Reconstruction of Surface using peak Function

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I. INTRODUCTION

In Surface reconstruction, Radial Basis Function(RBF) play a important role by calculating approximate the Shape of a surface from scattered and potentially irregularly distributed data points.These functions serves as a tool function centered at each data point, with their impact diminishing as one moves farther way. The RBF network combines the basis functions, weighted by coefficients, to estimate the surface. By adjusting these coefficients, the network fine-tunes the approximation to align with the input data. In sum up ,RBF networks is an effective techniques for the surface reconstruction. Mathematical expression for the Radial Basis Function(RBFs) in the context of surface reconstruction.
The general form of an RBF can be expressed as $\Phi(x)=\|x-c\|)$ where $\Phi(x)$ is the RBF centered at c, , ϕ is a radial basis function, and $\|x-c\|)$ represents the Euclidean distance between x and c [1].

In surface reconstruction, the approximation of the function f(x) is represented as a weighted sum of RBFs:

$$f=\sum_{i=1}^{n} w_i \cdot \Phi(x) \tag{1}$$

Here, w_i are coefficients or weighted associated with each RBF, and n is the total number of RBFs used.

II. PROBLEMS

In our first assignment we have given data file as name "Tshape.mat". we have to interpolate it. Questions are as fallows.

A. Part A

The input data file "Tshape.mat" contains 37605 scattered data points (xi, yi, zi), i=1, 2, . . . , 37605. Interpolating these scattered data (see Figure 1) using MATLAB "griddata" function and plot the surface shown in Figure 2.

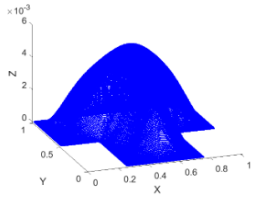

FIG. 1. Visual representation of 3D Surface plot of input data file "Tshape.mat".

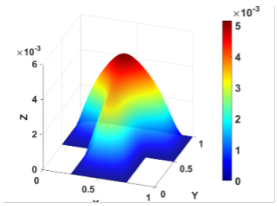

FIG. 2. Visual representation of 3D Surface plot of input data file "Tshape.mat".

B. PartB

Plot the function in the domain of a unit circle with non-concentric hole in the interior shown in Figure 3. Z2 is a circle with center at (0.3,0.3) and radius = 0.3, The profile of f(x,y) is shown in Figure 4.

$$f=\exp\left(-\frac{81}{4}\left(X^2+Y^2\right)\right) \tag{2}$$

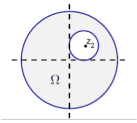

FIG. 3. Plot the function in the domain of a unit circle with non-concentric hole in the interior side given figure in problem.

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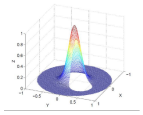

FIG. 4. Side Rotating view of unit circle with non-concentric hole in the interior side appear in problem.

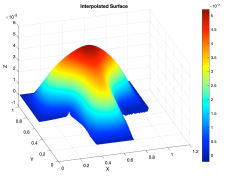

FIG. 5. Sid view of interpolated surface plot of Tshape.mat data of problem while plotting by me.

III. METHOD

Interpolation is a mathematical tool utilized to approximate values that lie between known data points. It finds widespread applications in various domains like mathematics, computer graphics, signal processing, and engineering. MATLAB offers several interpolation methods, including the 'cubic' and 'spline' techniques. The 'cubic' method calculates interpolated values at a specific point by employing cubic interpolation based on neighboring grid points in each dimension. This interpolation is performed using cubic convolution and relies on a cubic spline with not-a-knot end conditions. For the first problem, we applied cubic interpolation on a meshgrid, while for the second problem, a circular meshgrid was used.

IV. RESULTS

In the first problem, I load the data in Matlab using the command 'load "Tshape.mat"' and plot them. I define the grid for the interpolation using this command, meshgrid(linspace(min(x), max(x), 500), linspace(min(y), max(y), 500)).Let x0, y0, x1, and y1 be the coordinates to cut the surface for a specific section. In this problem, I have to remove a specific part from two sides, so I selected the coordinates of the two sides and made adjustments. I created regions int0 and int1 for interpolation and then combined them. To remove height NaN is used, and for a better view, an angle of (-45,75) is taken. The following figure was obtained, and its snapshot is attached."

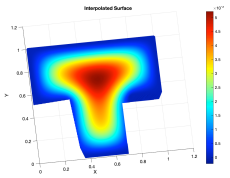

FIG. 6. Top view of interpolated surface plot of Tshape.mat data while plotting by me .

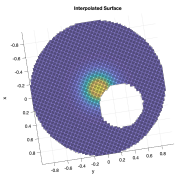

FIG. 7. Top view of unit circle with non-concentric hole in the interior side while plotting .

In the second problem , I created parameter for the circular meshgrid by taking different range of θ and r . Here θ takes value from 0 to 2 π and r = linspace(0, 1, 100).I changed cartesian coordinate into polar coordinate. i.e. X0 = R cos(θ) and Y0=Rsin(θ). I used NaN in the region of unite circle and interpolated them. 'FaceAlpha' denotes the color level, i used 0.7. Here is snap shoot of my surfaces plot and code .

[1] Fasshauer, G. E., and J. G. Zhang (2007), Numerical Algorithms **45**, 345.

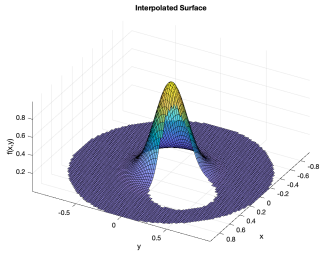

FIG. 8. This is side view of surface plot of problem 2 unit circle with non-concentric hole in the interior side while plotting.This problem2 plot .