Report - CBRS Propagation Modelling

Joshua Roy Palathinkal

1 Curve fitting for RSRP-distance data

Assuming x_i, y_i to be the distance (in meters) and RSRP (in dBm) values listed in the CBRS dataset, where $i = 1, ..., n$. All dependencies for RSRP can be captured in the form of the following equation [1, 2]:

$$\begin{aligned} y &= a_0 + a_1 log_{10}(x) + X_\sigma \\ X_\sigma &= y - a_0 - a_1 log_{10}(x) \end{aligned} \tag{1}$$

Variance for X_σ is defined as:

$$\sigma^2 = \sum_i \chi_i^2 / n = \sum_i (y_i - a_0 - a_1 log_{10}(x_i))^2 / n$$

To minimize σ^2:

$$\begin{aligned} &\frac{\partial \sigma^2}{\partial a_0} = (-2/n) \sum_i (y_i - a_0 - a_1 log_{10}(x_i)) = 0 \\ &\implies \sum_i y_i = n a_0 + a_1 \sum_i log_{10}(x_i) \iff \boxed{a_0 = \overline{y} - a_1 \overline{log_{10}(x_i)}} \end{aligned} \tag{2}$$

$$\begin{aligned} &\frac{\partial L}{\partial a_1} = (-2/n) \sum_i \{(y_i - a_0 - a_1 log_{10}(x_i))(log_{10}(x_i))\} = 0 \\ &\implies \sum_i \{y_i log_{10}(x_i)\} = a_0 \sum_i log_{10}(x_i) + a_1 \sum_i log_{10}^2(x_i) \end{aligned} \tag{3}$$

Using equation 3 in equation 2:

$$\sum_i \{y_i log_{10}(x_i)\} = \{(\overline{y} - a_1 \overline{log_{10}(x_i)})\} \sum_i log_{10}(x_i) + a_1 \sum_i log_{10}^2(x_i)$$

$$\iff \boxed{a_1 = \frac{\sum_i \{y_i log_{10}(x_i)\} - n \overline{log_{10}(x_i)} \overline{y}}{\sum_i log_{10}^2(x_i) - n \overline{log_{10}(x_i)}^2}}$$

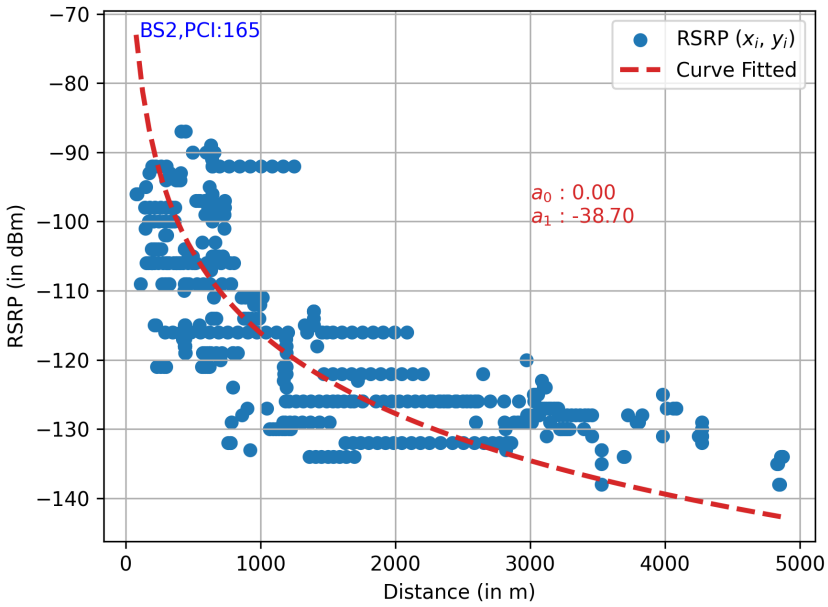

Figure 1: Curve fitting for equation 1

PCI	a_0	a_1
14	0.00	-42.09
88	0.00	-40.64
189	0.00	-43.87
1	0.00	-39.51
96	0.00	-41.36
26	0.00	-43.11
195	0.00	-40.88
46	0.00	-47.19
6	0.00	-42.99
150	0.00	-42.50
10	0.00	-41.14
200	0.00	-39.54
165	0.00	-38.70
169	0.00	-42.59
194	0.00	-43.61
78	0.00	-41.24
69	0.00	-41.32
187	0.00	-47.16

Table 1: Calculated a_0 and a_1 for different PCI

References

[1] Aziz Altaf Khuwaja, Yunfei Chen, Nan Zhao, Mohamed-Slim Alouini, and Paul Dobbins. A survey of channel modeling for uav communications. *IEEE Communications Surveys & Tutorials*, 20(4):2804–2821, 2018.

[2] Shu Sun, Theodore S Rappaport, Sundeep Rangan, Timothy A Thomas, Amitava Ghosh, Istvan Z Kovacs, Ignacio Rodriguez, Ozge Koymen, Andrzej Partyka, and Jan Jarvelainen. Propagation path loss models for 5g urban micro-and macro-cellular scenarios. In *2016 IEEE 83rd Vehicular Technology Conference (VTC Spring)*, pages 1–6. IEEE, 2016.