RFCM FOR DATA ASSOCIATION AND MULTITARGET TRACKING USING 3D RADAR

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Methods - Regularized FCM

\[ \min_{\mathbf{c}} \sum_{i=1}^{N} \left( \sum_{j=1}^{c} w_{ij}^2 d_{ij}^2 + \frac{1}{C-1} \sum_{k=1}^{c} \left| d_{ik} \right| \right)^{\frac{2}{p}} \]

- \( d_{ij} = \left| \mathbf{c}_i - \mathbf{x}_j \right| \) and \( d_{ik} = \left| \mathbf{c}_i - \mathbf{c}_k \right| \)
- \( w_{ij} \) is the weight for the \( j \)th data point to the \( i \)th centroid
- \( p \) is a parameter of the FCM algorithm

Reformulation

\[ \min_{\mathbf{c}} \sum_{i=1}^{N} \left( \sum_{j=1}^{c} w_{ij}^2 d_{ij}^2 + \frac{1}{C-1} \sum_{k=1}^{c} \left| d_{ik} \right| \right)^{\frac{2}{p}} \]

1. Use the DBSCAN clustering algorithm to determine the initial cluster for cycle 1
2. Use the resulting centroids as state and observation vector to the EKF to obtain the predicted and filtered location for cycle
3. Denotes the data point index such that it is not close to the mirror of \( \mathbf{c}_i \)
4. Two regularization terms offer robustness in case the observations of different targets are noisy or close to each other and overlapped

First Regularization Term

\[ f_1 = \alpha d_{i} \]

Second Regularization Term

\[ f_2 = \beta \left| \mathbf{c}_i - \mathbf{c}_k \right| \]

Third Regularization Term

\[ f_3 = \gamma \left| \mathbf{c}_i - \mathbf{c} \right| \]

Conclusions

- The proposed RFCM method is able to outperform the conventional FCM method in improving data association performance, which leads to improved tracking performance using the EKF
- Simulation results using simulated and field data have proven the efficacy of the proposed method

References