Supplement to: *Decision Fusion from Heterogeneous Sensors in Surveillance Sensor Systems*

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I. Additional Results

All the comparison results mentioned in the published article are included in Figs. 1-4. Figs. 1 and 2 illustrate the results for the first cost scenario $c_m = 100c_f$, using $FAP = MDP/100$ and $FAP = MDP$, respectively. Figs. 3 and 4 illustrate the misclassification rate of each decision rule (i.e., $c_m = c_f$), using $FAP = MDP/100$ and $FAP = MDP$, respectively. In order to make the illustration clearer, Figs. 3(b) and 4(b) zoom into the bottom region of Figs. 3(a) and 4(a), respectively, after removing the curve corresponding to the 1-out-of-n rule, which has much larger misclassification rate (due to a significantly large false alarm rate) than the others. Please note that Figs. 2 and 3(b) appear in the published article as Figs. 4 and 5, respectively.

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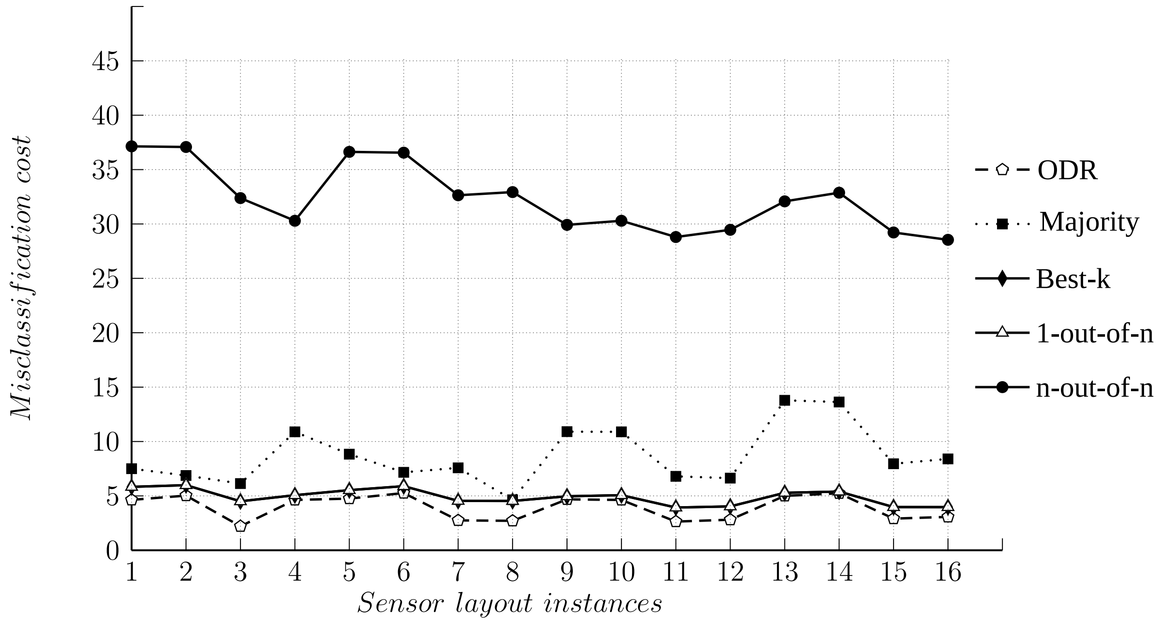


