MIF^3: Matlab Interface For Fast Field solvers

Matlab Interface For Fast Field solvers is a series of functions and scripts to work with MIT's Fast Field Solvers [1] to generate geometries, automate the simulation procedures and provide extra utilities for planar inductors and wireless power transfer coil designs.

The main objective of this project is to provide a very quick, powerful and accurate tool to estimate the self-inductance and couplings as well as ac resistance and capacitance between any number of inductors with arbitrary geometries and positions for a huge frequency range. The main limitation of this project is the impossibility of simulation of magnetic materials. Accordingly, these tools are specially designed for high frequency coreless magnetics and wireless power transfer systems.

The whole repository can be found here: https://github.com/JCCopyrights/MIF3

A general flow diagram of the different functions and data types can be found below:

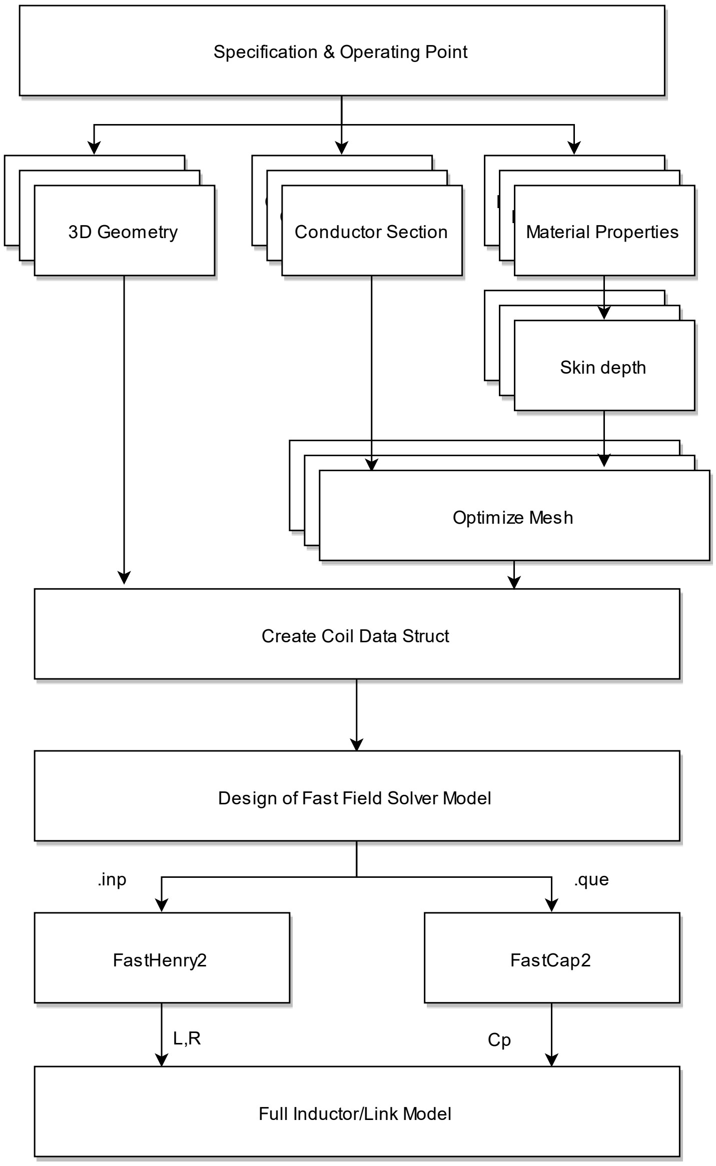

Figure 1: Flow Diagram

[1] FastFieldSolvers, "White Papers and application notes" [Online], Available https://www.fastfieldsolvers.com/

The library functions thus, can be classified in three main groups:

A.1. **Geometries:**

Functions that model the geometries of the inductors.

Name	Description	Function
Solenoid Spiral	Spring with flat turns	solenoid_spiral
Round Spiral	Single layer rounded spiral	round_spiral
Rectangular Spiral	Single layer rectangular spiral	square_spiral
Helix Spiral	Helicoidal spring	helix_spiral
Rectangular Planar Inductor	Multilayer rectangular spiral	rectangular_planar_inductor
Circular Planar Inductor	Multilayer circular spiral	circular_planar_inductor

