4th Industrial Revolution and Autonomous Vehicles: Current Status of Autonomous Vehicles

1. OVERVIEW

Audi released its plan to launch a new model of autonomous vehicles (also self-driving vehicles) and the German government amended its laws accordingly, while the “Fourth Industrial Revolution Committee” chaired by President Moon was reportedly established in Korea. An autonomous vehicle enables safe and convenient driving since it senses and judges its surrounding environment, exercises control and minimizes or replaces human input for driving. In this regard, autonomous vehicles are regarded as an aggregation of technologies for the Fourth Industrial Revolution and a growth engine for the next generation. Therefore, various industries such as the finished vehicle industry as well as auto parts, mobile communications technologies and ICT industries compete against or cooperate with one another in the development of relevant technologies. Further, governments of advanced nations, including the U.S. and European nations, are expending substantial efforts to enhance the competitiveness of their autonomous vehicle industries.

In preparing this series on major issues of the Fourth Industrial Revolution, Yoon & Yang first summarizes key contents regarding autonomous vehicles. This Article addresses the current status of companies related to autonomous vehicles and the policy directions of relevant advanced nations and Korea. The next newsletters of the series will address the recent legislations of advanced nations on autonomous vehicles and the plans to improve current laws and systems of Korea pursuant to the Korean legislation and technological developments.

2. CURRENT STATUS OF AUTONOMOUS VEHICLE INDUSTRY

A. Levels of Automated Driving Technology

- The National Highway Traffic Safety Administration of the U.S. (the “NHTSA”) defined the five levels of automation as shown in the table below.

- Major Korean and global companies have commercialized Level 2 technology and are expected to mass produce vehicles with Level 3 technology by 2020.

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### Legal update

<table>
<thead>
<tr>
<th>Level</th>
<th>Characteristics</th>
<th>Description</th>
<th>Driving Operation</th>
<th>Monitoring</th>
<th>Emergency Control</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No automation</td>
<td>Full-time performance by human driver</td>
<td>Driver (human)</td>
<td>Driver</td>
<td>Driver</td>
<td>ACC (Adaptive Cruise Control)</td>
</tr>
<tr>
<td>1</td>
<td>Function-specific automation</td>
<td>Automation of specific functions (i.e., support for single function at a time)</td>
<td>Driver &amp; Vehicle</td>
<td>Driver</td>
<td>Driver</td>
<td>LKAS (Line Keeping Assistanc e System) +ACC</td>
</tr>
<tr>
<td>2</td>
<td>Combined function automation</td>
<td>Automation of at least 2 primary control functions working in unison (i.e., support for multiple functions simultaneously)</td>
<td>Vehicle</td>
<td>Driver</td>
<td>Driver</td>
<td>Highway driving</td>
</tr>
<tr>
<td>3</td>
<td>Limited self-driving automation</td>
<td>Automation in certain driving situations (driver in control during emergency)</td>
<td>Vehicle</td>
<td>Vehicle</td>
<td>Driver</td>
<td>Highway driving</td>
</tr>
<tr>
<td>4</td>
<td>Full self-driving automation</td>
<td>Autonomous driving at all times (even during emergency)</td>
<td>Vehicle</td>
<td>Vehicle</td>
<td>Vehicle</td>
<td>City driving</td>
</tr>
</tbody>
</table>

Source: NHTSA (May 2013), Korea Development Bank (September 2016)

### B. Major Technologies

- An autonomous vehicle is an integration of various industrial technologies including sensors, software, control systems, V2X (vehicle–to–everything) technologies, precision mapping and road facilities.

- The Korea Evaluation Institute of Industrial Technology announced its plan in June 2017 to invest KRW 145.5 billion by 2021 for developing the following nine major parts/components of autonomous vehicles: (i) modules for front and rear image sensors, (ii) 77/79 GHz dual band radars, (iii) low-priced LIDAR sensors, (iv) accident data recorders (ADR), (v) V2X, (vi) digital maps, (vii) hybrid positioning modules, (viii) human–vehicle interface (HVI) and (ix) domain control units (DCU).

- V2X technologies include (i) wireless communications technology between vehicles (vehicle–to–vehicle or V2V), (ii) wireless communications technology between vehicles and infrastructure (such as nearby signaling systems) (vehicle–to–infrastructure or V2I) and (iii) wireless communications technology between vehicles and pedestrians (vehicle–to–pedestrian, V2P).

