

Diagnosis and Prediction in a Moving Vehicle: The Driver Advocate™

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Our Domain

We are investigating the issues surrounding information presentation to a vehicle operator, to enhance their environmental awareness and provide better on-task performance, despite the presence of numerous distractions. Two trends have caused us to focus on this area. First, the increased availability of inexpensive sensors such as GPS, radar and video that can provide additional services to a driver, such as navigation assistance, automatic cruise control, and collision warnings. Second, drivers are tending to spend more time in their vehicle, and wish to make productive use of this time, either in office productivity tasks, or maintaining external relationships (e.g., using a cellular phone to participate in meetings or engage in social conversations).

As the number and complexity of in-vehicle (or driver portable, e.g., bringing a portable CD player into the vehicle) services increases, the potential for Fatal Distraction™ also increases. While we have chosen this domain for the wide variety of experiments in human factors, interface design, and service architectures it affords, our current particular focus of attention is on an intelligent system that will monitor driver attention, and aid in appropriate information presentation to reduce distraction, and improve driver situation awareness.

Our Problem

We have chosen to use an intelligent agent architecture for a number of the beneficial attributes it affords. In particular, given our focus on driver assistance, we are attracted to the potential for robustness to unanticipated input, dynamic reconfiguration and resource optimization, as well as the ability to distribute both computational resources and human software engineering to rapidly prototype systems which can be used for human interface experiments (see, e.g., [Weiss 1999]). Because every individual driver has different capabilities and every vehicle performs differently, it is important for the system to adapt to the particular driver/vehicle combination (e.g., including sensor characteristics) it is presented with. With time, driver performance and vehicle characteristics can be expected to change as well, so it is important that we continue to adapt, rather

than simply register a given level of performance for long-term use.

Within this system, we are facing problems that are very similar to those faced by other workshop participants (e.g., resolving conflicts between different sensors and courses of actions suggested by different agents, the half-life of information, and resource management), with perhaps the added complexity of having to respond in time for the driver to react appropriately. That is, we do not seek to construct an autonomous vehicle. The driver will always be firmly in charge of making the ultimate decision as to what should be done in a given situation, and control of the vehicle will remain with the driver.

However, we will need to deal with integrating the data from multiple sensors (e.g., radar and vision), both in terms of the extensional object that is being sensed, and time aligning the reports for different latency periods. Because we will have limited computational resources, we cannot pay constant attention to all of our sensors, but must make intelligent decisions about what data is important to gather depending on the situation the system believes itself to be in. And the value of information will decay slowly or rapidly, depending on its own context and quality, e.g., driver information presentation preferences should be maintained over multiple sessions with the driver, while information on the vehicle ahead of us is only relevant while it can influence our current behavior.

Fundamentally, the decision making our system is doing is the presentation of information in the quantity, quality and time most appropriate to influence “correct” driver behavior. An added complication is that correct behavior must be analyzed *post hoc*, when we may have difficulty determining all of the potential influences on the behavior.

Our Approach

We are just at the beginning of this research project, and one reason we are attracted to this forum is to get acquainted with various solutions and techniques others are using in this general problem domain. Our own thoughts at this point are as follows.

First, we will use reinforcement learning, e.g., along the lines of [Tan 1993], to induce how system behaviors and environmental factors influence driver behavior. We will start with a system with specific cases identified and behaviors programmed based on human factors experiments

in driving simulators. We will then introduce an evaluation function for driver performance and distraction. This will be used to have the system evaluate its own performance as the system is used, as well as having inferred information about the subjective state of the driver. We will then, for a particular driver and a particular vehicle attempt to infer which behaviors lead to decreased driver distraction when the situation warrants it, and what we can do to improve overall driver performance on task. This will involve not only prediction about the drivers own goals (plan recognition), but being able to posit possible future scenarios based on current choices, which need to be optimized over several criteria, including the driver achieving her goal, the driver operating the vehicle in a safe manner (which may involve interactions with and estimates of the safety of other vehicles and people near the driver's vehicle), and making sure all global constraints (e.g., socially imposed rules on driving behavior such as obeying speed limits or not running over children in a school zone) will hold.

References

Tan, Ming, 1993. Multi-Agent Reinforcement Learning: Independent vs. Cooperative Agents. In Proceedings of the Tenth International Conference on Machine Learning, Amherst, MA. 330—337.

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