CS471X/691X/791X

Project 2. Consensus Filters for Sensor Networks

Project Deadline: Nov. 13 2014 (Return report in the class.)

Please email me (bravehung@yahoo.com) project 1 and 2 reports.

Case 1. Estimate single cell (single scalar value)

We randomly generate a connected network of 10 nodes in the area of 4x4. The cell is located at the center of this area. The ground truth of the measurement at this location is 50.

Each node makes a measurement as

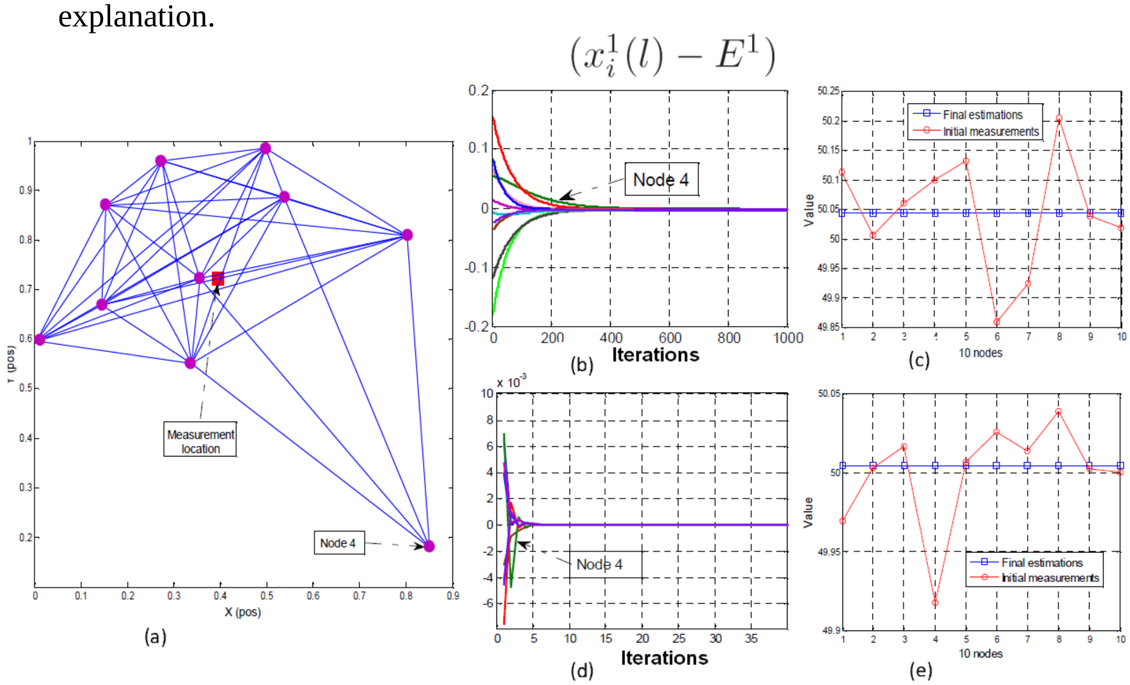
$$m_i^1 = F^1 + n_i^1.$$

Here, $F^1 = 50$, and n_i^1 is the Gaussian noise, $N(0, V_i^1)$, with $V_i^1 = \|q_i - \overline{q}\|^2 + c_v/(r_i^s)^2$, $c_v = 0.01$, $r_1^s = r_2^s = \ldots = r_{10}^s = 1.6$, and $\overline{q} = 1/10 \sum_{i=1}^{10} q_i$. The initial condition for running consensus filter 1 is $x_i^1(l=0) = m_i^1$.

1. Show the results of the convergence of consensus filter 1 (Weighted Average Consensus) associated with two different weights, i.e., *weight design 1* and *weight design 2*. Explain the obtained results.

2. Show the results of the convergence of consensus filter 2 (Average Consensus) with both Max-degree and Metropolis weights. Explain the obtained results.

3. Show the convergence of the node which has the smallest number of neighbors and the node which has the largest number of neighbors. Observe the obtained results and give explanation.



Case 2. Estimate multiple cells (scalar field):

To model the environment, four multiple variate Gaussian distributions ($K = 4$) with $\Theta = [20\ 50\ 35\ 40]$ are used, and each one is represented as

$$\phi_1 = \frac{1}{\sqrt{\det(C_1)(2\pi)^2}} e^{\frac{-1}{2}(x-2)C_1^{-1}(y-2)^T}$$

where $C_1 = \begin{bmatrix} 2.25 & 0.2999 \\ 0.2999 & 2.25 \end{bmatrix}$, with the correlation factor $c_1^0 = 0.1333$

$$\phi_2 = \frac{1}{\sqrt{\det(C_2)(2\pi)^2}} e^{\frac{-1}{2}(x-1)C_2^{-1}(y-.5)^T}$$

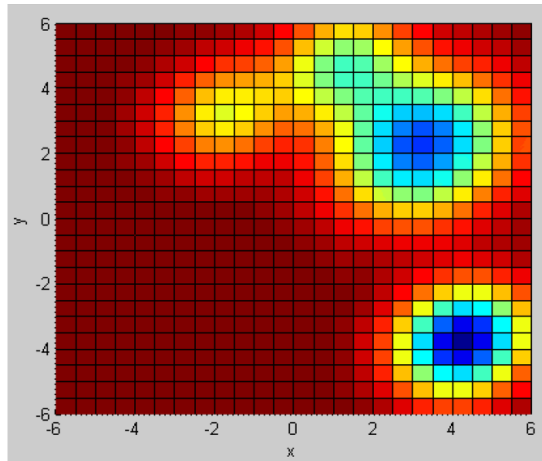
where $C_2 = \begin{bmatrix} 1.25 & 0.1666 \\ 0.1666 & 1.25 \end{bmatrix}$, with the correlation factor $c_2^0 = c_1^0$

$$\phi_3 = \frac{1}{\sqrt{\det(C_3)(2\pi)^2}} e^{\frac{-1}{2}(x-4.3)C_3^{-1}(y-3.5)^T}$$

where $C_3 = C_2$, with the correlation factor $c_3^0 = c_2^0$, and

$$\phi_4 = \frac{1}{\sqrt{\det(C_4)(2\pi)^2}} e^{\frac{-1}{2}(x-3)C_4^{-1}(y+3)^T}$$

where $C_4 = C_3$, with the correlation factor $c_4^0 = c_3^0$.



The field F has a size $x \times y = 12 \times 12$, and it is partitioned into $25 \times 25 = 625$ cells.

1. Generate a connected network of 30 nodes in the area of 12x12 so that they can cover the entire area. You can select the node's sensing range (may be $r^s_i = 5$).
2. Running the Consensus 1 (Weighted Average Consensus) to obtain the estimate at each cell of the field F
3. Build the map of this scalar field
4. Plot the error between the build map and the original one in both 2D and 3D, respectively, and give explanation for the obtained results
5. Running the Consensus 2 (Average Consensus) to find out the confidence (weight) of the estimate at each cell, then plot the confidence (weight) in both 2D and 3D **(Optional)**