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Poster

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Abstract

In this work, a thorough analysis based on the two-ray model in the presence of tides is performed. The study aims to provide a tool to guide the deployment of near-surface overwater wireless sensor networks, and thus improve its overall link quality regardless of the variations of the tides. We consider realistic parameters, such as the distance between the nodes and the tide-levels range taken from the mouth of the Douro river, Porto and the Seixal Bay, Lisbon. In future works, we will complement the theoretical analysis with network level simulations and an extended experimental campaign.

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Abstract

In this work, a thorough analysis based on the two-ray model in the presence of tides is performed. The study aims to provide a tool to guide the deployment of near-surface overwater wireless sensor networks, and thus improve its overall link quality regardless of the variations of the tides. We consider realistic parameters, such as the distance between the nodes and the tide-levels range taken from the mouth of the Douro river, Porto and the Seixal Bay, Lisbon. In future works, we will complement the theoretical analysis with network level simulations and an extended experimental campaign.

Author Keywords. Channel Analysis, Fresnel Coefficient, Water Environments, Wireless Sensor Networks.

Type: Oral Communcation

1. Motivation

The two-ray propagation model is a well-known method used to characterize the wireless channel, especially common over water surfaces (Wang et al. 2018). It describes the fading of a channel as a geometric model based on two dominant paths; the first component is the free-space line-of-sight ray between the transmitter and the receiver, and the second one is the reflected ray from the water surface. This representation is considered to be accurate for predicting the propagation of radio signals over distances of several kilometers (long-range) with antenna heights over 50 meters (Rappaport 2002). In recent studies, the validity of the model has also been tested on quite different overwater configurations (Yang et al. 2010) (Reyes-Guerrero, Sisul and Mariscal 2012). However, its applicability at short-range distances (<500m) with antennas close to the water surface (<5m) is not yet clear. At this setting, the grazing incidence angle of the reflected ray (<10º) imply extra considerations on both the antenna polarization and the Fresnel reflection coefficient (Pereira 2010). This is augmented by the natural fluctuations of water levels, which leads to a rather significant and barely explored challenge.

2. Overwater Wireless Sensor Networks Design

The ITU-R P530-17 recommendation provides guidelines for the design of line-of-sight links which cover the overwater case, and also a number of mitigation techniques for reducing the effect of significant surface reflections (ITU, 2017). The techniques range from the careful selection of nodes locations and antenna parameters (such as heights, inclination or polarization), to strategies that require some kind of diversity reception or transmission (such as space, angle and frequency diversity). Although the considerations here included are theoretically and empirically well-supported, the applicability of these results is limited to the range of parameters examined, i.e., kilometric distances between nodes and antenna heights of some tens of meters.

In this work, we present a particularly different scenario given by an overwater wireless sensor network with nodes sited close to the water surface (<5m). We consider realistic parameters, such as the distance between the nodes and the tide-levels range taken from the mouth of the Douro river, Porto and the Seixal Bay, Lisbon. The setting serves as a reference to study how pertinent is the two-ray model as a valid propagation prediction method to design overwater line-of-sight systems in the presence of tidal variations. The ITU-R recommendation is introduced as a relevant framework that includes mitigation techniques that may be desirable to be adapted to the near-surface overwater context.

3. Conclusions

The decisions involved in the design of overwater wireless sensor networks are not trivial. The rise and falls of water levels and the predominant fading due to surface reflections may have a negative impact on the link quality, and thus affect the overall performance of the associated applications. The adjustment of the parameters involved is crucial, and thus a tool to guide the deployment of overwater wireless sensor networks regardless of the tide-levels is a valuable direction to pursue. In future works, we aim to complement the theoretical analysis with network level simulations and an extended experimental campaign.

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