Assessing the Readiness of Autonomous Vehicles

Jim Henderson

May 2018

The Problem – Assessing Autonomous Vehicle Readiness

- Many Autonomous Vehicles (AuVs) are being developed, but how can government determine if they're ready to drive on public streets?
- Government hasn't yet developed substantial frameworks for AuVs
- There is very little legal precedent regarding AuVs and liability
- Naturally, governments and developers are erring on the side of caution

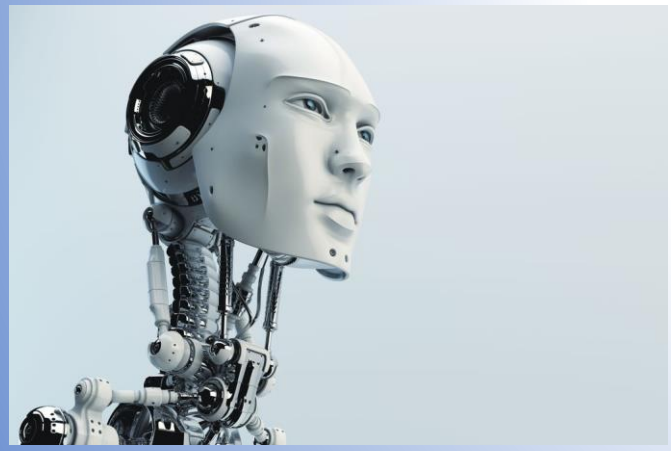
Can we trust the AuV on our roads?

Autonomous Vehicle Background

- Definition
- Benefits
- Types
- Status

Background - Autonomous Vehicles (AuVs) - Definition

Autonomous, driverless, robotic, or Self-Driving Vehicles are vehicles capable of sensing the environment and operating without human input



Background - Benefits of AuVs

- AuVs offer many potential benefits including:
  - Increased safety
  - Increased traffic flow
  - Reduced infrastructure costs
  - Increased mobility (especially for the young, disabled, and children)
  - Increased user satisfaction
  - Reduced parking space requirements
  - Reduced crime
- A significant reduction in traffic accidents could also lead to fewer injuries, fewer repairs, and lower insurance costs

AuVs offer many benefits that can help individuals and society

Background - AuV Types/levels

- Not all AuVs are created equal and can have different capabilities or levels of sophistication
- The Society of Automotive Engineers (SAE) defines a 6-level classification scheme:
  - 0 - Automated system issues warnings and may momentarily intervene but has no sustained vehicle control
  - 1 – “Hands on” - The driver and the automated system share control of the vehicle. Examples included Adaptive Cruise Control, Parking Assistance, and Lane Keeping Assistance. The driver must be ready to retake full control at any time.
  - 2 – “Hands off” - The automated system takes full control of the vehicle (accelerating, braking, and steering. The driver must monitor the driving and be prepared to intervene immediately at any time if the automated system fails to respond properly.
  - 3 - “Eyes off“ - The driver can safely turn their attention away from the driving tasks, e.g. the driver can text or watch a movie. The vehicle will handle situations that call for an immediate response, like emergency braking. The driver must still be prepared to intervene within some limited time, specified by the manufacturer, when called upon by the vehicle to do so.
  - 4 - “Mind off" - As level 3, but no driver attention is ever required for safety, i.e. the driver may safely go to sleep or leave the driver's seat
  - 5 - “Steering wheel optional“ - No human intervention is required. An example would be a robotic taxi

Background - AuV Status

- A variety of AuV systems, of varying SAE levels, are being tested around the world
  - Most are highly successful and continue improving
  - None are perfect
- Unresolved problems, challenges, and concerns remain though these vary by the system/technology:
  - Safety
  - Technology issues
  - Questions of liability
  - Resistance by individuals to forfeiting control of their cars
  - Establishing legal and governmental regulation frameworks
  - Risk of loss of privacy
  - Cybersecurity concerns (hacking, etc.)

