Package 'tetrascatt'

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Type Package

Title Acoustic Scattering for Complex Shapes by Using the DWBA

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Description Uses the Distorted Wave Born Approximation (DWBA) to compute the acoustic backward scattering, the geometry of the object is formed by a volumetric mesh, composed of tetrahedrons. This computation is done efficiently through an analytical 3D integration that allows for a solution which is expressed in terms of elementary functions for each tetrahedron.
It is important to note that this method is only valid for objects whose acoustic properties, such as density and sound speed, do not vary significantly compared to the surrounding medium. (See Lavia, Cascallares and Gonzalez, J. D. (2023). TetraScatt model: Born approximation for the estimation of acoustic dispersion of fluid-like objects of arbitrary geometries. arXiv preprint <doi:10.48550/arXiv.2312.16721>).

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License GPL (>= 2)

Imports Rcpp (>= 1.0.9)

LinkingTo Rcpp, RcppArmadillo

RoxygenNote 7.2.3

NeedsCompilation yes

Repository CRAN

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Contents

`read_mesh` *read_mesh*

Description

This function reads the mesh from a file .mesh (extension)

Usage

```
read_mesh(meshfile)
```

Arguments

`meshfile`	a string with the name of the file that contains the volumetric mesh in GMF format (Gamma Mesh Format), conventionally, an ASCII file with ".mesh" extension.

Value

a list representing the mesh, it should include

- `vertex`: a data frame with the vertices of the tetrahedra, each vertex must have three coordinates
- `tetra`: a data frame containing the four vertex-index of each tetrahedron

Examples

```
# Generates a pseudofile that has  the mesh of
# a cube with edges one metre in length, centered at the origin.

pseudofile=c("MeshVersionFormatted 2",
  "","Dimension 3","","Vertices","8","-0.5 -0.5 0.5 6 ",
   "-0.5 -0.5 -0.5 7 ","-0.5 0.5 0.5 9 ","-0.5 0.5 -0.5 11 ",
   "0.5 -0.5 0.5 16 ","0.5 -0.5 -0.5 17 ","0.5 0.5 0.5 19 ",
   "0.5 0.5 -0.5 21 ","","Edges", "12","2 1 5 ","1 3 8 ",
   "4 3 10 ","2 4 12 ","6 5 15 ","5 7 18 ","8 7 20 ","6 8 22 ",
  "2 6 25 ","1 5 26 ","4 8 29 ","3 7 30 ","","Triangles",
  "12","2 1 3 3 ","3 4 2 3 ","5 6 8 13 ","8 7 5 13 ",
  "2 6 5 23 ","5 1 2 23 ","8 4 3 27 ","3 7 8 27 ","2 4 8 31 ",
  "8 6 2 31 ","3 1 5 33 ","5 7 3 33 ","","Tetrahedra",
  "5","5 2 1 3 1 ","4 2 8 3 1 ","8 5 7 3 1 ","8 2 6 5 1 ",
  "3 2 8 5 1 ","","End","" )

# creating an empty temporary mesh file
temp_mesh_file=tempfile(fileext = ".mesh")
# loading the file with data.
```

```
writeLines(pseudofile,temp_mesh_file)
# reading the mesh
my_mesh=read_mesh( meshfile=temp_mesh_file)

# see the bounding box of the volumetric mesh.
lapply(my_mesh$vertex,range)

# unliking the teporary file.
unlink(temp_mesh_file)
```

`tetrascatt` *tetrascatt*

Description

This function computes the volumetric backscattering from a mesh of tetrahedrons.

Usage

```
tetrascatt(parameters, freq, mesh, kversor)
```

Arguments

`parameters`	a list including the parameters model, it must include • `cw`: sound speed in the water in m/s • `g`: g density constrast value, i.e g= rho1/rhow, where rho1 and rhow are the density values of the stcatterer and the media (sea water) respectively. • `h`: h density sound speed contrast value, that is h= c1/cw where c1 is the sound speed of the stcatterer.
`freq`	an array of frequencies where the scattering is computed.
`mesh`	a list representing the mesh, it must include • `vertex`: a data.frame with the vertex of the tetrahedra, each vertex has to have three coordinates. • `tetra`: a data.frame containing the four index of each tetrahedra.
`kversor`	A three component vector that indicates the direction of the incident plane wave.