Fig. 1. $FAP = MDP/100$, $c_m = 100c_f$

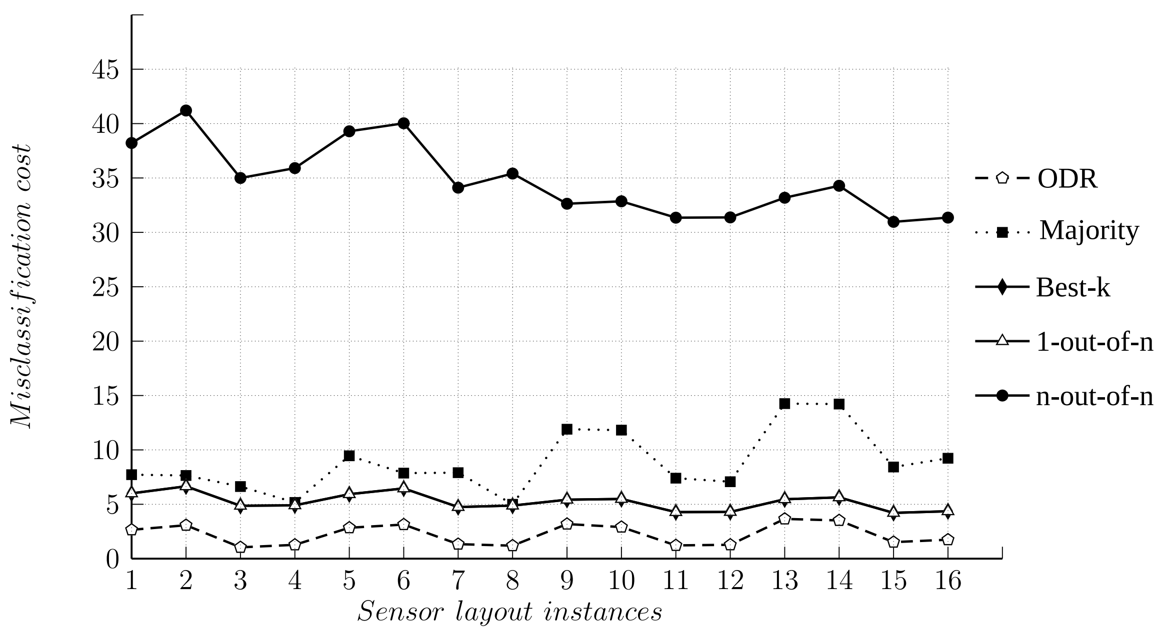
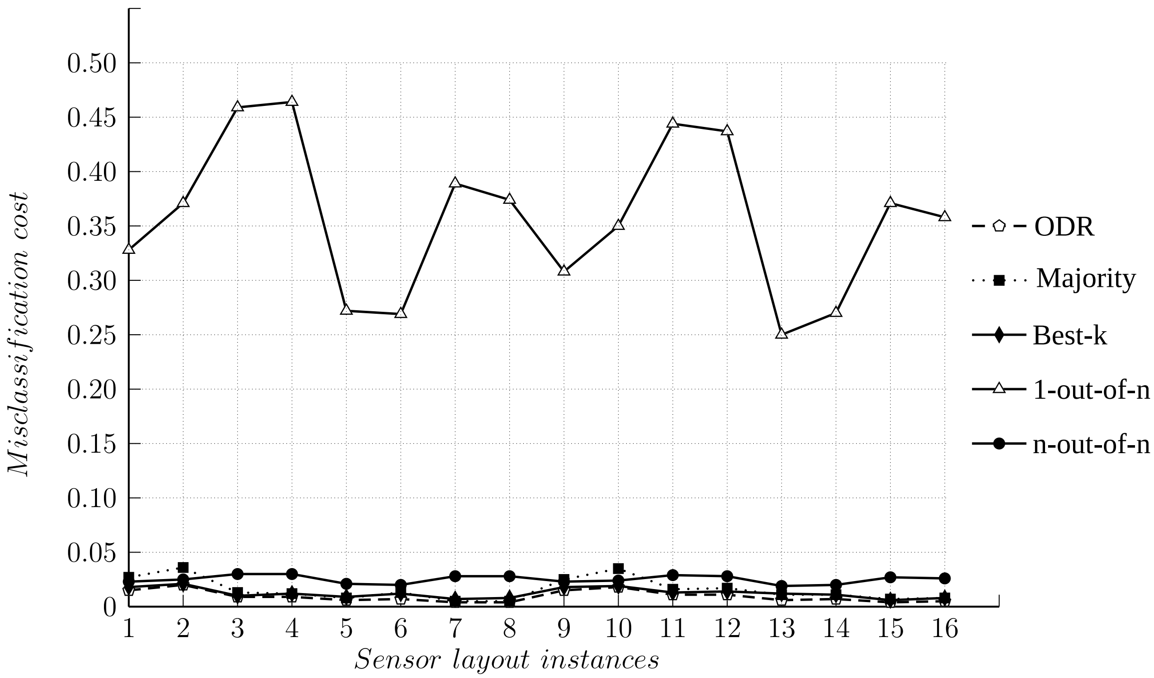
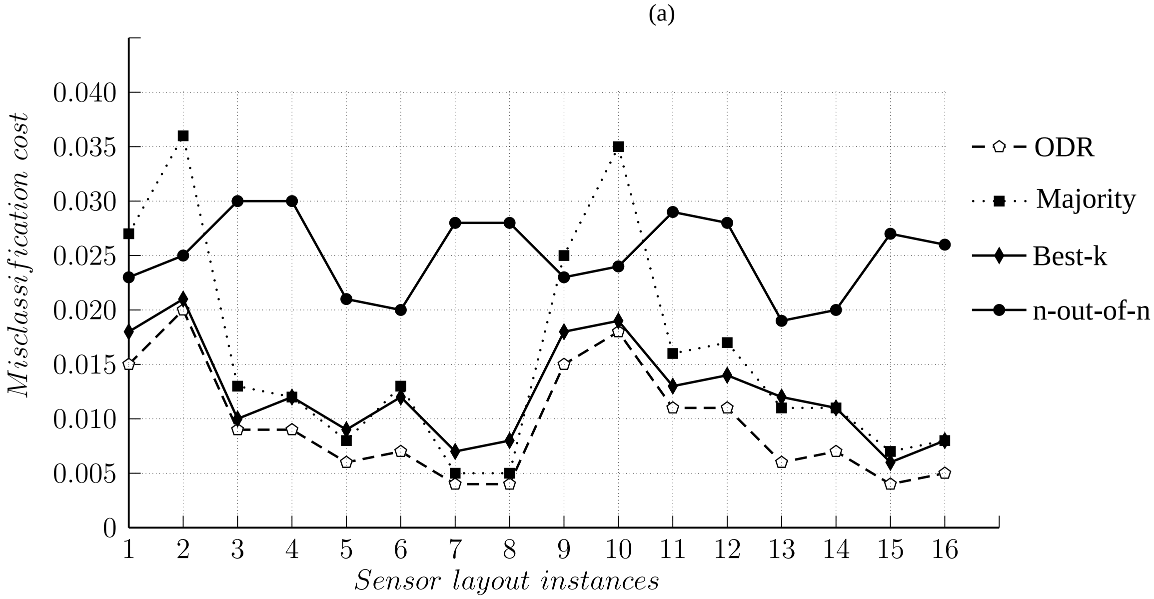