Table 1: Geometry Functions

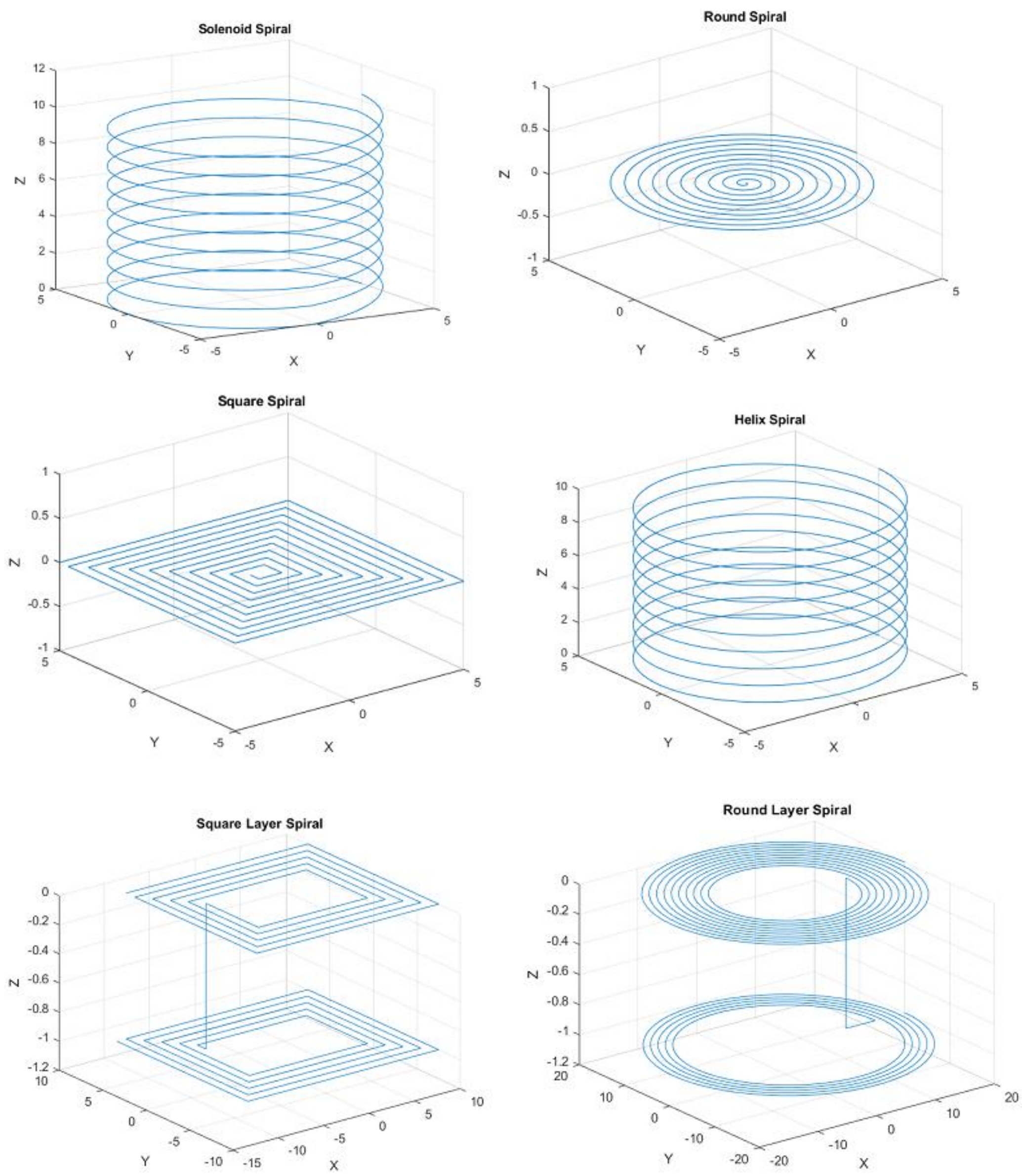

Figure 2: Geometries

A.2. **Fast Field Solver Interface:**

Functions that create the data structures and interfaces to work with Fast Field Solvers

Name	Description	Function
Generate Coil	Generates a struct with the coil geometry and conductor properties.	generate_coil
Discretization Tools	Calculates a mesh discretization that allows an arbitrary width filament in the edges of the conductors. [*]	optimize_discr
FastHenry Creator	Creates a. inp model containing all the geometry and conductor data for FastHenry.	fasthenry_creator
FastHenry Runner	Runs the fasthenrymodel and retrieves the results	fasthenry_runner
FastCap Creator	Creates a. list and .que files containing the conductor surfaces	fastcap2_creator
FastCap Runner	Runs the fastcap model and retrieves the Maxwell capacitance matrix	fastcap2_runner

Table 2: Fast Field Solver interface functions

[*] The discretization of the segments is probably the most important characteristic of the model to accurately simulate the inductors. In FastHenry the size of the discretization filaments can be controlled modifying the number of filaments in the width and height of the conductor. In this library the most external filaments (the most critical ones) width and height can be introduced, and the nhinc and nwinc parameters will be calculated in a way that assures the size of these filaments. Every other filament width and height is geometrically increased with a selectable values (rh,wh).

