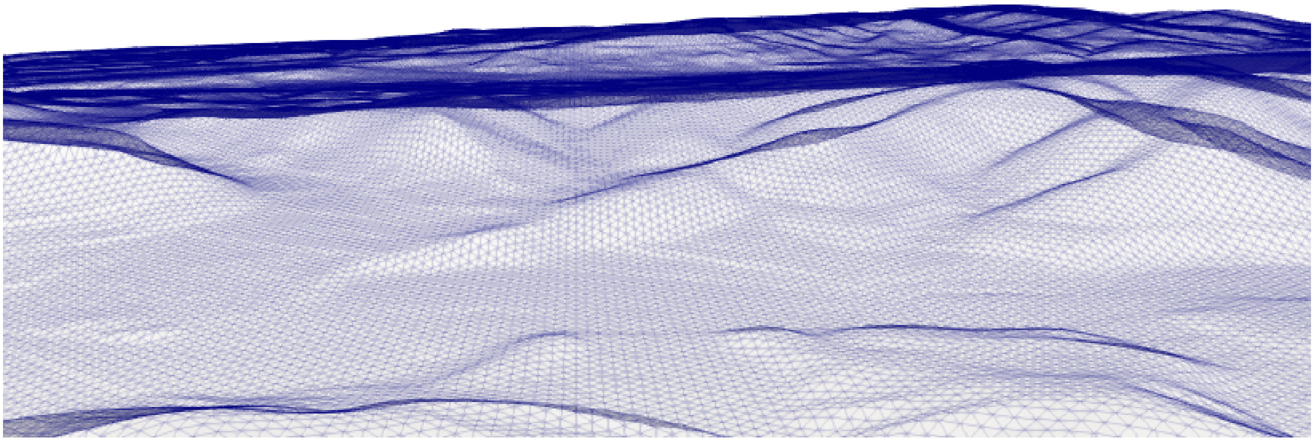

Introduction

topIIvol meshing tool provides sequential/parallel tools for creating volumetric tetrahedral meshes from a given topology (point-cloud `*.xyz`). The volumetric meshes can be extracted in Gmsh's `*.msh` format or medit's `*.mesh` format. The framework is written in C++, and uses MPI I/O and MPI for parallelization. One could produce distributed meshes suitable for domain-decomposition based solvers or simply non distributed meshes (single mesh) suitable for a sequential/parallel solver.

topIIvol consists a total of four tools:

1. `topIIvol_PreProc`

This tool is a point-cloud preprocessor. Often point-cloud data is huge and requires some alterations. This tool takes in a point-cloud as an input (`.xyz`). It can be used to coarsen a structured point cloud, by skipping a specified n number of points.

2. `topIIvol_Mesher`

This is a sequential computing tool. This tool takes in a point-cloud as an input (`.xyz`) and generates volumetric meshes that can be extracted in Gmsh's `*.msh` format or medit's `*.mesh` and `*.meshb` format.

3. `topIIvol_ParMesher`

This is a parallel computing tool. This tool takes in a point-cloud as an input (`.xyz`) and generates volumetric meshes that can be extracted in medit's `*.mesh` format.

4. `topIIvol_DistMesher`

This is a tool to create embarrassingly parallel distributed meshes. The mesher takes in a point-cloud as an input (`.xyz`) and outputs distributed mesh.

Installation process

Before you begin installing topIIvol please check if your system meets the dependencies.

Dependencies

- automake
- C++
- MPI

Now that I have all the dependencies what next

Goto `top-ii-vol-Source` folder and

- step 1

```
autoreconf -i
```

- step 2

```
./configure
```

Note: `./configure` will install topIIvol in `/usr/local/bin` or `/usr/bin`, you generally need to be a superuser (sudoer) to have access to these directories. If you prefer to install at any other directory of choice `--prefix=Your/Own/Path` with `./configure`:

```
./configure --prefix=Your/Own/Path
```

- step 3

```
make
```

- step 4

```
make check
```

- step 5

```
sudo make install
```

Note: if you used `--prefix` during the configure phase, you can avoid using `sudo` for this step and simply `make install`.

- Step 6 (optional)

```
make tutorials
```

this will install some basic tutorial at `$HOME/topIIvol-tutorials`.

