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Project Overview

Generated binary files using tecio library provided by Tecplot and incorporating MPI for parallel processing

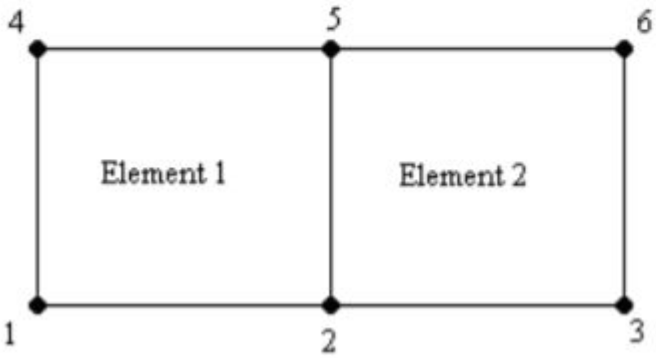
- Built the libraries and used the compilers supported by the software
- Converted the ASCII files to binary files for flow visualization
- Produced the data by the processors and made the data files in parallel

Data Structure

Two different types of data

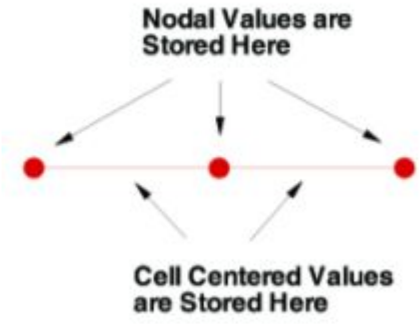
I) Ordered Data : points stored in a one, two, or three-dimensional array.

II) Finite Element Data : consist of two arrays, a variable array and a connectivity matrix.

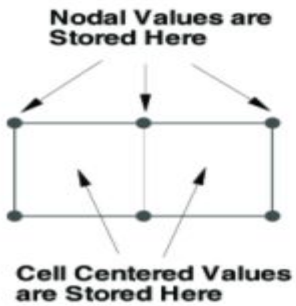


Ordered Data

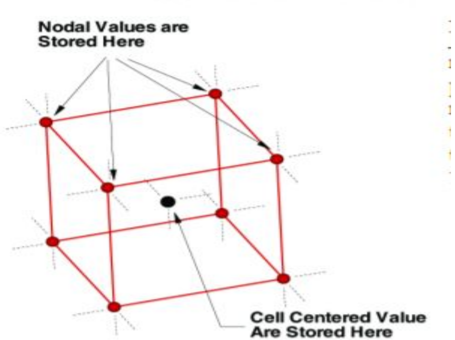
- One-dimensional Ordered Data (I-ordered, J-ordered, or K-ordered)
- Two-dimensional Ordered Data (IJ-ordered, JK-ordered, IK-ordered)
- Three-dimensional Ordered Data (IJK-ordered)



(i)



(ii)

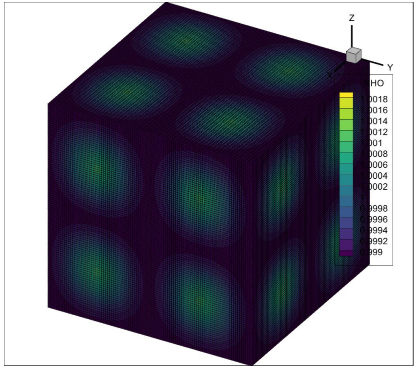


(iii)

Work Done

01 Converting the ASCII format to binary files

```
VARIABLES= X, Y, Z, RHO, UX, UY, UZ
ZONE I =100, J=100, K=100
1        1        1        0.99884222      0.00001645      0.00001645      0.00001645
2        1        1        0.99884332      0.00002987      0.00002698      0.00001016
3        1        1        0.99884515      0.00003756      0.00004384     -0.00000021
4        1        1        0.99884771      0.00003745      0.00006606     -0.00001441
5        1        1        0.99885102      0.00002836      0.00009241     -0.00003215
6        1        1        0.99885505      0.00001005      0.00012146     -0.00005296
```



- Converted ASCII files to the binary files which led to faster visualization on Tecplot.
- We used a set of functions for this, which are as follows:
  - TECINI142 (initialize the data file)
  - TECZNE142 (information for the next zone to be added)
  - TECDAT142 (to add the data in form of arrays to the zone)
  - TECEND142 (to close the current data file)
- Significant amount of time to read the big files containing millions of points

02 Writing the data by the processors directly to binary

- Instead of reading, added the data from the code, leading to significant decrease in the run time of the code
- Created 1D arrays for the data points using the index and directly added the arrays to the binary file

```
double U0 = 0.05;

for (int k = 0; k < ZDIM; k++)
{

    for (int j = 0; j < YDIM; j++)
    {

        for (int i = 0; i < XDIM; i++)
        {
            int index = (k * YDIM + j) * XDIM + i;
            x[index] = (double)i;
            y[index] = (double)j;
            z[index] = (double)k;
            rho[index] = 1;
            ux[index] = U0 * sin(i * (2 * pi / XDIM)) * (cos(3 * j * (2 * pi /
            uy[index] = U0 * sin(j * (2 * pi / YDIM)) * (cos(3 * k * (2 * pi /
            uz[index] = U0 * sin(k * (2 * pi / ZDIM)) * (cos(3 * i * (2 * pi /
        }
    }
}
```

- Limitations of a processor to handle such large numbers of data points

03 Integrating parallel processing and TecioMPI

- Divided the data sets into partitions and each processor adds its own partition

```
INTEGER4 numPartitions = 4;
vector<INTEGER4> partitionOwners;
for (INTEGER4 ptn = 0; ptn < numPartitions; ++ptn)
    partitionOwners.push_back(ptn % commSize);
TECZNEMAP142(&numPartitions, &partitionOwners[0]);


for (INTEGER4 partition = 1; partition <= 4; ++partition)
{

    if (commRank == mainRank || partitionOwners[partition - 1] == commRank)
    {

        INTEGER4 partitionIMin = partitionIndices[partition - 1][0];
        INTEGER4 partitionJMin = partitionIndices[partition - 1][1];
        INTEGER4 partitionKMin = partitionIndices[partition - 1][2];
        INTEGER4 partitionIMax = partitionIndices[partition - 1][3];
        INTEGER4 partitionJMax = partitionIndices[partition - 1][4];
        INTEGER4 partitionKMax = partitionIndices[partition - 1][5];
        I = TECIJKPTN142(&partition, &partitionIMin, &partitionJMin, &partitionKMin, &partitionIMax, &partitionJMax, &pa
        I = outputVarData(x, XDIM, YDIM, ZDIM, partitionIMin, partitionJMin, partitionKMin, partitionIMax, partitionJMa
```

- Additional functions used here were as follows:
  - TECMPIINIT142 (Initializes MPI and joins a specified MPI communicator)
  - TECZNEMAP142 (it maps the processes to the partition to be printed in the zone)
  - TECIJKPTN142 (manages information about partitions, later reassembled into a single zone)
- The ending indices and the starting indices of the next partition should be same for TECIJKPTN142 to function properly