Temasek Defence Systems Institute

Recognition of Traffic Signs on Road for Autonomous Vehicles with Machine Learning Techniques

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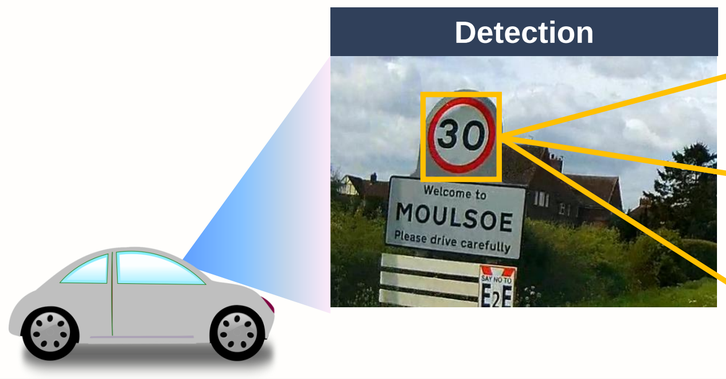
Aim and Objectives

To investigate the effects of cost-sensitivity on autonomous vehicle perception systems

- Develop machine learning algorithms for traffic sign recognition.
- Compare and evaluate the performances of the cost-sensitive and non-cost-sensitive algorithms.



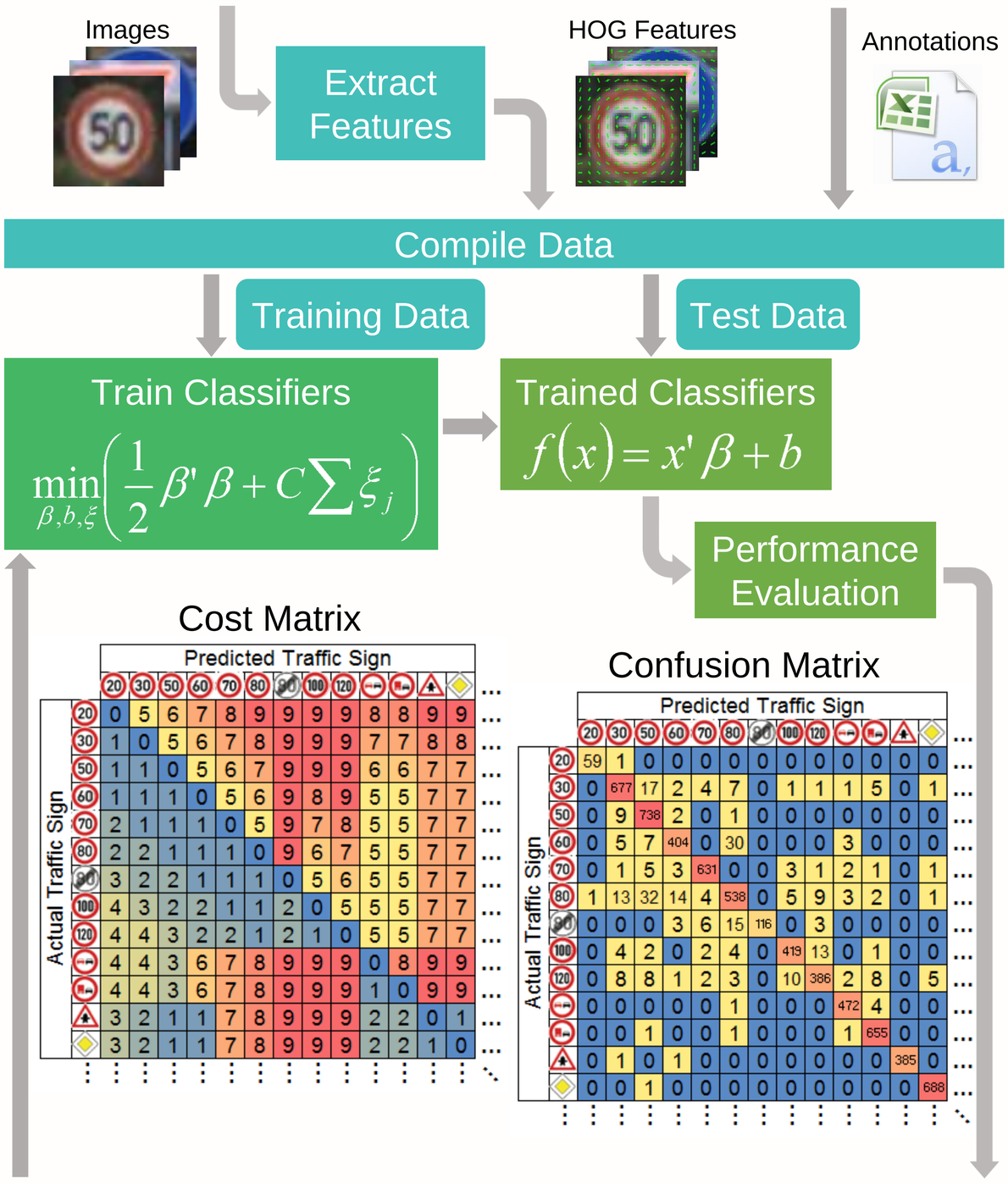
Classification	Cost
30	Zero. Correct Classification.
20	Low. Nuisance created.
80	High. Safety Hazard.

