HELLENIC MEDITERRANEAN UNIVERSITY

SCHOOL OF ENGINEERING

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

MSc in Informatics Engineering

Advanced Topics in Antennas, Propagation of EMF fields, and Wireless Networks

First Project

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Introduction

Welcome to the **Propagation Model Calculator**, a user-friendly Python-based GUI application designed to compute and visualize path loss for various indoor and outdoor radio propagation models. This tool is ideal for engineering students, RF planners, and researchers who need quick insights into signal attenuation in diverse environments.

In this guide, you'll find detailed explanations of each propagation model, step-by-step instructions on using the interface, and troubleshooting tips should you encounter any issues.

Program Interface Overview

The main window of the **Propagation Model Calculator** consists of:

- **Menu Bar**:
    - **File**: Open PDF Report.
    - **Edit**: Clear all input fields, Reset selections to defaults.
    - **About**: Displays program information.
- **Help Button**: Opens the detailed PDF report if you need additional assistance.
- **Environment Selection**: Dropdown to choose between *Outdoor* and *Indoor* models.
- **Model Selection**: Dropdown that dynamically updates to show available models for the selected environment.
- **Input Fields**: Text boxes for model-specific parameters (e.g., Frequency, Heights, Distance).
- **Calculate Button**: Computes path loss using chosen model and displays a graph.
- **Plot Area**: Embedded matplotlib canvas showing path loss vs. distance.
- **Save Graph**: Button to save the generated plot as an image file.

Propagation Models Explained

This application includes several widely used propagation models. Below is an overview of each model and the required input parameters.

Outdoor Models

Free Space Model

Description: Calculates free-space path loss assuming a clear line-of-sight path.
Formula: $L = 32.44 + 20 \log_{10}(f) + 20 \log_{10}(d)$
Inputs:

- **Frequency (MHz):** Operating frequency in megahertz.

Hata Model

Description: Empirical model for urban areas, accounts for base and mobile antenna heights.
Formula: $L = 69.55 + 26.16 \log_{10}(f) – 13.82 \log_{10}(hb) – a(hm) + [44.9 – 6.55 \log_{10}(hb)] \log_{10}(d)$
Inputs:

- **Frequency (MHz)**
- **Base Station Height (m)**
- **Mobile Height (m)**

Cost-231 Hata Model

Description: Extension of Hata for 1500–2000 MHz and includes city size factor.
Formula: Similar to Hata with an added constant *C*.
Inputs:

- **Frequency (MHz)**
- **Base Station Height (m)**
- **Mobile Height (m)**
- **City Size (0 = small/medium, 3 = large)**

Okumura Model

Description: Empirical model based on extensive measurements; includes area gain factor.
Simplified Formula: *L = Lf + Amu – G(hb) – G(hm) – Garea*
Inputs:

- **Frequency (MHz)**
- **Base Station Height (m)**
- **Mobile Height (m)**
- **Max Distance (km)**
- **Area Gain (dB)**

Indoor Models

ITU Indoor Model

Description: Used for path loss within buildings, accounts for floor penetration.
Formula: $L = 20 \log_{10}(f) + n \log_{10}(d) + 28$
Inputs:

- **Frequency (MHz)**
- **Floor Penetration Factor (n)**

Log-Distance Model

Description: General model for indoor or outdoor, uses path loss exponent.
Formula: $L(d) = L_o + 10\, n \log_{10}(d/d_o)$
Inputs:

- **Reference Distance (m) (d_o)**
- **Distance (m) (d)**
- **Path Loss at Ref (dB) (L_o)**
- **Path Loss Exponent (n)**

How to Use the Program

1. Set Up the Environment

Before launching the application, follow these steps to set up your Python environment:

1. **Create a Virtual Environment**
   Open your terminal and run:

   python -m venv venv

2. **Activate the Virtual Environment**
   - On **Windows**:

     venv\Scripts\activate

   - On **macOS/Linux**:

     source venv/bin/activate

3. **Install Required Packages**
   Use the provided requirements.txt file:

   pip install -r requirements.txt

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2. Launch the Application

Run the main script to start the program:

python main.py

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3. Using the Interface

- **Select Environment:** Choose either “Outdoor” or “Indoor” from the dropdown menu.
- **Select Model:** Pick the desired propagation model from the list.
- **Enter Parameters:** Input all required numeric values (non-numeric input is not accepted).
- **Calculate:** Click the **Calculate** button to process the data.
- **View Graph:** A graph of path loss vs. distance will be displayed.
- **Save Graph:** Click **Save Graph** to export the graph as a PNG image.

- **Help:** Click the **Help (Open PDF)** button or go to **File → Open PDF Report** to view the user guide.
- **About:** Click **About** in the menu bar to see version and author details.

Troubleshooting

- **Invalid Input**: Ensure all fields contain numeric values. The program blocks non-numeric entries.
- **No Graph Displayed**: Verify that all required parameters are filled, then click Calculate again.
- **PDF Report Not Opening**: Confirm report.pdf is in the application directory.
- **Application Lag or Freeze**: Close unused programs; restart the app for memory reset.

Credits & Version Information

Program Title: Propagation Model Calculator
Author: Toutoudakis Emmanouil
Version: 1.0
Date: April 2025

Thank you for using the Propagation Model Calculator! For further questions, refer to the PDF manual or contact the author.