Running topIIvol

If the compilation went successful you should have three tools at your disposal `topIIvol_ParMesher`, `topIIvol_Mesher`, `topIIvol_PreProc`, and `topIIvol_DistMesher`. These tools can be worked with command line inputs. Normally, these tools should be present in `/usr/local/bin` or `/usr/bin` folder, or else if you used `--prefix=your/directory` at the time of configure then these tools should be present in `your/directory/bin`.

How to use topIIvol_PreProc ?

- If you wish to coarsen your mesh by skipping 10 points in x and y direction

```
topIIvol_PreProc --xpoints 500 --ypoints 451 --xskip 10 --yskip 10 \
--in ./../etc/DEM_10m.xyz --out out-coarse.xyz
```

Command-line option definitions

Option	Type	Comment
`--xpoints`	`[int]`	These are # of x points present in your point cloud.
`--ypoints`	`[int]`	These are # of y points present in your point cloud.
`--xskip`	`[int]`	These are # of periodic x points you would like to skip.
`--yskip`	`[int]`	These are # of periodic y points you would like to skip.
`--in`	`[string]`	Sting to provide the input point cloud file `.xyz`
`--out`	`[string]`	Sting to provide the output coarsened/stripped point cloud file `.xyz`

Note that after successfully running `./topIIvol_PreProc`there will be a info file `info-<out-coarse.xyz>.txt` that give the number of x an y points in the coarsened mesh cloud.

How to use topIIvol_Mesher ?

This is the sequential mesher

- For sequential mesher producing `*.mesh` mesh.

```
topIIvol_Mesher --xpoints 32 --ypoints 29 --zpoints 15 --depth -1000 \
--in ./../etc/DEM_160m.xyz --out out-mesh.mesh --mesh mesh
```

- For sequential mesher producing `*.msh` mesh.

```
topIIvol_Mesher ---xpoints 32 --ypoints 29 --zpoints 15 --depth -1000 \
--in ./../etc/DEM_160m.xyz --out out-mesh.msh  --mesh msh
```

Command-line option definitions

Option	Type	Comment
`--xpoints`	`[int]`	These are # of x points present in your point cloud.
`--ypoints`	`[int]`	These are # of y points present in your point cloud.
`--zpoints`	`[int]`	These are # of z points intended in the z direction.
`--in`	`[string]`	Sting to provide the input point cloud file `.xyz`
`--out`	`[string]`	Sting to provide the output mesh file `.mesh`
`--depth`	`[int]`	This is the depth of the mesh needed.
`--mesh`	`[string]`	To specify the kind of mesh needed

How to use topIIvol_ParMesher ?

This is the parallel mesher (still under heavy development)

- For parallel mesher producing `*.mesh` mesh with 2 MPI ranks.

```
mpirun -n 2 topIIvol_ParMesher --xpoints 32 --ypoints 29 --zpoints 15 \
--depth -2000 --in ./../etc/DEM_160m.xyz  --out Parallel-out-mesh.mesh
```

Command-line option definitions

Option	Type	Comment
`--xpoints`	`[int]`	These are # of x points present in your point cloud.
`--ypoints`	`[int]`	These are # of y points present in your point cloud.
`--zpoints`	`[int]`	These are # of z points intended in the z direction.
`--in`	`[string]`	Sting to provide the input point cloud file `.xyz`
`--out`	`[string]`	Sting to provide the output mesh file `.mesh`
`-n`	`[int]`	Provide the # of MPI ranks.

How to use topIIvol_DistMesher ?

This is tool to created distributed mesh from partitioned point cloud

- Examples 3D partitioning of distributed mesher producing `*.mesh` mesh with 24 MPI ranks (with 24 subdomains divided between x, y and z directions):

```
mpirun -n 24 topIIvol_DistMesher --zpoints 50 --xpoints 32 --ypoints 29 \
--depth -1000 --partition_x 2 --partition_y 3 --partition_z 4 \
--out top-ii-vol-mesh  --in ./../etc/DEM_160m.xyz
```

or

```
mpirun -n 24 topIIvol_DistMesher  --zpoints 50 --xpoints 32 --ypoints 29 \
--depth -1000 --partition_x 3 --partition_y 2 --partition_z 4 \
--out top-ii-vol-mesh  --in ./../etc/DEM_160m.xyz
```

or

```
mpirun -n 24 topIIvol_DistMesher  --zpoints 50 --xpoints 32 --ypoints 29 \
--depth -1000 --partition_x 2 --partition_y 2 --partition_z 6 \
--out top-ii-vol-mesh  --in ./../etc/DEM_160m.xyz
```

