**MATLAB codes for the 1-D AC potential drop measurements for nondestructive testing**

There are 5 parts of the codes:

1. Data extraction/preparation: prepare raw data for the inversion
2. Coefficient classes.
3. Forward problem: simulate the potential drop data, for validating the model and for testing the inverse algorithm with simulated data. The forward solver will also be used in nonlinear inverse problem (updated later)
4. Inverse algorithm
5. Visualization

**Data extraction:** *acpd1d\_data\_extract*(inputfile, outputfile)

Extract only the real part and imaginary part of the potential drop data. The original data file provided by John Bowler consist of 9 columns, we only use three columns: frequency, real and imaginary parts of the potential drop. This part must be updated if new data formats are provided.

Coefficient classes: these are classes for different types of coefficients such as piecewise linear coefficients, piecewise constant coefficients. More types of coefficients can be implemented in the future. The base class is ***Coefficient.m*.** All other classes are subclasses of this base class.

**Forward solver**: the user-interface file: *acpd1d\_simulate\_data.m*

Solve the forward problem after the Hankel transform. There are four methods for four cases:

1. Homogeneous medium
2. Two layered medium
3. General medium with varying conductivity and permeability by solving an initial value problem
4. Linearization, as in the linearized inverse problem setting.

To run the forward solver, the user must provide a text file with simulation parameters in a specific format, see the examples in the folder. It also requires a .mat file name for storing the coefficients. These coefficients are implemented as classes.

The implementation of the methods is in the file *acpd1d\_potentialdrop.m*. The file *test\_acpd1d\_potentialdrop.m* compares some simulations with experimental data.

**Inverse solver**: this is the main part of this project. To run the inverse solver, a parameter file, which consists of all parameters chosen for the inverse solver, is required. These parameters are loaded into the program by the function acpd1d\_invprob\_lin\_get\_parameters.m

To run the inverse solver, you can run the file “run\_acpd1d\_invprob\_lin.m”. There are two options: use a recursive algorithm or just a one-time algorithm. The recursive algorithm uses first the high frequencies to get an estimate of the coefficient values near the surface, then uses lower frequencies to estimate the coefficients at deeper depths, and so on. The case of two-layered media is treated separately in the file “acpd1d\_invprob\_twolayers”.

To get an estimate of the reference values of the conductivity and permeability, we use the algorithm with constant coefficients implemented in the function “acpd1d\_invprob\_hom.m”.

**Visualization**: to plot the coefficients and the potential drop profile.

**Steps to run the code:**

For simulated data:

1. Simulate the data: run the routine: acpd1d\_simulate\_data.m
2. Check the figures for suitability of the simulated data.
3. Run the inverse solver: run\_acpd1d\_invprob\_lin.m

For real data:

1. Extract the data
2. Check the data to see if preprocessing is needed.
3. Run the inverse solver.