

# **Research Needs: Automotive Electronics**

April 30, 2019

Semiconductor Research Corporation (SRC), Durham, NC 27703

## Overview

Thank you for your interest in reviewing research needs for *Automotive Electronics*, an emerging research program of Semiconductor Research Corporation (SRC). The mission of the research program is to enable the revolutionary transition from driver assistance to fully autonomous vehicles. Academic research will enable 10x improvements in sensor sensitivity and cost, 100x improvements in computer vision and machine learning performance along with new, resilient, high dependability architectures for providing both safe and secure systems.

Research projects at SRC typically focus on research in a timeframe 5 – 8 years ahead of technology release. This timeframe represents the “sweet spot” for pre-competitive collaborative research, after which the industry focuses on proprietary development for technology differentiation by each company. Successful research proposals should match this timing.

## Research Needs

The transformation of automobiles into safe, dependable, autonomous vehicles has already started with the increasing availability and capabilities of advanced driver-assistance systems today. This research program attempts to identify and define the technology required to enable the revolutionary transition from driver assistance to fully autonomous vehicles. In particular autonomous vehicles need to be better than their human counterparts in perceiving and understanding their environment, making the appropriate decisions, as well as, remaining safe and dependable in all driving conditions. To make this dream a reality, this program targets orders of magnitude improvements in perception, environmental learning, dependability, safety, power and cost. We highlight the key strategic challenges divided into five categories:

1. **Advanced Reasoning and Learning**
2. **Sensor Fusion and Perception**
3. **High Dependability**
4. **Robust security of systems, components, and networks**
5. **Automotive Communications**

This document is not intended to cover the complete landscape of the required research, but rather to identify the most critical areas for university research to address.

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<b>1</b>	<b>Advanced Reasoning and Learning</b>
1.1	Ability to reason causally about real-world actions, including the vehicle itself, other vehicles, and pedestrians
1.2	Learning approaches from shared observations from a network of connected, fully autonomous agents
1.3	Use of contextual explanatory models to justify decisions and to enable improved performance of the system
1.4	Modification of the driving style based on the identity and state of the passenger
1.5	Intuitive, intelligent user interfaces for modifying system operation
<b>2</b>	<b>Sensor Fusion and Perception</b>
2.1	Multimodal fusion to substantially improve performance over conventional object-level fusion, where each modality contributes an independent detection result
2.2	Use of intermediate sensor responses (e.g. extracted features) to dynamically tune, align and calibrate multimodal systems
2.3	<b>Multi-sensor and multi-modal context-aware sensing that integrates sensors and processing to provide significantly enhanced sensor output</b>
2.4	Robust environmental models that outperform those available from conventional sensor systems by more accurately capturing, modeling, and tracking complex, dynamic scenarios in challenging conditions
2.5	<b>Approaches for either outlier rejection, risk based decision processes, or compensation for known sensor weaknesses</b>
<b>3</b>	<b>High Dependability</b>
3.1	Self-adaptive systems to improve efficiency, including continuous self-optimization
3.2	Anomaly detection to promote functional safety
3.3	Self-healing, on-line system reconfiguration to handle hardware, sensor and software failures
3.4	Dependable operations using a bounding envelope for constraining the range of allowable AI actions
3.5	Safety/security/dependability co-design to ensure robust and safe operation under all conditions
<b>4</b>	<b>Robust security of systems, components, and networks</b>
4.1	Computing architectures for improved machine learning and decision making algorithms
4.2	Decision frameworks and algorithms for reliable sensor fusion and safe and secure actuation
4.3	Efficient and robust overall system design and architecture
4.4	Methods to reduce computation for automotive machine vision neural networks
4.5	Computation optimized radar-based pedestrian detection
<b>5</b>	<b>Automotive Communications</b>
5.1	V2X communication, sensor communications and advanced security protocols
5.2	Algorithms for self-optimization of many vehicles and for robust collaboration among cars
5.3	Advanced crypto algorithm development for performance and attack resilience
5.4	Advanced authentication and verification methodologies