Identifying Shortcomings in Autonomous Vehicles Technologies

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Vehicular automation involves the use of:
- Mechatronics;
- Artificial intelligence; and
- Multi-agent system to assist a vehicle.

These features and the vehicles employing them may be labeled as intelligent or smart.

An autonomous car is an autonomous vehicle capable of fulfilling the human transportation capabilities of a traditional car.

As an autonomous vehicle it is capable of sensing its environment and navigate without human input.

Potential advantages of autonomous vehicles utilization:
- Fewer traffic collisions;
- Increased roadway capacity and reduced traffic congestion;
- Relief of vehicles occupants from the driving and navigation chores;
- Higher speed limits for autonomous vehicles;
- Reduction in the need for traffic police and vehicle insurance;
- Reduction of physical road signage;
- Smoother rides.
Potential obstacles for autonomous vehicles use:

- Liability for damages;
- Resistance for individuals to forfeit control of their cars;
- Software reliability;
- Cyber security / loss of privacy;
- Implementation of legal framework and establishment of government regulations;
- Reliance on autonomous drive produce less experienced driver for when manual drive is needed;
- Loss of driver related jobs;

Potential obstacles for autonomous vehicles use:

- Autonomous cars relying on the lane markings cannot decipher missing or incorrect lane marking;
- Temporary construction zones which are not posted to any maps or data bases; and
- Determination of the severity of traffic lane obstacles, as in the question of safely cruise a pothole or debris.

Current State of Utilization of AV:

- Autonomous Vehicle (AV) technology is quickly becoming a reality on U.S. roads;
- Testing on public roads is currently undergoing, with many Autonomous Vehicle makers located and testing in California;

Current State of Utilization:

- Disengagements data is analyzed in this work, given the safety-critical role of AV disengagements, which require the control of the vehicle to be handed back to the back-up human driver;
- This study provides a comprehensive overview of the fragmented data obtained from AV manufacturers testing on California public roads of 2017.
Disengagement and Limitations:

- Whether forced by design choices or due to insufficient information regarding the context of a particular situation, an autonomous car can suffer from what it is called a “disengagement mode”.
- During disengagement, the full control and authority of the car movement is handed from the autonomous technology that acts as “brain” of the vehicle to the back-up human driver.
- The California Department of Motor Vehicles (CA DMV) currently mandates that reports for such disengagements during testing and/or field operations be drafted and made available to the public (California Department of Motor Vehicles (CA DMV), 2016).
- Currently, 57 Autonomous Vehicle Testing Permit (full list at https://www.dmv.ca.gov/portal/dmv/detail/vr/autonomous/testing).
- As of July 2018, only 11 manufacturers have reported disengagements.

#### Autonomous miles driven by manufacturer:

- Waymo: 362,044 miles
- GM Cruise LLC: 131,878 miles
- NVIDIA: 10,090 miles
- Tesla, Inc.: 9,926 miles
- Bosch: 8,576 miles
- Baidu: 6,241 miles
- Audi North America, Inc.: 5,881 miles
- ZF: 5,525 miles

Breakdown of autonomous miles driven, data from September 2016 to December 2017

#### Disengagements by manufacturer:

- Tesla: 726
- Waymo: 490
- GM Cruise LLC: 218
- NVIDIA Corporation: 100
- Baidu: 98
- Audi North America, Inc.: 97
- ZF: 48
- NVIDIA: 37
- Bosch: 32
- Continental: 26

Breakdown of disengagements, data from September 2016 to December 2017

#### Analysis of AT disengagements:

- Developing a structure to organize the reported causes into macro- and micro-categories to would allow to encompass the bulk of the “causes” reported by each manufacturer.
- The identified macro-categories were:
  1. Human Factors: the human driver is directly responsible or involved in the decision to initiate the disengagement of the AV technology.
  2. System Failure: hardware and/or software failure of the AV technology.
  3. External Conditions: disengagements related to the external environment.
  4. Other: all disengagements causes in which the specific terminology used by the manufacturer was not directly traceable to any of the previous macro-categories.
Breakdown of disengagements reported in four categories:  
- System Failure 555  
- Human Factor 316  
- External Causes 156  
- Other 216  
Total 1243  

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Disengagements reported in four categories:  
- System Failure 15%  
- Human Factor 25%  
- External Causes 19%  
- Other 41%  

Breakdown of Macro-categories into Micro-categories for disengagement causes:  
- Each macro-category is further subdivided in micro-categories, organized and inspired by the existing taxonomy;  
- All the “causes” reported by manufacturers were considered for the creation of micro-categories that would encompass all the verbiage used by different manufacturers;  
- Each micro-category was then mapped to one of the four macro-categories identified;  
- For each macro-category the micro-categories with higher frequency of occurrence are clearly indicated.
Conclusions:

- This study presented an analysis of the data currently available on disengagements of autonomous vehicles.
- The data was reported by manufacturers that are currently testing on California public roads to the Department of Motor Vehicles.
- The results focused on examining reported contributory factors and probable causes of the disengagements.
- We highlighted the importance of examining disengagements as precursors of transportation accidents, thus providing an added layer of "defense" for safety practitioners and researchers to study contributory factors and prevent future accidents.

References:


