lightlabsFDS File Format

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Abstract

lightlabsFDS uses the HDF5 file format as a low-level interface. HDF5 files are used to store both the input and output parameters of a simulation. This specification is particularly useful in determining whether a feature or function is the responsibility of the client or server.

1 General remarks

- All floating-point values are stored in single-precision, and all three-dimensional fields are subject to lossless compression.
- Be aware that Matlab arrays are stored in column-major ordering; however, HDF5 uses row-major ordering. To convert a three-dimensional array from column-major to row-major ordering in Matlab, one can use the `permute` function.

The following work-distribution is implied from the input and output file formats. Specifically, the server is only responsible for computing the output E-fields based on the information found in the input file. Consequently, the client is then responsible for features such as

- setting up PML parameters,
- taking care of symmetry planes,
- shape generation (including edge-smoothing),
- any mode-solving necessary for determing input sources,

- visualizing input and output fields,
- calculating D-, H-, and B- output fields, and
- interpreting those output fields (calculating flux, energy, ...).

2 Input file format

The input HDF5 file consists of the following fields:

`reservation_id` An identifier of some kind. Some kind of random number that certifies that this is indeed from the correct user. The purpose is to reserve the user's place in line and to authenticate the user as well.

`omega` Floating-point scalar which determines the angular frequency of the simulation.

`shape` A 3-element array of positive integers in the format `xx` $\times$ `yy` $\times$ `zz`.

`boundary_conditions` 6-element array of character strings which denote the boundary conditions at the endfaces of the grid in the order $-x$, $+x$, $-y$, $+y$, $-z$, and $+z$. Each element must be one of three character strings: `pec` (perfect electrical conductor), `pmc` (perfect magnetic conductor), or `per` (periodic).

`sx_real, sx_imag, sy_real, sy_imag, sz_real, sz_imag` One-dimensional floating-point arrays describing the stretched-coordinate distances between adjacent grid points. Specifically, these denote the distances *between* integer points along the x-, y-, and z-directions (e.g. distance between $x = 0$ and $x = 1$). The length of the `si_real` or `si_imag` array, where `i = x,y,z`, are `xx`, `yy`, and `zz` respectively. Lastly, the first element of the array corresponds to the distance between the points at positions `0` and `1`, while the last element of the array corresponds to the distance between the points at positions `N` and (hypothetical) `N+1`.

`tx_real, tx_imag, ty_real, ty_imag, tz_real, tz_imag` One-dimensional floating-point arrays describing the stretched-coordinate distances between adjacent grid points. Specifically, these denote the distances *centered* at integer points along the x-, y-, and z-directions (e.g. distance between $x = 0$ and $x = 1$) The length of the `ti_real` or `ti_imag` array, where `i = x,y,z`, are `xx`, `yy`, and `zz` respectively. Lastly, the first element of the array corresponds to the distance between the points at positions `-0.5` and `0.5`, while the last element of the array corresponds to the distance between the points at positions `N-0.5` and (hypothetical) `N+0.5`.

`ex_real, ex_imag, ey_real, ey_imag, ez_real, ez_imag` Three-dimensional floating-point arrays describing the values of ϵ. The shape of the arrays must be `xx` $\times$ `yy` $\times$ `zz`.

`mx_real`, `mx_imag`, `my_real`, `my_imag`, `mz_real`, `mz_imag` Three-dimensional floating-point arrays describing the values of μ. The shape of the arrays must be `xx` $\times$ `yy` $\times$ `zz`.

`Jx_real`, `Jx_imag`, `Jy_real`, `Jy_imag`, `Jz_real`, `Jz_imag` Three-dimensional floating-point arrays describing the values of the current sources. The shape of the arrays must be `xx` $\times$ `yy` $\times$ `zz`.

3 Output file format

The output HDF5 file that is returned to the user consists of the following fields:

`Ex_real`, `Ex_imag`, `Ey_real`, `Ey_imag`, `Ez_real`, `Ez_imag` Three-dimensional floating-point arrays describing the values of the current sources. The shape of the arrays is `xx` $\times$ `yy` $\times$ `zz`.