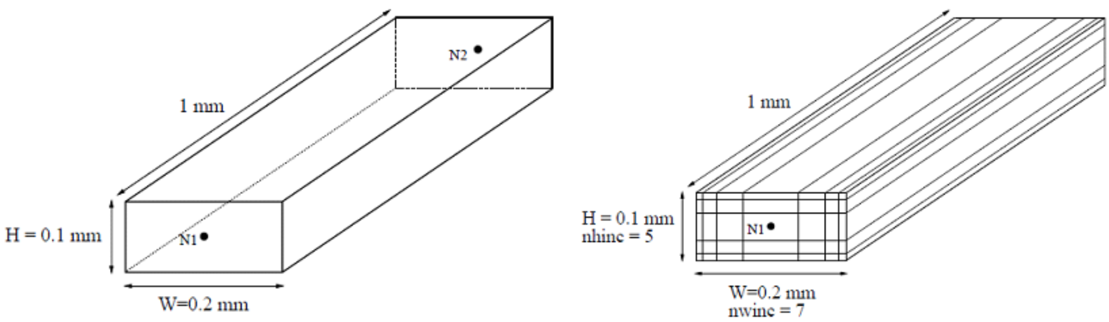

Figure 3: Discretization of conductors

A.3. **Utilities:**

Other functions and utilities that help and complete the functionalities of the main library.

Name	Description	Function
Import Bode100	Imports data from a csv file generated with bode100 suite	import_bode100
Generate Model Bode100	Takes data imported from bode100 and generates a L, C, R model that matches the data	model_bode100
Real Coil	Takes parameters from a model and calculates the series impedance equivalents	real_coil
Import raw LTSpice	Takes a .raw file from a Spice simulation and imports it as a struct	LTautomation
Run LTSpice	Runs a .asc LTSpice simulation file	LTspice2Matlab
Modify LTSpice	Looks for a component in a .asc file and modifies its value	LTmodify

Table 3: Utilities functions

A.4. **Example Topologies:**

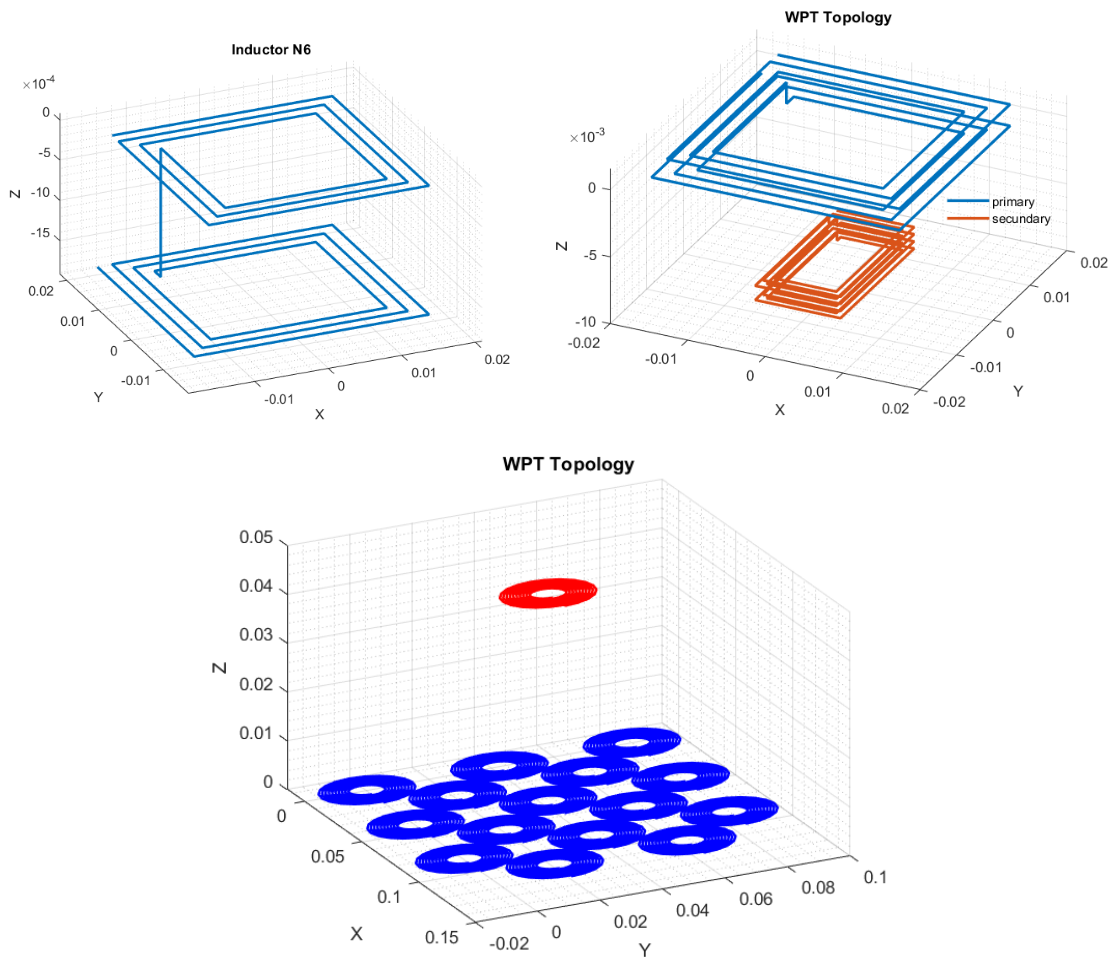

Figure 4: a) Inductor b) WPT system c) Multiple WPT