OOMMF
2D Solver
Advanced
Details
Solver Module Features

- 3D spins on a square 2D grid
- LLG ODE solver
- Demag calculated via FFT
- Anisotropy, applied field, and initial magnetization ptwise selectable
- Shaped elements
Micromagnetic Equations

Landau-Lifshitz-Gilbert:

\[
\frac{dM}{dt} = \frac{-\omega}{1 + \lambda^2} M \times H_{\text{eff}} - \frac{\lambda \omega}{(1 + \lambda^2)M_s} M \times (M \times H_{\text{eff}})
\]

\[
H_{\text{eff}} = -\frac{1}{\mu_0} \frac{\partial E_{\text{density}}}{\partial M}
\]

Energies:

\[
E_{\text{exchange}} = \frac{A}{M_s^2} \left( |\nabla M_x|^2 + |\nabla M_y|^2 + |\nabla M_z|^2 \right)
\]

\[
E_{\text{anis}} = \frac{K_1}{M_s^4} \left( M_x^2 M_y^2 + M_y^2 M_z^2 + M_z^2 M_x^2 \right)
\]

\[
E_{\text{demag}} = \frac{\mu_0}{8\pi} M(r) \cdot \left[ \int_V \nabla \cdot M(r') \frac{r - r'}{|r - r'|^3} d^3 r' \right. \\
\left. - \int_S \hat{n} \cdot M(r') \frac{r - r'}{|r - r'|^3} d^2 r' \right]
\]

\[
E_{\text{Zeeman}} = -\mu_0 M \cdot H_{\text{ext}}
\]
Sample MIF 1.1 File

# MIF 1.1
# material name:Custom
ms:1000e3
k1:0
anisotropy type:uniaxial
anisotropy dir1:0 0 1
demag type:constmag

part height:5e-6
part width:1e-6
part thickness:100e-9
part shape:rectangle
cell size:20e-9

init mag:uniform 85.0 63.8
randomizer seed:1

default control point spec: -torque 1e-5
field range: .1 .1 .1 0.01 0.01 0.01 9
field range: 0.01 0.01 0.01 0. 0. 0. 1 -torque 1e-6
field range: 0 0 0 -.03 -.03 -.03 6
field range: -.03 -.03 -.03 -.045 -.045 -.045 30
field range: -.045 -.045 -.045 -.05 -.05 -.05 1
field range: -.05 -.05 -.05 -.1 -.1 -.1 5

a:6.981317e-10
base output filename: prob2dlex30.00
user comment: muMag Problem 2, d/lex=30.0
Sample MIF edits

- Do Precess: 1
- gyratio: $2.21e5$ in m/(A.s)
- Default Control Point Spec: -torque 1e-5
  and/or -time, -iteration
- Field Type: OneFile *filename mult*
MIF 1.1 Files: Multiple Applied Fields

Part Width: 0.25e-6 # Nominal part width in m
Part Height: 1.0e-6 # Nominal part height in m
Part Thickness: 1e-9 # Part thickness in m.
Cell Size: 8.1e-9 # Cell size in m.

Field Type: Multi 4
7 Ribbon 1 0 1.0e-6 0.25e-6 1.0e-6 1e-9 \
7 Ribbon 1 0 0 0.25e-6 0 1e-9 \
9 Tie 100 0 0 0.12e-6 0.5e-6 0.13e-6 0.5e-6 8.1e-9 \
1 Uniform
# The above positions ribbons of positive charge along the upper
# and lower edges with strength Ms, applies a large (100 Ms) field
# to the center cell, and also applies a uniform field across the
# sample stepped from (-.05,-.01,0.) to (.05,.01,0.) (Tesla), and
# back, in approximately 0.001 T steps.
MIF 1.1 Files: Dynamics

