ygomi

Automated Driving for Trucks: Potential, Status, and Challenges

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Potential Effects: Safety

Highly automated driving in trucks could prevent vehicle crashes and save many lives

- 2,502 semi trucks were in fatal crashes in 2012[1]
  - 5.5% of vehicles involved in fatal crashes[1]
- 90% of commercial truck crashes are due to driver error[2]
  - One in eight of these crashes is due to driver fatigue[2]
- Like ESC[3] and other vehicle control technologies, highly automated driving could substantially reduce heavy vehicle crashes

1. http://www-fars.nhtsa.dot.gov/Vehicles/VehiclesAllVehicles.aspx
2. http://www.cnet.com/news/freightliner-autonomous-inspiration-truck
3. http://www.nhtsa.gov/About+NHTSA/Press+Releases/2012/New+NHTSA+Report+Shows+Federal+ESC+Requirement+Saving+Lives

Potential Effects: Environment

Highly automated driving in trucks can improve the environment

- The efficiency of automated driving can reduce fuel use and CO_2 emissions. Estimates include
  - Efficient driving: 3% reduction of fuel and CO_2[1]
  - Truck platooning: 5%-10% fuel reduction[2, 3]
  - Up to 4.8% CO_2 reduction from truck platooning[4]
- Automated driving can reduce traffic congestion
  - Americans spend an average of 38 minutes a day in traffic delays[5]
  - Automated driving enables closer following[2] and more efficient maneuvering, which reduce congestion

1. http://www.conti-online.com/www/automotive_de_en/themes/commercial_vehicles/ch_interior_en/ehorizon_en/03_dynamic_ehorizon_en.html
2. http://atri-online.org/2015/05/27/new-research-assesses-potential-for-driver-assistive-truck-platooning
3. www.nrel.gov/docs/fy14osti/62494.pdf
4. http://orfe.princeton.edu/~alaink/SmartDrivingCars/ITFVHA13/ITFVHA13_JP_Energy_ITS_Tsugawa.pdf
5. http://mobility.tamu.edu/ums

Levels of Automation

NHTSA defines five levels of automation[1]

Level / Explanation	Example
Level 0: No Automation	Vehicles before 1971
Level 1: Function-Specific Automation ▸ Driver is mostly in control of the vehicle ▸ Each automated function is separate	Vehicle with ABS, electronic stability control, adaptive cruise control, etc., operating separately
Level 2: Combined Function Automation ▸ Driver is mostly in control of the vehicle ▸ Automated functions work together	A vehicle with adaptive cruise control combined with lane centering
Level 3: Limited Self-Driving Automation ▸ Automated functions can control the vehicle ▸ Driver is present and able to take over	▸ Mercedes Future Truck 2025 ▸ Freightliner Inspiration Truck ▸ Peterbilt Advanced Driver Assist
Level 4: Full Self-Driving Automation ▸ Allows, but does not require, a driver to provide navigational input	Vehicles used at low speeds in closed environments (mines, farms, ports, borders, etc.)

1. www.nhtsa.gov/About+NHTSA/Press+Releases/U.S.+Department+of+Transportation+Releases+Policy+on+Automated+Vehicle+Development

Use of GNSS in Automated Driving

Automated driving systems use GNSS but do not currently rely on it for precise positioning

- GNSS is currently used in prototype automated vehicles on public roads (with or without an augmentation system) for gross positioning
- Currently, GNSS is inadequate for precise positioning for automated vehicles on public roads because of inaccuracy, signal loss, and jamming
  - Needs augmented GNSS with accuracy to less than 10 cm and devices with complete reliability
- In current prototype automated vehicles on public roads, precise positioning is often provided by processing sensor data (cameras, radar, lidar), with or without use of pre-existing data about the environment (map or other database)

Autonomous Heavy Vehicles

NHTSA Level 3 and 4 automated heavy vehicles are already used in closed environments

- Example uses
  - Mining[1]
  - Farming[2]
  - Ports[3]
  - Border patrol[4]
- Guidance technologies
  - GNSS
  - Inertial navigation sensors
  - Digital maps
  - In-vehicle cameras, radar, lidar, other sensors
  - Markers or magnetic guides

1. http://www.mining.com/australias-big-miners-add-more-driverless-trucks-88704
2. http://farmofthefuture.net/#/slideshow/autonomous-tractors-take-field
3. http://www.terex.com/port-solutions/en/products/automated-guided-vehicles/index.htm
4. http://www.gizmodo.com.au/2014/11/the-amstaf-patrols-dangerous-borders-so-soldiers-dont-have-to

Challenges of Highly Automated Driving in Trucks

Automated driving for trucks presents larger technical challenges than for passenger cars

- Management of a much larger, heavier vehicle
- Greater variability of weight
- Greater vehicle movement affecting sensors
- Additional road data needed
  - Height of overpasses, bridges, etc.
  - Weight, height, class limitations
- In closed or remote environments, the issues above are more easily handled
  - Mining
  - Ports

Demonstrations of Highly Automated Driving in Trucks

- Many NHTSA Level 2 automated driving features have already been implemented by truck manufacturers
  - E.g., adaptive cruise control and lane keeping
- Truck platooning on expressways has been demonstrated by Volvo and Scania[1]
  - The lead vehicle is driven be a human driver
  - The following vehicles drive in automated mode following the first vehicle using a Wi-Fi connection for coordination
- Truck manufacturers have demonstrated NHTSA Level 3 automated driving in trucks
  - Daimler in Europe[2] and the U.S.[3]
  - Scania in Europe[4]
  - Peterbilt in the U.S.[5]

1. http://www.independent.co.uk/life-style/gadgets-and-tech/features/autonomous-vehicles-how-safe-are-trucks-without-human-drivers-9047546.html
2. http://www.goauto.com.au/mellor/mellor.nsf/story2/FD343BD2BA533A74CA257D0F002B26FC
3. http://www.informationweek.com/mobile/mobile-business/first-automated-truck-licensed-to-operate-on-public-roads/d/d-id/1320311
4. http://www.nltimes.nl/2015/02/10/self-driving-trucks-tested-dutch-highway
5. http://www.constructionequipment.com/peterbilt-demonstrates-autonomous-assist-driving

Regulatory Status

- The 1968 Convention on Road Traffic (the "Vienna Agreement") is being updated to allow NHTSA Level 3 automated driving[1, 2]
  - Final approval through the UN process might be completed in 2016
- UN-R 79 forbids automatic steering at speeds over 10 km/h except for corrective steering
  - UNECE WP.29 is working on a revision to allow full steering control, possibly by 2018[2]
  - The U.S. follows this structure by choice

1. http://safecarnews.com/un-amends-vienna-convention-on-road-traffic-to-allow-driverless-cars
2. http://www.daimler.com/dccom/0-5-1742887-1-1743264-1-0-0-1743248-0-0-135-0-0-0-0-0-0-0-0.html

Predictions

- There will be NHTSA Level 3 automated driving in passenger vehicles on expressways, possibly in 2020
- There will be NHTSA Level 3 automated driving in trucks on expressways, possibly by 2023
- There will also be NHTSA Level 2 and Level 3 automated vehicle control functions used on expressways and/or local roads to improve fuel economy
  - Stoplight recognition
  - Platooning
- There will be more NHTSA Level 4 automated vehicles in more closed and remote environments
  - Road trains
  - Ports
  - Manufacturing facilities

Thank You