanographic data collection, scientific ocean sampling, pollution and environmental monitoring, disaster prevention, underwater system maintenance, recreational scuba diving, is an exciting task. Due to the reduced visibility (for optical) or high attenuations (for radio) link, in most of the cases the communication between different locations cannot take place. When possible, this limitations are alleviated employing data transmission via cables, a solution that can be employed for both dynamic (e.g. on the scuba divers) or static (e.g. sensor nodes) systems. However, its use assumes that the movement among the different communicating objects is clearly strongly limited. On the other hand, the total lack of the possible communication among the divers substantially reduces the possibility of preventing dangers, avoiding the considered activity to be conducted in safe way.

Although the continued research over the last years has resulted in definition of possible communication systems with improved performances and robustness, the study and the design of a wireless underwater communication system still remains a challenging problem. In this framework, it is set the idea here presented, i.e. that of an electromagnetic wireless system allowing the communications among divers, specially thought for interaction in case of danger. It is known that the propagation of electromagnetic waves is strongly affected by the conductivity of the medium in which it propagates, that, in the case in which it is water, at its turn it depends on the characteristic parameters as salinity and temperature. The first part of our study has therefore been concentrated on the analysis of the dependence of the propagation characteristics, and in particular of the signal attenuation on the water physical characteristics: the result of this analysis aimed to define the range of frequencies that could be reasonably used and to the determination of the allowable length of the radio link. If on one side, the reduction of the attenuation is achieved using low frequencies, the need of designing reduced-size antennas, that could possibly be integrated in the diving suit, would make preferable to work at higher frequencies. For this reason, it was necessary to find a tradeoff between these two opposite requirements. The results of this analysis show that, for a medium range link, frequencies around 5 kHz have to be used, while for a short range system it is possible to used frequencies around 750 kHz. Once the operating frequency range has been defined, it is therefore possible to move to the design of the radiating element, that has to be miniaturized and properly located on the diving suit or on the tanks.