Methodology

Literature Review → Compile Data → Train ECOC Multiclass Linear SVM Classifiers → Evaluate Classifiers

Experiment

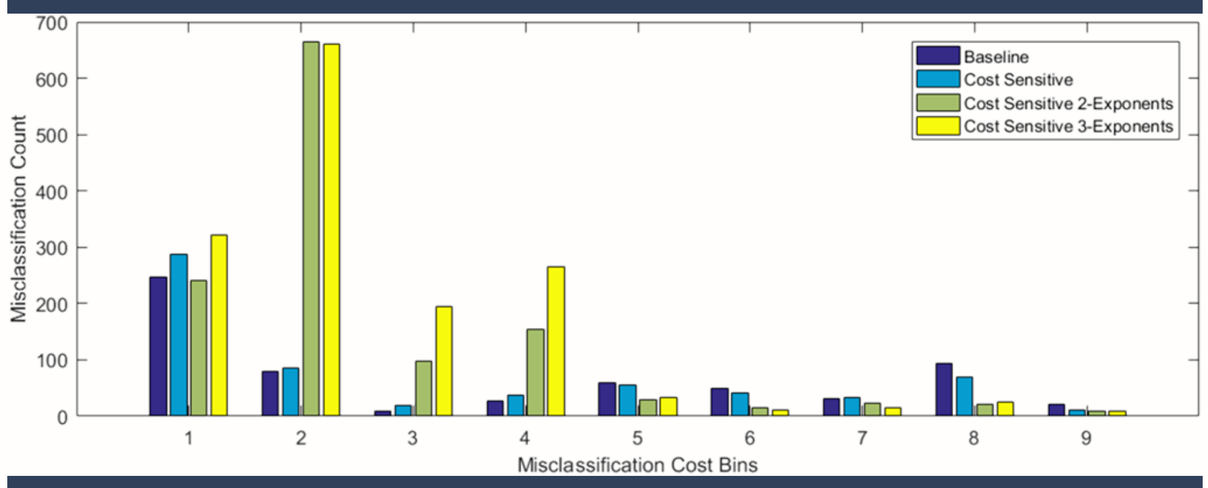
German Traffic Sign Recognition Benchmark Dataset
- 43 traffic sign classes
- 39,209 training images
- 12,630 test images



Cost-Sensitive Multiclass Linear SVM Classifiers

The Error-Correcting Output Codes (ECOC) model integrates 43 linear binary Support Vector Machine (SVM) classifiers to form a single multiclass classifier. Misclassification costs defined in the cost matrix modifies the loss function ($\frac{1}{2}\beta'\beta + C\Sigma\zeta_j$) for each binary classifier, penalizing specific misclassifications differently according to the cost matrix.

Results



Conclusion

- In this project, cost-sensitivity is introduced to traffic sign recognition for the first time.
- This research has shown that while costly misclassifications of traffic signs can be effectively reduced, this effect is accompanied by a proportional trade-off in recognition rate performance, ranging from 95% (Baseline Classifier) to 87% (Cost Sensitive 3-Exponents Classifier).
- By managing this trade-off, cost-sensitive classifiers add another layer of safety to the traffic sign recognition process while maintaining a comparable recognition rate performance with their non-cost-sensitive counterparts.
- Future work will improve recognition rate with cost awareness.

Benefits and Potential Applications

- Computer vision capabilities enabled by machine learning will have wide range of applications in Industry 4.0.
- Similar algorithms will be useful when applied to systems where cost of misclassifications are non-uniform, such as autonomous platforms, visual inspection workflows in the MRO sector, and video surveillance systems.

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