Background - Facing AuV Challenges

- Delays in fielding AuVs delays humanity enjoying the benefits of widespread fielding of AuVs
- Only a few of the concerns are technological (resolving glitches, further testing, and testing/hardening the cybersecurity of these systems)
  - The companies developing AuV systems are rapidly addressing these issues
- Most of the issues are man-made or human-oriented
  - The longest-term problem is questions of liability (whose fault is it if something goes wrong) and government's penchant for creating laws and regulations about new things so they can demonstrate relevance
  - Fear of liability slows progress and companies are effectively forced to act defensively and hyper-cautiously
  - Appropriate evaluation of safety

Appropriate Definition of a "Safe" AuV System

- In discussing AuVs, opponents or governments often insist on near-perfection – that the AuV must make the optimal decisions 99.9999% of the time to be considered 'safe' for use on publics streets
- This is deeply flawed standard to use and dramatically hinders AuV development, testing, and use
- The question should NOT be "is the AuV perfect" but, rather, "is the AuV at least as good as the average human"
- Taken on average, humans are far from perfect drivers. Humans:
  - Make the wrong decision with great frequency
  - In some cases, simply lack the vision, reflexes, or focus to drive well
  - Often operate distracted, tired, drunk, or otherwise impaired
  - Often fail to follow laws related to driving – speeding, running stop signs, etc.
  - Can be affected by road rage

The alternative to AuVs is often-flawed, human drivers
In assessing AuV safety, AuVs should be compared to average human drivers, NOT to perfection

So How Can We Assess Autonomous Vehicle Readiness

- In order to remove some uncertainty from AuV development, fielding, and acceptance, we need to develop a standard framework for judging their readiness to operate on public streets
- Without a clear model, governments will continue to err on the side of caution and companies will proceed slowly for fear of litigation
- Since comparing AuV performance to human performance is the logical comparison, I recommend using a standard based on the model we typically use to assess human readiness to drive on public streets – drivers' licenses

Assessing Human Readiness – Driver's Licenses

- In most regions today, before we allow a person to drive on public streets, they must acquire a driver's license
- Typical requirements for a person to get a drivers license include:
  - Minimum age
  - Adequate vision
  - A specified amount of safe driver under direct supervision of an adult with a valid driver's license, often after first obtaining a learner's permit
  - Passing a test on the traffic laws and signs for that region
  - Passing a driving test by a certified driving instructor/evaluator

Assessing AuV Readiness – Driver's Licenses

- A similar concept can be applied to judge AuV readiness with similar criteria:
  - Minimum age – largely irrelevant for an AuV, but certainly sufficient
  - Adequate vision – Typically no issue and the AuV's senses include some that humans lack, such as radar or laser range-finding, eyes "in the back of its head," etc.
  - A specified amount of safe driver under direct supervision of an adult with a valid driver's license
    - This can vary depending on the level of the license (see next slide)
  - Passing a test on the traffic laws and signs for that region
    - Typically trivially easy for a computer system as most are great at digesting and reciting data
  - Passing a driving test by a certified driving instructor/evaluator
    - This can be done when ready and only requires driving skill and sufficient natural language processing (NLP) to understand instructions

AuV Readiness – Driver's License Levels

- AuV licenses can be graduated, with levels roughly based on the SAE 6-level classification scheme discussed earlier:
  - 0 – is where most are cars today
  - 1 – "Hands on" –A learner's permit that allows supervised operation on the road
  - 2 – "Hands off" – A learner's permit that allows supervised operation on the road
  - 3 - "Eyes off" – A more sophisticated form of learner's permit that allows the human operator to be less engaged with the AuV, but still requires them to be ready to intervene
  - 4 - "Mind off" – A true driver's license. A human operator need never intervene, but may be required to allow operation.
  - 5 - "Steering wheel optional" – A fully autonomous driver's license – no human is needed
- The key thing these driver's license levels allow is a determination of liability. As long as the AuV only has a learner's permit (level 1-3), the human must be present and shares liability with the developer
- At level 4, liability shifts to the developer unless the human operator violates a term of use of the level 4 license
- At level 5, liability is totally with the developer

Conclusion

- **AuVs offer many potential benefits, both to individuals and to society**
- **We should promote the development, testing, and use of AuVs to secure these benefits**
  - **The technological issues are relatively rare and minor and can be addressed fairly quickly**
  - **Government must act prudently to promote AuVs, not hinder them**
  - **Let us look to the future and its benefits and not be hindered or delayed by fears out of proportion to the concerns**
- **Driver's licenses for AuVs are one framework to assessing AuV readiness that can help define the shifting liability**

I WANT MY AuV AND I'LL FEEL SAFER WHEN YOU HAVE ONE