Value

List containing the frequencies, `freq`, and their corresponding Target Strength values, `ts` .

See Also

`read_mesh` to get this kind of list from a .mesh file.

Examples

```
########################################
### Set  the Frequency range    ########
########################################
fmin=12
fmax=400
freqs= seq(fmin,fmax, by=1)
# for tetrascatt freq unities  should be in Hz.
freq=freqs*1000
############################################################
########### Set properties of media and scatterer ######
############################################################
cw <- 1477.4 #soundspeed surrounding fluid (m/s)
rho <- 1026.8 #density surrounding fluid (kg/m^3)
g <- 1028.9/rho #density contrast
h <- 1480.3/cw #soundspeed contrast
my_parameters=list(cw=cw,g=g,h=h)

##########################################################
### Set the incident direction of the plane wave #####
##########################################################
kversor=c(1,0,0)

##########################################################
### Set the scatterer geometry ######################
##########################################################
# generates a pseudofile that has  the mesh of cube of one meter
# side
pseudofile=c("MeshVersionFormatted 2",
  "","Dimension 3","","Vertices","8","-0.5 -0.5 0.5 6 ",
   "-0.5 -0.5 -0.5 7 ","-0.5 0.5 0.5 9 ","-0.5 0.5 -0.5 11 ",
   "0.5 -0.5 0.5 16 ","0.5 -0.5 -0.5 17 ","0.5 0.5 0.5 19 ",
   "0.5 0.5 -0.5 21 ","","Edges", "12","2 1 5 ","1 3 8 ",
   "4 3 10 ","2 4 12 ","6 5 15 ","5 7 18 ","8 7 20 ","6 8 22 ",
  "2 6 25 ","1 5 26 ","4 8 29 ","3 7 30 ","","Triangles",
  "12","2 1 3 3 ","3 4 2 3 ","5 6 8 13 ","8 7 5 13 ",
  "2 6 5 23 ","5 1 2 23 ","8 4 3 27 ","3 7 8 27 ","2 4 8 31 ",
  "8 6 2 31 ","3 1 5 33 ","5 7 3 33 ","","Tetrahedra",
  "5","5 2 1 3 1 ","4 2 8 3 1 ","8 5 7 3 1 ","8 2 6 5 1 ",
  "3 2 8 5 1 ","","End","" )

# creating an empty temporary mesh file
temp_mesh_file=tempfile(fileext = ".mesh")
# loading the file with data.
writeLines(pseudofile,temp_mesh_file)


#reading the mesh
my_mesh=read_mesh( meshfile=temp_mesh_file)

# Computing the scattering
```

```
output= tetrascatt(parameters=my_parameters,freq,
                   mesh=my_mesh,kversor)

plot(output$freq,output$ts)

# unliking the teporary file.
unlink(temp_mesh_file)
```

`tetrascatt_c` *tetrascatt_c*

Description

Computes scattering from a volumetric mesh efficientlty, it is an auxiliary function called by tetrascatt function.

Usage

```
tetrascatt_c(cw, g, h, freq, Tet, Ver, kversor)
```

Arguments

`cw`	sound speed in the water in m/s
`g`	density constrast value, i.e g= rho1/rhow, where rho1 and rhow are the density values of the stcatterer and the unbounded medium respectively
`h`	density sound speed constrast value i.e h= c1/cw, where c1 is the sound speed of the stcatterer
`freq`	an array of frequencies, where the scattering is computed.
`Tet`	a matrix containing the four index of each tetrahedron.
`Ver`	a matrix with the vertex of the tetrahedra, each vertex has to have three coordinates.
`kversor`	three component vector that indicates the direction of the incident plane wave.

Value

A complex number array which contains the backward differential far-field scattering cross-section (f infinity) values at each frequency.

See Also

`tetrascatt`

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