MATLAB Homework

Deadline: June 21st

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Question1: reading data from excel and estimation of an unknown area

Assume that our university is a blind spot of cellular communication signals. We wish to provide coverage for it, by installing few base stations. In order to do this, we need some information about the university, including its area. Here we arrive at the second assumption.

Assume that the area of the university has never been calculated by anyone and you are the first person ever who is tasked with estimating the area of the university. One way to do so is to choose a larger known area that includes the whole unknown blind spot like the one shown in Fig.1. Surrounding the black box (in this case, our university), there are a lot of base stations whose coordinations are given to us. Finally, there is a third assumption.

We are told that the whole surface of the larger area- the black box excluded- can be divided into smaller triangular subareas. At each apex of triangles there is a base station and it is known which three base stations create a triangular element. These subareas don't overlap each other and don't necessarily have equal areas. The described system model is shown in Fig.2.

Using the given assumptions, compute the area of the university.

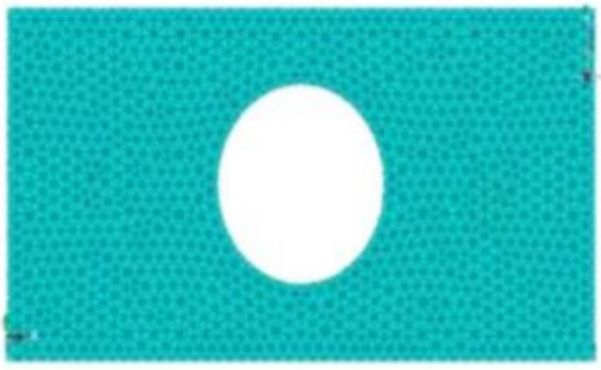

Figure 1. placing the unknown area inside a well-defined area

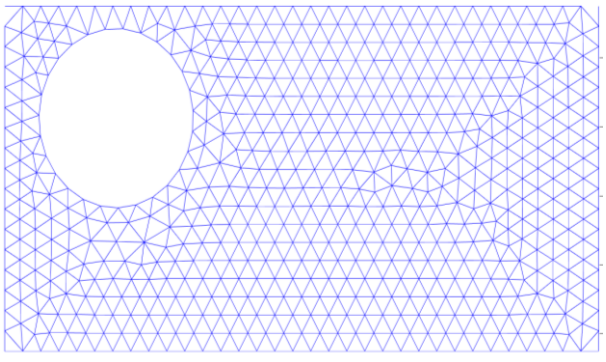

Figure 2. dividing the known space into triangular subspaces

P.S: the coordination of the base stations and the index of base stations creating subspaces are given in the *"node.xlsx"* and *"element.xlsx"* file respectively. (use *"xlsread"* function to read date from an excel file. If you have issues about its syntax, you can simply *doc* it or ask me)

Question2: Edge detection

The objective of this question is to study and implement some of edge detection algorithms. Edge detection is an image processing technique that finds the borders of objects in an image by detecting the change in the color density. This technique is used in object detection and classification in computer vision and learning-based image processing projects.

a. Implement the Sobel algorithm (will be taught in the TA class) to find the edges of objects in the attached image. Your output shall be something like Fig.4

b. Explain other methods of edge detection other than Sobel and implement one of them via MATLAB.

Note: you are not allowed to use "edge" function defined in MATLAB.

Figure 3. input image

Figure 4. output image

Question3: Fourier series part 1

we know for all the functions that meet Dirichlet conditions, the function can be written as sum of sinusoids. This is the main definition of Fourier series. If a function or/and its differentiate, has/have discontinuity in its/their period, the number of Fourier series' coefficients becomes unlimited. In this question we tend to observe these facts. Take this shape for instance:

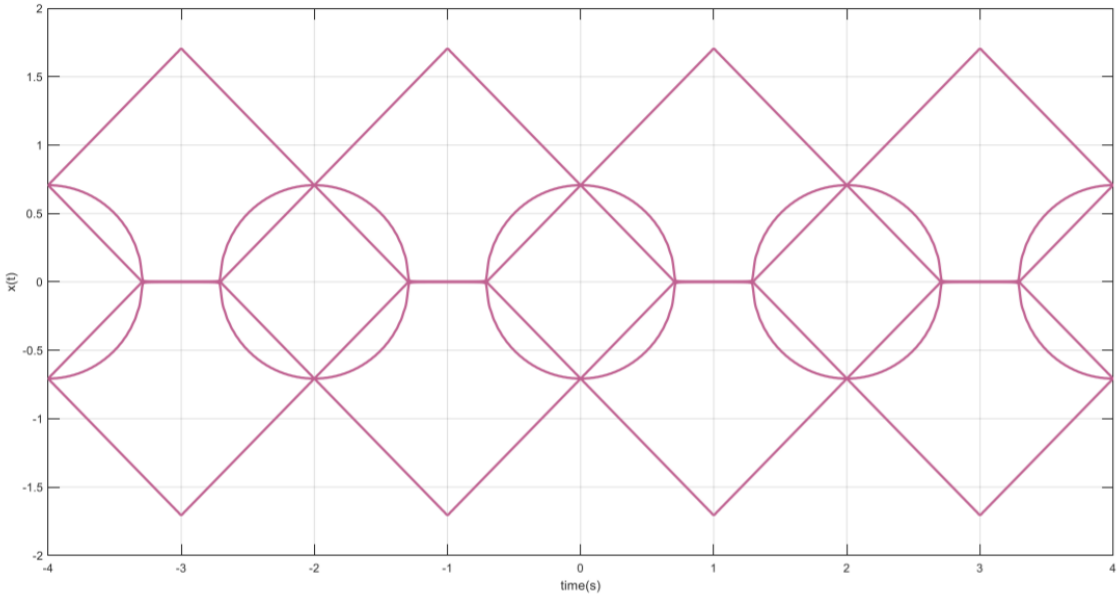

Figure 5. A desired shape

We wish to recreate the shape using its Fourier series' coefficients. The shape has a period time $T = 2s$, A circle with the radius $R = \frac{1}{2}\sqrt{2}$, a square inside the circle, and two lines outside the circle which are in parallel with the sides of the inner square.

Plot the described shape under the following conditions:

a. $k = -1:1:1$ $(3\ fourier\ series\ coefficients)$
b. $k = -10:1:10$ $(21\ fourier\ series\ coefficients)$
c. $k = -30:1:30$ $(61\ fourier\ series\ coefficients)$
d. $k = -60:1:60$ $(121\ fourier\ series\ coefficients)$

By limiting the number of Fourier series coefficients, we ignore the effect of higher frequency sinusoids. How does it affect the ideal shape? why?

Hint: Since Fourier series are defined for "functions" and Fig.5 is definitely not a function, you can break the shape into some subfunctions and obtain the coefficients for each one and plot them one by one in one figure to obtain the original shape. Also, you can use various functions like "trapz" , "integral" , etc to compute integral if needed.

Question4: Fourier series part 2

Consider a periodic pulse $x(t)$ with $T = 2s$ defined in one period as:

$$\hat{x}(t) = \begin{cases} 1 & |t| < 0.5 \\ 0 & 0.5 < |t| < 1 \end{cases}$$

a. Using the same number of Fourier series coefficients defined in Q3, plot $x(t)$ for 10 periods of time. (20 seconds)

b. Plot the magnitude and phase of the Fourier series coefficients. Is it what you theoretically expected?

c. For $y(t) = x(t - \frac{1}{2})$ repeat part *a* and *b*. Justify your answer theoretically using Fourier series properties.

d. In part *a* you observe a peek at the edges of the pulse (if you don't, doubt your answer). This is called Gibbs phenomenon. What is it and why does it happen?

About submission:

Send your .m files and results along with a detailed report (in .pdf format) in a single .rar file to the email address of the class before the deadline is reached. submission won't be considered if:

- It is sent after the deadline (June 21_{st})
- There is no report explaining your work.

Good luck :)