Vehicle Electronics
Vehicle Electronics – Strategic Drivers

- Exponential growth in automotive electronics as measured by:
  - Number of circuits
  - Number of components
  - Lines of software
  - Complexity
  - Data communications
  - Consumer demand
  - Safety-critical control
  - Safety-critical reliance
  - Development effort
  - Verification effort

- Moore’s Law: Doubling of complexity capability every 18 months.
  - 10 years from now: Factor of 100
  - 20 years from now: Factor of 10,000
Vehicle Electronics – Strategic Drivers

Nissan to introduce steer-by-wire cars in 2013

Select Infiniti models will get electronic steering, which could reduce driver fatigue. Emergency braking and steering could follow.

Tesla Working Towards 90 Percent Autonomous Car Within Three Years

By Evan Ackerman

The auto industry has already developed the technology necessary to create fully autonomous vehicles. Ford engineers claim the reasons there aren’t driverless cars all over the road today is partly due to issues — the sensors and automated intelligence required aren’t cheap — but mainly one of driver mindset. Your typical commuter isn’t quite ready to take the plunge from cruise control to completely automated driving.

Tesla CEO Elon Musk said his electric car maker has already built research vehicles with high-resolution surround-sensing cameras that can see the road and the cars surrounding it better than any driver with side mirrors. They also have scanning lasers that can model the world around it in 3D, while the vehicle’s 100s of communications standards have been finalized that would allow cars not only to broadcast their location and speed to one another but also stream all their vehicle network — even data that could coordinate the actions of thousands of automobiles on the roads.

Ford is ready for the autonomous car. Are drivers?

By Kevin R.楂　April 9, 2012 | 11:56 AM EDT

The auto industry has already developed all the technology necessary to create fully autonomous vehicles. Ford engineers claim the reasons there aren’t driverless cars all over the road today is partly due to issues — the sensors and automated intelligence required aren’t cheap — but mainly one of driver mindset. Your typical commuter isn’t quite ready to take the plunge from cruise control to completely automated driving.

There is no technology barrier from going where we are now to the autonomous car, said Jim Hackett, a Ford Research and Innovation technical expert who specializes in autonomous vehicle technologies. “There are affordability issues, but the big barrier overcome is customer acceptance.”
From a Recent *IEEE Spectrum* Article ...

On autonomous cars:

It's unfortunate that while the technology for all of this is arguably mostly ready, society (socially and legally) just isn't yet. You can buy cars with adaptive cruise control and lane departure warnings, which could hypothetically let the car drive itself, at least under some specific circumstances. And despite the fact that even a bad autonomous (or semi-autonomous) car would still save lives overall, there's no legal infrastructure in place to make it possible for manufacturers to implement such technology without undue risk of being sued into oblivion the first time something goes wrong.

The automotive industry does not (yet) fully appreciate the challenges associated with the reliable design of complex electronic systems.

- Very unlikely to fail is not good enough.
  - $10^{-6}$/hr probability of causing a fatal accident translates to thousands of fatal accidents in a popular vehicle model.
  - ISO 26262 target is $10^{-10}$/hr.

- Traditional design, modeling and verification procedures are failing to keep up.
Vehicle Electronics – Vision at CU-ICAR

Vision Statement

CU-ICAR will be the recognized leader in research leading to the safe, reliable design and integration of electronic systems in automobiles.

Key Areas of Research

- HMI and Human Factors
- Recognizing component and system failures before they are a safety issue
- Design of reliable components and systems
- Design and integration methodologies that guarantee performance
- Effective test procedures that validate designs
Vehicle Electronics – Focus Areas

Vehicle Electronics Research at ICAR

- HMI and Human Factors
- Recognizing component and system failures before they are a safety issue
- Design of reliable components and systems
- Design and integration methodologies that guarantee performance
- Effective test procedures that validate designs
- Wireless charging of vehicles (emphasis on safety, reliability)
- Battery aging and characterization
Vehicle Electronics – Research Projects

Vehicle Electronics Research at ICAR

- Phase IV: Investigation of Design and Test Practice Related to Electronic Throttle and Braking Controls in Trucks and Automobiles
- Wireless Charging – ORNL
- Investigation of Capacitor Response to Electrical Transients
- Detecting MOSFET and IGBT Failures in Power Inverters
- Low-Noise Power Inverter Design
- Performance-Based Design for Ensuring Electromagnetic Compatibility
Project Goal: Demonstrate that the unintentional electromagnetic emissions from power inverters and motor drivers can be monitored to anticipate electronic component failures before they occur.
Project Goal: Develop a method for designing electronic systems that are guaranteed to comply with their electromagnetic compatibility requirements.
CU-ICAR Personnel

Todd Hubing
Electromagnetic Compatibility, EM Modeling, Fault Detection.

Joachim Taiber
Wireless Charging, Vehicle Communications

Pierluigi Pisu
Fault Diagnosis, Energy Management

David Smith
Human-Machine Interfaces, Automotive Software

Simona Onori
Integrated Powertrain Control and Optimization
Characterization, Aging and Modeling of Automotive Batteries
Main Campus Collaborators

Electrical Eng.

KC Wang
Wireless Networks, Ad Hoc Networks, V2I Communications

Keith Corzine
Power Electronics

Adam Hoover
Embedded Systems, Driver Alertness Monitoring

Computer Science

Murali Sitaraman
RESOLVE (Fully Specified, Fully Verified) Software

Jason Hallstrom
Dependable Systems

John MacGregor
Dependable Systems
Labs