Fig. 2. $FAP = MDP$, $c_m = 100c_f$



(a)



(b)

Fig. 3. $FAP = MDP/100$, $c_m = c_f$

II. PROOFS OF THEOREMS

A. Proof of Theorem 1

Let

$$\hat{c}_j^f(\mathbf{y}_j) = c_j^f P(\mathbf{Y}_j = \mathbf{y}_j | U_j = 0) P(U_j = 0)$$

and

$$\hat{c}_j^m(\mathbf{y}_j) = c_j^m P(\mathbf{Y}_j = \mathbf{y}_j | U_j = 1) P(U_j = 1).$$

Since outputs $\mathbf{y}_j$ are mutually exclusive, (3) is

$$C_j^* = \sum_{\mathbf{y}_j \in \{0,1\}^{n_j}} f(\mathbf{y}_j)$$

where

$$f(\mathbf{y}_j) = \min\{\hat{c}_j^f(\mathbf{y}_j) x(\mathbf{y}_j) + \hat{c}_j^m(\mathbf{y}_j)(1 - x(\mathbf{y}_j)) \mid x(\mathbf{y}_j) \in \{0,1\}\}. \quad (1)$$

For each $\mathbf{y}_j \in \{0,1\}^{n_j}$, an optimal solution to (1) is given by

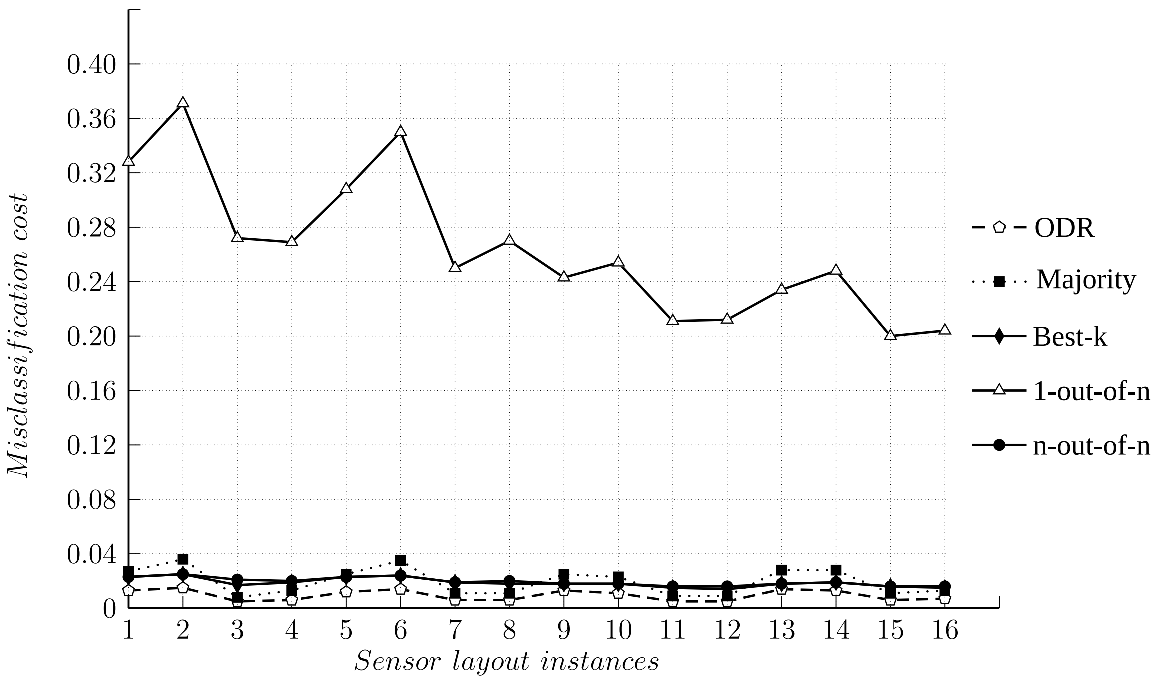
$$x^*(\mathbf{y}_j) = \begin{cases} 1 & \text{if } \hat{c}_j^m(\mathbf{y}_j) \geq \hat{c}_j^f(\mathbf{y}_j) \\ 0 & \text{otherwise,} \end{cases}$$

establishing (4).

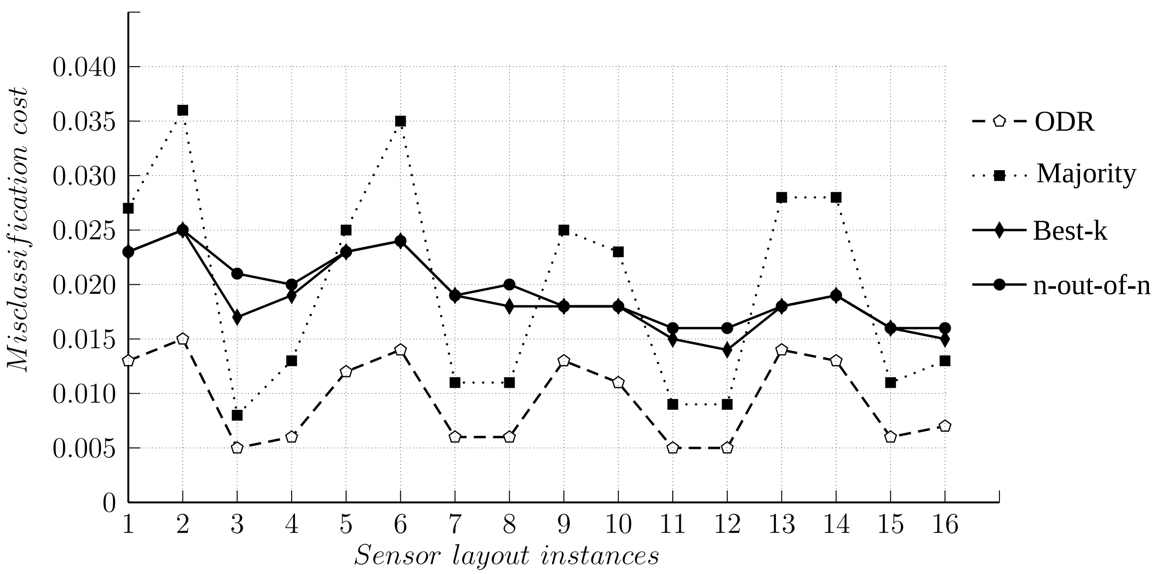
B. Proof of Lemma 1

Lemma 1 follows because

$$\begin{aligned}
T(\mathbf{y}_j) &= \prod_{i \in I_j \setminus S(\mathbf{y}_j)} \frac{P(Y_{ij} = y_{ij}^* | U_j = 1)}{P(Y_{ij} = y_{ij}^* | U_j = 0)} \prod_{i \in S(\mathbf{y}_j)} \frac{P(Y_{ij} = 1 - y_{ij}^* | U_j = 1)}{P(Y_{ij} = 1 - y_{ij}^* | U_j = 0)} \\
&= \prod_{i \in I_j} \frac{P(Y_{ij} = y_{ij}^* | U_j = 1)}{P(Y_{ij} = y_{ij}^* | U_j = 0)} \prod_{i \in S(\mathbf{y}_j)} \frac{P(Y_{ij} = y_{ij}^* | U_j = 0)}{P(Y_{ij} = y_{ij}^* | U_j = 1)} \frac{P(Y_{ij} = 1 - y_{ij}^* | U_j = 1)}{P(Y_{ij} = 1 - y_{ij}^* | U_j = 0)} \\
&= T_{max} \prod_{i \in S(\mathbf{y}_j)} \frac{P(Y_{ij} = y_{ij}^* | U_j = 0)}{P(Y_{ij} = y_{ij}^* | U_j = 1)} \frac{P(Y_{ij} = 1 - y_{ij}^* | U_j = 1)}{P(Y_{ij} = 1 - y_{ij}^* | U_j = 0)} \\
&= T_{max} \prod_{i \in S(\mathbf{y}_j)} \frac{1}{\delta_i}
\end{aligned}$$



(a)



(b)

Fig. 4. $FAP = MDP$, $c_m = c_f$