Putting Blind Sensor Networks In Touch Via Peripheral Measurements

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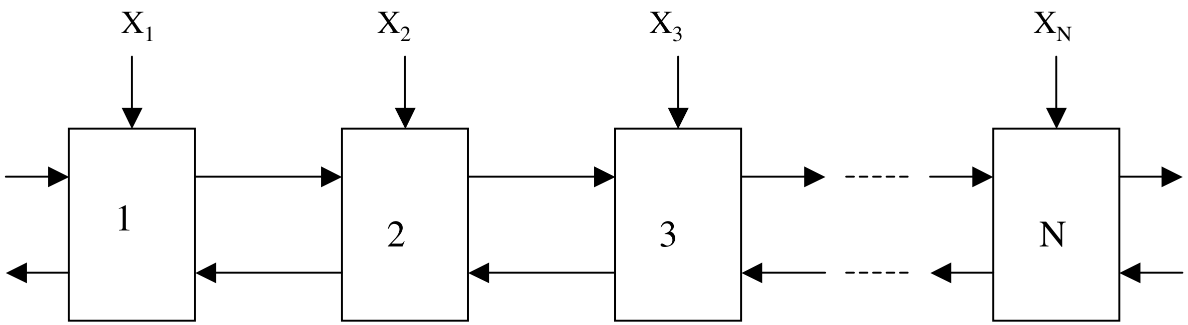
OVERVIEW

