Integrated Classification and Localization of Targets using Bayesian Framework in Automotive Radar

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A. Dubey, A. Santra, J. Fuchs, M. Lübke, R. Weigel and F. Lurz

Institute for Electronics Engineering,
FAU Erlangen-Nürnberg, Germany
Content

• Problem Statement
• Contribution
• Results
• Conclusion
Problem Statement (1/2) – Feature Similarity
Problem Statement (2/2) – Conventional Tracker

Problem
- Target Association
- Target Classification

Contribution
- Augmented State Vector +
- Bayesian Gating
- Feature tracking

FP due to wrong target association
Bayesian Integrated Framework (1/2)

Deep Metric Learning + VAE – Training (1/2)

a) TNN

b) TVAE

Shared Encoder CNN

Shared Decoder CNN

Classification
Deep Metric Learning + VAE – Training (2/2)

1) Online Triplet Mining

2) Loss function:

\[ \mathcal{L}_{\text{TVAE}} = \alpha \cdot \mathcal{L}_{\text{reconstruction}} + (1 - \alpha) \cdot (\mathcal{L}_{\text{KL}} + \mathcal{L}_{\text{triplet}}) \]
Bayesian Integrated Framework (2/2)

Augmented Bayesian Tracker – Inference (1/2)
Integrated Bayesian Tracker – Inference (2/2)

1. Augmented State Vector

\[ x_a = \begin{bmatrix} px & py & v & Az & \mu_{11} & \mu_{12} & \cdots & \mu_{1M} \end{bmatrix}^T \]

\[ g(x_a) = \begin{bmatrix} px^P & py^P & v^P & Az^P & \mu_{11}^P & \cdots & \mu_{1M}^P \end{bmatrix}^T \]

2. Gating

\[ d_{det} = (z^p - z^m)S_{det}^{-1}(z^p - z^m)^T \]
\[ d_{cls} = (E^p - E^m)S_{cls}^{-1}(E^p - E^m)^T \]
Results (1/2) – Classification Accuracy

Accuracy = 75.56%

Accuracy = 98.1%

0 – female; 1 – male; 2 – teen; 3 – cycle1; 4 – cycle2; 5 – cycle3
Results (1/2) – Tracking Association
Summary

Conclusion

✓ Target Association
✓ Integrated Target Classification

Future Work

☐ Uncertainty Analysis
☐ Distance Learning between feature embedding