Validation of Path Loss for Near-Ground Sensor Networks

Thomas Jørgensen
7. semester, Wireless
Communication Systems
Aalborg University
Email: tkjj13@student.aau.dk

Kemal Kapetanovic
7. semester, Wireless
Communication Systems
Aalborg University
Email: kkapet08@student.aau.dk

Mads Gotthardsen
7. semester, Wireless
Communication Systems
Aalborg University
Email: mgotth13@student.aau.dk

***Abstract*—The abstract goes here.**

I. Introduction

In the future it is likely that more and more wireless sensor networks (WSN) will appear. Many of such networks may be placed close to or directly in the ground for instance to monitor traffic flow or home power consumption examples could also include industrial or military uses. In such networks both power efficiency as well as reliability is key to maximise the performance. To estimates those a reliable model for the path loss (PL) is needed. Compared to typically used models a few problems occur, when placing the antenna so close to the ground. These problems still needs to be investigated further to effectively estimate the PL. Many of the earliest works only focus on frequencies below 30 MHz [1], and states that the complexity increases as frequency increases. Most of the more recent works focus only on equal height for receiver and transmitter or neglect a verification of the purposed model.

A. Modeller

In terms of calculating the path loss, different path loss propagation models can be applied, to calculate the power received, given different conditions. The Friss transmission equation calculates the power received, given only free space loss, meaning no reflections are introduced ,and is given in the following Equation:

$$P_r = P_t G_t G_r (\frac{\lambda}{4\pi d})^2 \tag{1}$$

where P_r is the power received, G_t and G_r are the gains in the transmitting and receiving antenna respectively. While λ is the wavelength of the transmitted signal, d is the distance between the transmitting and receiving antenna. The model given above given in Equation 1 is not the the complete Friss transmission equation, as it indicates perfect polarization, and the the antennas are pointing directly at each other, and perfect matching between the system and antennas. As it can be read the Friss transmission equation does not take into account the reflected wave. Therefore another model can be used called, the two-ray-ground-reflection path loss model, and is given as:

$$P_r(d) = \frac{P_t G_t G_r h_t^2 h_r^2}{L \cdot d^4} \tag{2}$$

where $P_r(d)$ is the power received given the distance between the transmitter and receiver antenna, G_t and G_r are the gains in the transmitting and receiving antenna respectively. h_t^2, h_r^2 is the height of the transmitting and receiving antenna respectively. While L is the system loss, and d^4 is the distance between the transmitter and receiver antenna. As the two-ray-ground-reflection path loss model considers two signals, a direct and a reflected signal, this gives the following condition

$$d < d_c \tag{3}$$

where d is the distance between the transmitter and receiver antenna, while d_c is called the cross over distance and is given as:

$$d_c = \frac{4\pi \cdot h_t^2 h_r^2}{\lambda} \tag{4}$$

If introduced condition is true the model predicts oscillations which are caused by the constructive and destructive combination of the two rays.

B. Method

To solve a problem like this there is generally two types of approaches a theoretic approach where the models are derieved using physics and electromagnetism and an experimental approach where the PL is measured and a model is fitted to the data. This article will focus on validation of existing models using experiments.

The validation will be made over multiple steps, the first is to assume no knowledge of existing model and design a measurement campaign which accounts for all possible parameters that might affect the PL. The next step is to try and exclude parameters that have little to no statistical influence on the PL. Lastly the data will be matched with the data to verify if the model predicts the PL within an acceptable margin.

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II. Conclusion

The conclusion goes here [2].

Acknowledgment

The authors would like to thank...

References

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