- Problem statement
- Issues to be addressed
- Applications

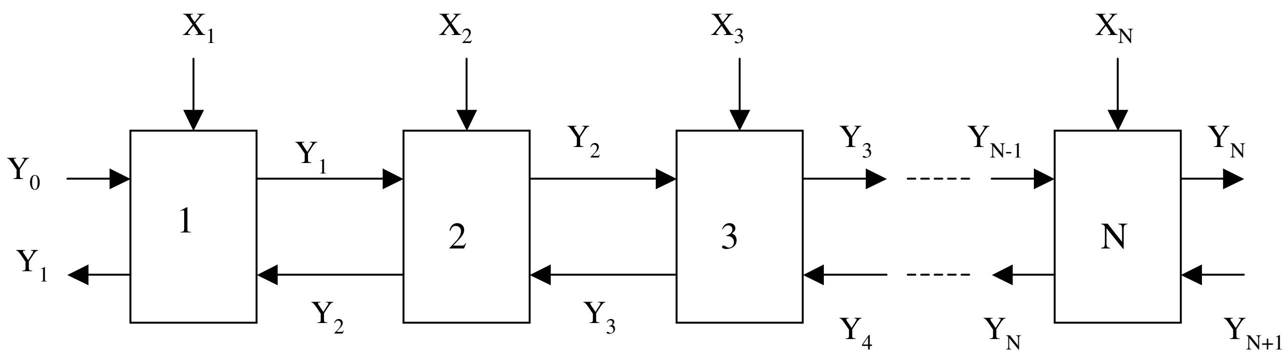
Problem

1-D Network of Sensors



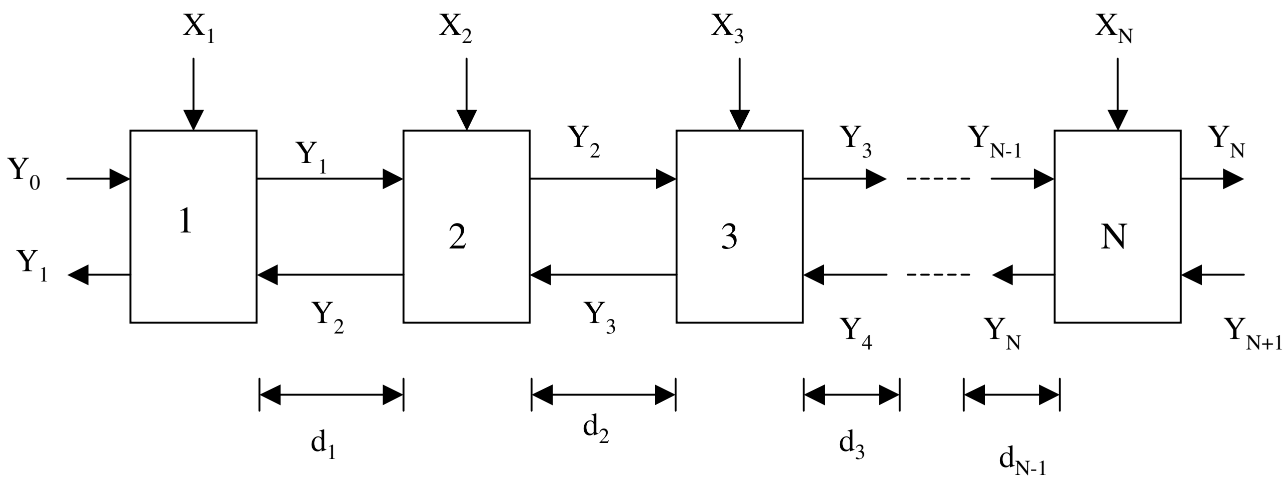
Problem

1-D Network of Sensors



Problem

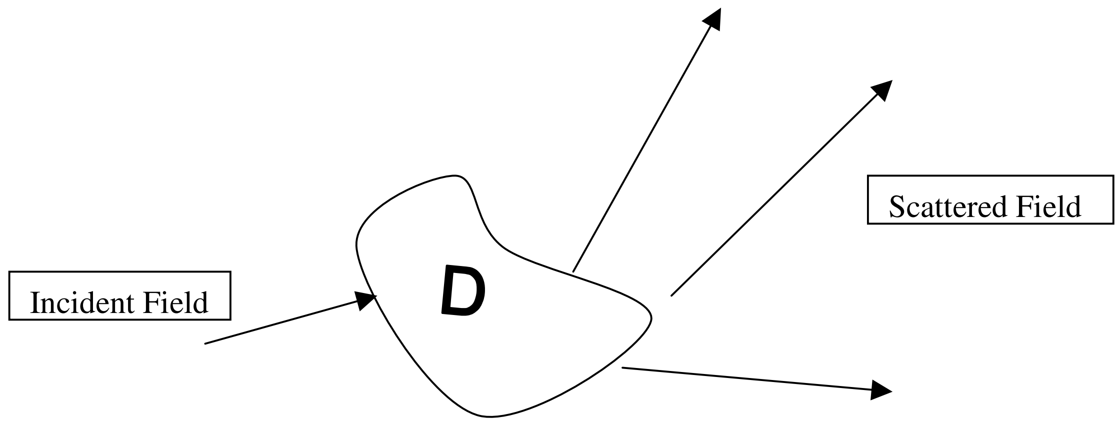
1-D Network of Sensors



Problem (contd.)

- Observe samples of Y_1 and Y_N at different frequencies and
  - Identify the network (d_i's)
  - Extract information (X_i)

Inverse Scattering



Matrix-vector formulation

$$Y_i(w) = H(w)[d_{i-1}Y_{i-1}(w) + d_iY_{i+1}(w) + F(X_i)]$$

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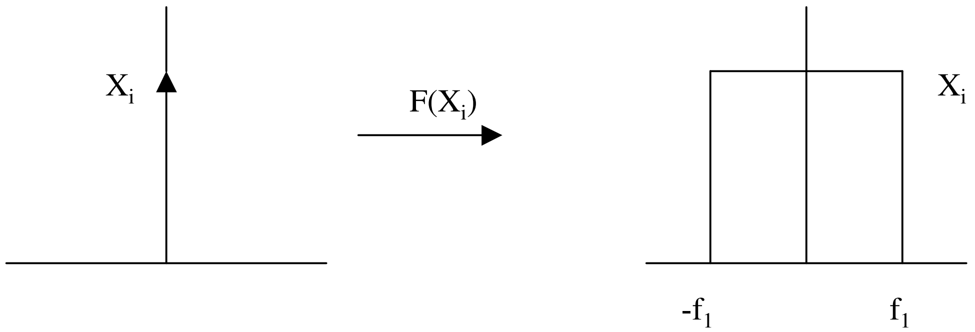