- Examples 2D partitioning of distributed mesher producing `*.mesh` mesh with 8 MPI ranks (with the 8 subdomains divided between x and y directions):

```
mpirun -n 8 topIIvol_DistMesher --zpoints 50 --xpoints 32 --ypoints 29 \
--depth -1000 --partition_x 2 --partition_y 4 --partition_z 1 \
--out top-ii-vol-mesh  --in ./../etc/DEM_160m.xyz
```

or

```
mpirun -n 8 topIIvol_DistMesher --zpoints 50 --xpoints 32 --ypoints 29 \
--depth -1000 --partition_x 4 --partition_y 2 --partition_z 1 \
--out top-ii-vol-mesh  --in ./../etc/DEM_160m.xyz
```

- Examples 2D partitioning of distributed mesher producing `*.mesh` mesh with 6 MPI ranks (with the 6 subdomains divided between x and z directions):

```
mpirun -n 6 topIIvol_DistMesher --zpoints 50 --xpoints 32 --ypoints 29 \
--depth -1000 --partition_x 2 --partition_y 1 --partition_z 3 \
--out top-ii-vol-mesh  --in ./../etc/DEM_160m.xyz
```

or

```
mpirun -n 6 topIIvol_DistMesher --zpoints 50 --xpoints 32 --ypoints 29 \
--depth -1000 --partition_x 3 --partition_y 1 --partition_z 2 \
--out top-ii-vol-mesh  --in ./../etc/DEM_160m.xyz
```

- Examples 2D partitioning of distributed mesher producing `*.mesh` mesh with 16 MPI ranks (with the 16 subdomains divided between y and z directions):

```
mpirun -n 16 topIIvol_DistMesher --zpoints 50 --xpoints 32 --ypoints 29
\
--depth -1000 --partition_x 1 --partition_y 8 --partition_z 2 \
--out top-ii-vol-mesh  --in ./../etc/DEM_160m.xyz
```

or

```
mpirun -n 16 topIIvol_DistMesher --zpoints 50 --xpoints 32 --ypoints 29
\
--depth -1000 --partition_x 1 --partition_y 2 --partition_z 8 \
--out top-ii-vol-mesh  --in ./../etc/DEM_160m.xyz
```

or

```
mpirun -n 16 topIIvol_DistMesher --zpoints 50 --xpoints 32 --ypoints 29
\
--depth -1000 --partition_x 1 --partition_y 4 --partition_z 4 \
--out top-ii-vol-mesh  --in ./../etc/DEM_160m.xyz
```

- Examples 1D partitioning of distributed mesher producing `*.mesh` mesh with 4 MPI ranks (letting the algorithm decide the partition direction):

```
mpirun -n 4 topIIvol_DistMesher --zpoints 50 --xpoints 32 --ypoints 29 \
--depth -1000 --out top-ii-vol-mesh  --in ./../etc/DEM_160m.xyz
```

- Examples 1D partitioning of distributed mesher producing `*.mesh` mesh with 4 MPI ranks (enforced partitioning in x direction):

```
mpirun -n 4 topIIvol_DistMesher  --zpoints 50 --xpoints 32 --ypoints 29
\
--depth -1000 --partition_x 4 --partition_y 1 --partition_z 1 \
--out top-ii-vol-mesh  --in ./../etc/DEM_160m.xyz
```

- Examples 1D partitioning of distributed mesher producing `*.mesh` mesh with 8 MPI ranks (enforced partitioning in y direction):

```
mpirun -n 8 topIIvol_DistMesher  --zpoints 50 --xpoints 32 --ypoints 29
\
--depth -1000 --partition_x 1 --partition_y 8 --partition_z 1 \
--out top-ii-vol-mesh  --in ./../etc/DEM_160m.xyz
```

- Examples 1D partitioning of distributed mesher producing `*.mesh` mesh with 3 MPI ranks (enforced partitioning in z direction):

```
mpirun -n 3 topIIvol_DistMesher  --zpoints 50 --xpoints 32 --ypoints 29
\
--depth -1000 --partition_x 1 --partition_y 1 --partition_z 3 \
--out top-ii-vol-mesh  --in ./../etc/DEM_160m.xyz
```

Command-line option definitions

Option	**Type**	**Comment**
`--xpoints`	`[int]`	These are # of x points present in your point cloud.
`--ypoints`	`[int]`	These are # of y points present in your point cloud.
`--zpoints`	`[int]`	These are # of z points intended in the z direction.
`--partition_x`	`[int]`	These are # of x partitions in x direction.
`--partition_y`	`[int]`	These are # of y partitions in y direction.