# MIF 1.1
# material name:Custom
ms:8e5
a:13E-12
k1:0
damp coef:0.02
#damp coef:0.5
anisotropy type:uniaxial
anisotropy init:constant
anisotropy dir1:1 0 0
anisotropy dir2:0 1 0
demag type:constmag
part height:500E-9
part width:125E-9
part thickness:3e-9
part shape:rectangle
#cell size:3.125e-9
#cell size:2.5e-9
cell size: 5e-9
init mag:avffile app/mmpe/examples/prob4-start.omf
base output filename:prob4
magnetization output format:binary 4
total field output format:binary 4
data table output format:%.15g
randomizer seed:0
randomizer seed:0
max time step: 0.2e-12
field range: 0 0 0 0 0 0 0 -torque 1e-9
field range: 0.0063 -0.0355 0 0.0063 -0.0355 0 5000 -time 1e-12
Sample Batch Launch Commands

- Process one MIF file:
  \texttt{tclsh oommf.tcl batchsolve taskA.mif}

- Process a sequence of MIF files:
  \texttt{tclsh oommf.tcl batchmaster simpletask.tcl}
Sample Batch Task File

# FILE: prob2task.tcl
#
# This is a sample batch task file. Usage example:
#
#     oommf.tcl -fg batchmaster -tk 0 prob2task.tcl
#
# LOCAL MODIFICATIONS: It is recommended you copy this sample file and
# make modifications to the copy (which is then specified on the
# batchmaster.tcl command line in place of prob2task.tcl). You will
# want to change
#
# $TaskInfo SetSlaveInitScript --- This script is sent to each slave
# when it is first brought up. Do any one-time
# initialization here, but also define the procs
# SolverTaskInit, SolverTaskCleanup and optionally
# BatchTaskRelaxCallback. Use SolverTaskInit to
# perform task-specific initialization.
# $TaskInfo AppendTask --- List of tasks. Each entry is a pair
# consisting of a task label (id), and a Tcl script to
# eval.
#
# Task script configuration
set BASEMIF prob2 ;# Base mif name
#set CELLSIZE 20 ;# Simulation cellsize in nm
#set dlex_list { 30 25 20 15 10 5 }
#set CELLSIZE 40 ;# Simulation cellsize in nm
#set dlex_list { 15 10 5 }
set CELLSIZE 250 ;# Simulation cellsize in nm
set dlex_list { 0.25 0.125 }
#
# Slave initialization script (with batchsolve.tcl proc redefinitions)
set init_script {
    # Initialize solver. This is run at global scope
    set basename __BASEMIF__ ;# Base mif filename (global)
    set cellsize __CELLSIZE__ ;# Simulation discretization size
    mms_mif New mif
    $mif Read [FindFile ${basename}.mif]
    # Redefine TaskInit and TaskCleanup proc’s
    proc SolverTaskInit { args } {
        global mif outtextfile basename cellsize
        #
set dlex [lindex $args 0]
set outbasename "$basename-dlex$dlex-cellsize$cellsize"
# Convert d/lex to A
set tmp [expr [$mif GetPartWidth]*[$mif GetMs]/$dlex]
set A [expr $tmp*$tmp*6.2831853e-7]
$mif SetA $A
$mif SetCellSize [expr $cellsize*1e-9] ;# Convert to meters
$mif SetOutBaseName $outbasename
$mif SetUserComment "muMag Problem 2, d/lex=$dlex,
  cellsize=$cellsize nm"
set outtextfile [open "$outbasename.odt" "a+"]
puts $outtextfile [GetTextData header \"mmSolve run on $basename.mif, for d/lex=$dlex (A=[$mif GetA])\"
flush $outtextfile
}
proc SolverTaskCleanup { args } {
global outtextfile
close $outtextfile
}
# Substitute $BASEMIF in for __BASEMIF__ in above script
regsub -all -- __BASEMIF__ $init_script $BASEMIF init_script
# Substitute $CELLSIZE in for __CELLSIZE__ in above script
regsub -all -- __CELLSIZE__ $init_script $CELLSIZE init_script
# Set init script into TaskInfo
$TaskInfo SetSlaveInitScript $init_script
# Create task list
foreach dlex $dlex_list {
    $TaskInfo AppendTask "d/lex=$dlex" "BatchTaskRun $dlex"
}