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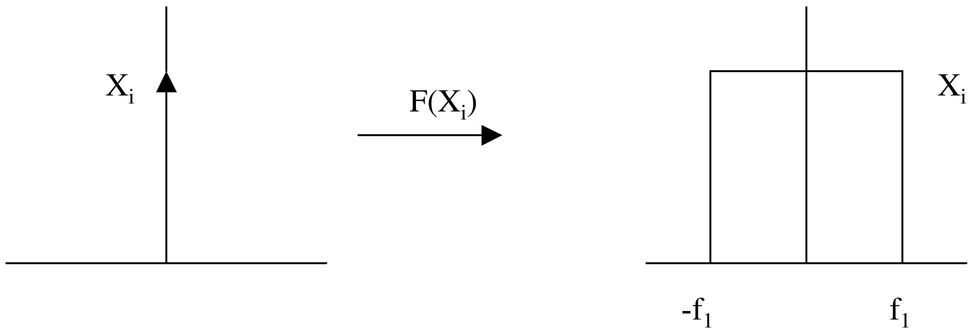

$$y = HDy + H'x + b$$

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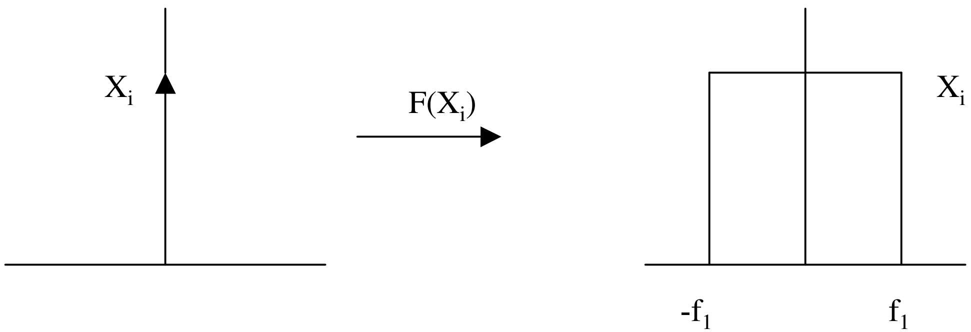

$$y = HDy + H'x + b \quad \rightarrow \quad b = \begin{bmatrix} Y_0 \\ 0 \\ \vdots \\ Y_{n+1} \end{bmatrix}$$

Network Identification

- Identify D
  - Observations at 4N or more high frequencies
    - $y = HDy + b$
    - Calculate d_1
      - $Y_1 = H[Y_0 + d_1 Y_2]$
    - Layer peeling to obtain D

Extracting Information

- Solve for X_i by making observations at N/2 or more low frequencies

$$\left[\overline{I - HD} \quad \overline{H}'\right]\begin{bmatrix}\overline{y} \\ \overline{x}\end{bmatrix} = \overline{b}$$

Extracting Information

- Solve for X_i by making observations at N/2 or more low frequencies

$$\left[\overline{I - HD} \quad \overline{H}'\right]\begin{bmatrix}\overline{y} \\ \overline{x}\end{bmatrix} = \overline{b}$$

$$\overline{I - HD} = \begin{bmatrix} I - H_1 D & & \\ & \ddots & \\ & & I - H_k D \end{bmatrix}$$

Extracting Information

- Solve for X_i by making observations at N/2 or more low frequencies

$$\left[\overline{I - HD} \quad \overline{H}\,'\right] \begin{bmatrix} \overline{y} \\ x \end{bmatrix} = \overline{b}$$

$$\begin{bmatrix} (I-HD)_1 & & \\ & \ddots & \\ & & (I-HD)_k \end{bmatrix} \qquad \begin{bmatrix} (H')_1 \\ \vdots \\ (H')_k \end{bmatrix}$$

Extracting Information

- Solve for X_i by making observations at N/2 or more low frequencies

$$\begin{bmatrix} \overline{I - HD} & \overline{H}' \end{bmatrix} \begin{bmatrix} \overline{y} \\ x \end{bmatrix} = \overline{b} \rightarrow \begin{bmatrix} (b)_1 \\ \vdots \\ (b)_k \end{bmatrix}$$

$$\overline{I - HD} = \begin{bmatrix} (I-HD)_1 & & \\ & \ddots & \\ & & (I-HD)_k \end{bmatrix} \qquad \overline{H}' = \begin{bmatrix} (H')_1 \\ \vdots \\ (H')_k \end{bmatrix}$$

Issues to be solved

- Settling time of the system
- Stability analysis of the algorithm
- Optimal Transfer function
- Channel noise model
- Cross Talk between sensors

Applications

- Monitoring of borders
- Wired Networks
  - Examining pattern of stress on the wings of an airplane
  - Stress pattern on the beams in a building

Thank You !