Option	Type	Comment
`--partition_z`	`[int]`	These are # of z partitions in z direction.
`--in`	`[string]`	Sting to provide the input point cloud file `.xyz`
`--out`	`[string]`	Sting to provide the output mesh file `.mesh`
`-np`	`[int]`	Provide the # of MPI ranks.

To report bugs, issues, feature-requests contact:*

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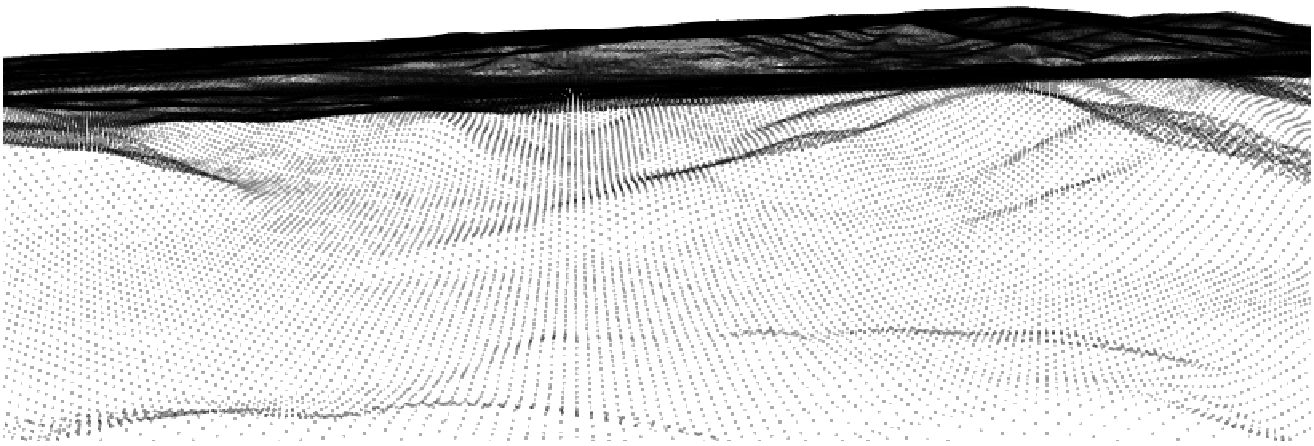
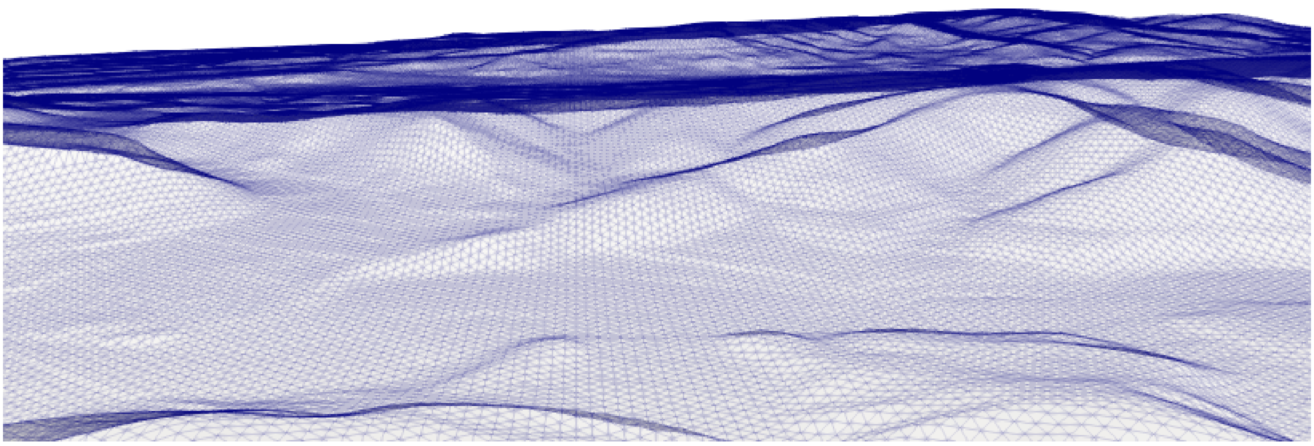
- **mohd-afeef.badri@hotmail.com**

Point cloud



Surface triangulation of point cloud



Finite element solution field