MTRN4010.2021 – Project #4

Problem 2: Applying an optimizer for estimating position by triangulation

Given a set of 5 landmarks (which are always visible, and whose positions, in a given coordinate frame, are known), and a sensor which provides range measurements respect to all those landmarks, simultaneously, you are required to estimate the position of the sensor by minimizing a cost function.
You will implement a Matlab function, named *GetMySolutionXY,* which will process the 5 range measurements associated to the 5 landmarks, in order to estimate the position of the sensor. The position of the sensor must be expressed in the same coordinate frame in which the positions of the landmarks are expressed.

The positions of the map's landmarks and the measured ranges can be read, at any time, from the global variable **Data5**.
Data5 is a structure that has three (3) fields:

Data5.ranges:	The measured ranges (array of 5 values, in meters)
Data5.Lx:	coordinates X of landmarks' positions (array of 5 values, in meters)
Data5.Ly:	coordinates Y of landmarks' positions (array of 5 values, in meters)

The physical meaning of these variables is according to the following range equation:

$$r_j = \sqrt{\left(x - x_j\right)^2 + \left(y - y_j\right)^2}$$

In which

$$r_j = \text{Data5.ranges(j)}$$
$$x_j = \text{Data5.Lx(j)}$$
$$y_j = \text{Data5.Ly(j)}$$

Your function does not have arguments, since all the necessary data in contained in the global variable Data5 (so that your program simply reads, from that global variable, the necessary data). Your function must return the estimated 2D position, [x;y], as a 2x1 vector.

```
function xy =GetMySolutionXY()
        % This example is an empty function
        % Do your calculations here.
```

```
    xy=[0;0];          % you must calculate xy, the estimated sensor's position
end
```

Inside that function you will use an optimizer such as *fminsearch*, or a PSO solver. Your function must return the estimated sensor's position, by minimizing a cost function of the following class:

$$\mathbf{x} = \begin{bmatrix} x & y \end{bmatrix}^T$$

$$\mathbf{x}^* = \underset{\mathbf{x}\in\Omega_{\mathbf{x}}}{\operatorname{argmin}}\left(C\left(\mathbf{x}\right)\right)$$

$$C\left(\mathbf{x}\right) = \sum_{j=1}^{5}\left| r_j - \sqrt{\left(x - x_j\right)^2 + \left(y - y_j\right)^2} \right|$$

For testing your function, you may use the following program *TestYourFunction*

Which simulates the measurements, and then it calls your function providing to it the simulated measurements and the map, via the global variable Data5. Then the program uses the estimated position, which is returned by your function, for plotting it jointly with the real position.
TestYourFunction always calls the function named *GetMySolutionXY* when it requires the estimated position (so your function must have that name, *GetMySolutionXY.m*)

TestYourFunction accepts one argument, for specifying the standard deviation of noise being added to the simulated range measurements, to simulate polluted measurements.
For instance, *TestYourFunction*(0.1) will result in the program adding Gaussian noise of standard deviation =0.1 meter. If you want to simulate perfect measurements, you must use *TestYourFunction*(0)

Inside your function *GetMySolutionXY()* you implement your code. You may use the optimizer that you prefer, e.g. fminsearch() or the PSO optimizer.

This problem gives you 50% of Project4's overall mark. The rest of the marks are given by Problem 1, in which you implement an MPC controller (that problem was released on week 8).

You will submit both programs, via Moodle. No report is required for this project. Your solution for Problem 2 will be tested using *TestYourFunction,* in the same way you tested

it. We will verify that for the case *TestYourFunction(0)*, the solution is almost at the real position. The lecturer will show his solution in class.
Submission of this project Friday week 10, 11PM.
There is an automatic extension of one day. for the submission of this project (i.e. on Saturday 24/April, 11PM). There is no penalty for using this extension.