A Vision for Automotive CPS

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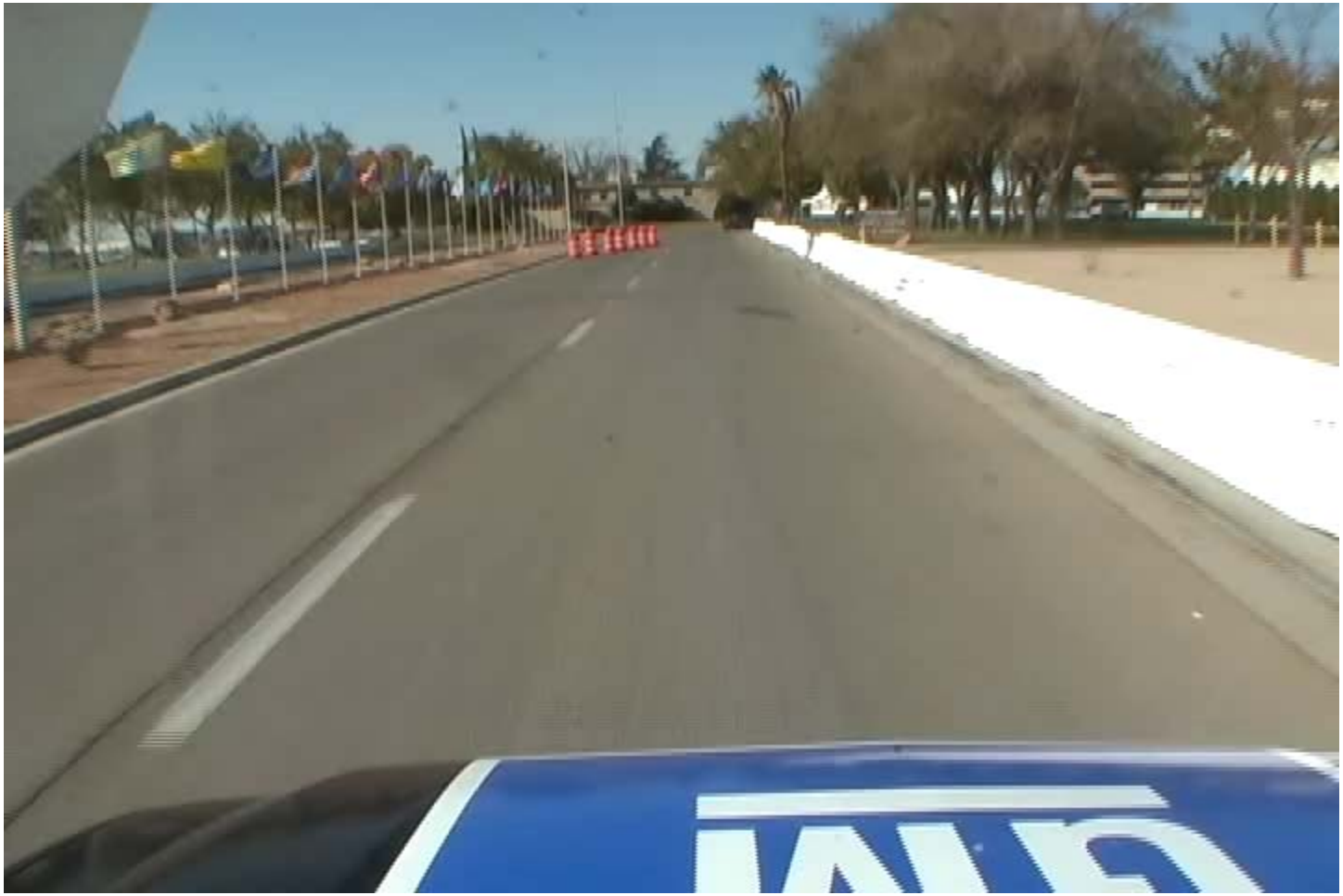
Automobiles and Societal Impact

- About 40,000 people are killed and 3 million people are injured every year in the US alone in automobile accidents.
- Globally,
  - Road traffic injuries is **the leading killer** of people aged 10 to 24.
  - About **400,000 automobile fatalities** every year.
  - **Annual cost** of road injuries in medical care, disability and property damage is $518 billion.
- Traffic congestion:
  - The average US driver spends **a week stuck in traffic per year**.
  - In the **EU, 80 billion euros wasted per year** due to traffic congestion.
- Independence?
  - For women, **10 years of transportation dependency** (95 - 85)

Autonomous Driving Capabilities



CMU’s Tartan Racing Wins Autonomous Driving Urban Challenge

Intermediate Milestones

- Pedestrian, child, bicyclist or animal **warnings**
- Part-time chauffeuring
  - **Virtual Valet**
  - **Highway Chauffeur**
  - **Traffic jam Chauffeur**
- Dependable, safe and real-time embedded computing and communications
- **Cables** (tend to) **go away**

What's Ahead?

- External: Complexity and **uncertainty in the environment**
  - Weather, lighting, and road conditions; construction; accidents; and obsolete information.
- Internal: **Online and safe recovery** from failures of sensors, actuators, computing or communications.
  - Sensors
    - Calibration, wear and tear, failures.
    - Occasional loss of GPS
- **Vehicular Networks**
  - communicate securely and coordinate carefully
- **Societal acceptance**
  - Reliability, cost and maintenance
- **Legal** implications
- **Incremental** deployment

Research Challenges

- Robust perception of a continually changing world
  - Deal with exceptions
- Know how to behave safely under all conditions
- Detect, isolate and recover from failures of sensors, actuators, computing and communications
- Diagnostics and prognostics
- Verification & validation not just of the software but of the entire system
- Cost-effective transducers

Broader Implications

- If a car can drive itself in relatively unstructured and uncontrolled environments and be safe,
  - **Rail**: “cars” on well-defined rails (“railroads”) with different physical dynamics
  - **Aviation**: A2A and A2I (A2X ~ V2X)
  - **Autonomous Mobile Entities**
    - Assisted living for seniors, young, the busy, the bored at home
    - Healthcare: mobile and infrastructural entities that understand, alert, alleviate and aid