A Numerically-Determined Steepest-Descent Path Package for the Dielectric Half-Space Problem.

Amit Hochman

Abstract

This document explains how to use the Numerically-Determined Steepest Descent Path (NDSDP) package for MATLAB . The package includes a simple Graphical User Interface (GUI), `ndsdpGui` that demonstrates the use of the NDSDP. The algorithm implemented in this package is described in detail in [1].

1 Getting Started

To install the `ndsdp` package, extract all files to one directory and add the directory to the MATLAB path with the `path` command. The package creates a directory in which it stores Gaussian quadrature rules to avoid their re-calculation each time they are needed. By default, this directory is

```
[matlabroot '\NDSDP_quad_rules']
```

where `matlabroot` is the MATLAB root directory. This directory can be changed by editing the file `initialize_globals.m` and setting the variable `RULES_DIR` to a different directory. A good starting point for getting acquainted with the `ndsdp` is the function

```
ndsdpGui
```

which launches a GUI that demonstrates the use of the package. To learn quickly how to use the `ndsdp` inside MATLAB code, see the file `example.m`.

2 The NDSDP function

The `ndsdp` function is used to calculate the fields of a line-source near a dielectric (lossless) half-space. The function is called as follows,

```
[field, nPoints] = ndsdp(EvalAt, Source, permittivityLowerRegion, ....
    permittivityUpperRegion, componentString, Options);
```

Inputs:

`EvalAt.x, EvalAt.y`	vectors or matrices of the coordinates at which the fields are evaluated.
`Source.x, Source.y`	source coordinates.
`Source.polarizationString`	'TM' for an electric line-source, 'TE' for a magnetic one.
`permittivityLowerRegion`	relative permittivity of the $y < 0$ region.
`permittivityUpperRegion`	relative permittivity of the $y > 0$ region.
`componentString`	string specifying the component to be calculated. Allowed values are: `'Ex'`, `'Ey'`, `'Ez'`, `'Hx'`, `'Hy'`, `'Hz'`, `'Dx'`, `'Dy'`, `'Dz'`.
`Options.quasistaticRule`	string specifying the quadrature rule used for the quasi-static case. Allowed values are: `'discretization'` and `'Legendre'` (default). `'discretization'` usually yields better accuracy but the generation of the rule may take longer.
`Options.useAdaptive`	if true, change the number of points adaptively. If false, use `Options.nPoints` for all observation points. If `options.useAdaptive == true`, the following options must be set:
`Options.tol`	Maximum relative error for adaptive scheme.
`Options.maxPoints`	Maximum number of integration points in the adaptive scheme. If `options.useAdaptive == false` the following option must be set:
`Options.nPoints`	number of integration points (should be even).

Outputs:

`field`	field component specified by `componentString`.
`nPoints`	number of integration points used. If `Options.useAdaptive == true`, the number of integration points used for each observation point is return in `nPoints`, which is the same size as `EvalAt.x`. If `Options.useAdaptive == false`, then `nPoints = Options.nPoints`.

Details of the algorithm implemented in the `ndsdp` package are give in [1]

3 License

The Numerically Determined Steepest Descent Path (ND-SDP) Package is copyright 2009, Technion - Israel Institute of Technology.

The Numerically Determined Steepest Descent Path (ND-SDP) Package is free software: you can redistribute it and/or modify it under the terms of the GNU General Public License as published by the Free Software Foundation, either version 3 of the License, or (at your option) any later version.

This program is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU General Public License for more details. You should have received a copy of the GNU General Public License along with this program. If not, see http://www.gnu.org/licenses/

References

[1] A. Hochman and Y. Leviatan, ”A Numerical Methodology for Efficient Evaluation of 2D Sommerfeld Integrals in the Dielectric Half-Space Problem,” *to appear in IEEE Transactions on Antennas and Propagation.*

Acknowledgement

This software is the outgrowth of my PhD research conducted in the Department of Electrical Engineering at the Technion - Israel Institute of Technology. My advisor, to whom I am much indebted, was Prof. Yehuda Leviatan.