Automated Intersections: A CPS Grand Challenge*

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Imagine driving through intersections without traffic lights nor STOP signs, where your car decides when to cross the intersection and how fast it should go. It safely does so, guaranteeing a smooth and collision-free crossing. Slowing down but not stopping would save energy as well as waiting time. Absence of collisions would save repair costs and prevent serious (often deadly) accidents.

We believe that developing such an automated intersection system is a cyber-physical system (CPS) *grand challenge*, not only because of its obvious societal benefits, but also because of the significant technical and other design and implementation challenges that it raises. Some of these challenges are listed below:

- *Control*: this is probably the most interesting aspect of the problem, as it impacts and is at the same time impacted by all other aspects. What type of control should such a system use? Centralized, where all cars around an intersection, communicate with a central point which handles reservations and scheduling? Distributed, where cars "negotiate" crossing among themselves? Which type of sensors/actuators/communication does the control system rely upon, and how economic is it to equip cars with those? What about older vehicles which will not be equipped, but will continue to circulate for years to come? What about pedestrian, bicycle, and other traffic?
- *Design objectives*: in addition to relatively clear *safety* objectives such as absence of collisions, the controller must also meet a number of other fairness and optimality objectives (e.g., evergy/time savings) which are likely to be more interesting to define and design for.
- *Security* concerns will also be important in such a system, including resilience against malicious attacks, but also provisions for privacy protection.
- *Legal and business aspects* will be essential for the deployment and adoption of such a system. We view these as part of the CPS challenge. We believe that research in fields such as certification and verification should have a more direct role to play in overcoming obstacles such as legal issues.
- *Vehicles and infrastructure*: cars are already equipped with devices providing many different capabilities beyond driving. Equipment such as radar may be useful or even required in an automated intersection setting. In addition, road infrastructure may need significant investment in terms of equipment, depending on the type of control (e.g., centralized).

References

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