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C. Recent Trends of Major Foreign Companies

<table>
<thead>
<tr>
<th>Classification</th>
<th>Company</th>
<th>Model</th>
<th>Automated System</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finished vehicle manufacturers</td>
<td>Tesla</td>
<td>Model: S/X/3</td>
<td>AutoPilot</td>
<td>Commercialize autonomous electric vehicles with Level 3 automation by 2018</td>
</tr>
<tr>
<td></td>
<td>Ford</td>
<td>Fusion Hybrid</td>
<td>Virtual Driver System</td>
<td>Produce fully autonomous vehicles (Level 4 automation) by 2021</td>
</tr>
<tr>
<td></td>
<td>GM</td>
<td>Chevrolet Bolt</td>
<td>Super Cruise → Applied to Cadillac CT6 to be launched in the 2nd half of 2017</td>
<td>Develop and test-drive fully autonomous vehicles (Level 4 automation) by 2021</td>
</tr>
</tbody>
</table>

Qualcomm, Intel, NVIDIA
- Qualcomm acquired NXP, i.e., the world’s largest company specializing in semiconductors for vehicles and is focused in developing cellular V2X (C-V2X) technologies, which grafted LTE technologies onto V2X technologies, in cooperation with Audi, etc.
- Intel acquired Mobileye, i.e., a company specializing in semiconductors for autonomous vehicles, and agreed with BMW to develop a fully autonomous vehicle called “iNext” by 2021.
- NVIDIA, in partnership with Audi, supplied automated driving technologies to Audi’s new A8 model.

Google
- World’s first automated driving in public streets in October 2015
- Separated its autonomous vehicle projects into its subsidiary “Waymo” (i.e., self-driving car development company) in December 2016
- Aims to commercialize fully autonomous vehicles (Level 4) by early 2020s.

Uber
- Focuses on unmanned taxis and unmanned trucks in cooperation with automakers including Ford and Volvo
- Operated automated taxis in San Francisco in December 2016 for one week and suspended operations due to regulations
- Operated automated taxis in Arizona in February 2017, but suspended operations due to a collision accident in March
- Aims to commercialize unmanned taxis and unmanned trucks

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### D. Recent Trends of Domestic Companies

<table>
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<tr>
<th>Company</th>
<th>Status</th>
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</table>
| Hyundai Motor | • Plan to commercialize vehicles with Level 3 automation by 2018  
• Succeeded at night-time city driving in Las Vegas in December 2016  
• Announced on August 15, 2017 the commencement of verification and research on utilizing the V2X system by establishing a road for autonomous driving in Hwaseong  
• Possesses the most advanced technologies in Korea |
| Mando         | • First in Korea to test-drive an autonomous vehicle equipped with domestic sensors (radar and camera)                                                                                                    |
| Samsung       | • Acquired Harman, i.e., the world’s largest manufacturer of electronic equipment for automobiles, in March 2017  
• May 2017: First to acquire a “temporary operation permit” (required for test-driving autonomous vehicles) among Korean electronics companies |
| Electronics   |                                                                                                                                                                                                     |
| LG Electronics| • Executed a contract in June 2017 to supply camera systems for autonomous vehicles to Benz  
• Acquired the “temporary operation permit” for the test-driving of autonomous vehicles in July 2017                                                                                                  |
| Naver         | • Feb. 2017: First to acquire the “temporary operation permit” for the test-driving of autonomous vehicles among Korean IT companies  
• Developing autonomous vehicles with AI deep learning technology as a major feature (Level 3 automation)                                                                              |
| SK Telecom    | • July 2017: First to acquire the “temporary operation permit” for the test-driving of autonomous vehicles among Korean telecommunications companies  
• Conducting research on technologies related to autonomous driving in joint cooperation with Seoul National University and NVIDIA                                                   |

* The companies listed above were selected among companies that acquired temporary operation permits for test driving as of July 2017; besides this, Seoul National University and the Korea Transportation Safety Authority also acquired such permit.

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E. Policy Direction

1) United States

- The Defense Advanced Research Projects Agency under the U.S. Department of Defense (the “DARPA”) has substantially invested in the development of autonomous vehicles, such as by continuously holding the “DARPA Grand Challenge” which is a prize competition for autonomous vehicles.

- The NHTSA released guidelines for the safety standards of autonomous vehicles on September 20, 2016 and recommended that each state standardize according to the guidelines. The NHTSA also provided fifteen (15) safety standards for autonomous vehicles.

- Although there are differences in legislations and policies for each state to a certain extent, states such as California, Nevada, Arizona, Florida and Columbia permit test-driving of autonomous vehicles in public streets.

- The U.S. government invested KRW 11.6 billion to establish and operate a test bed named “M-City” within the University of Michigan in July 2015. The government plans to have autonomous vehicles run the public streets of southeastern part of Michigan based on such test bed.

   (See Korea Institute for Advancement of Technology (KIAT): “US” section of Trends in Europe’s Automated Vehicle Technologies and Policies)

2) Germany

- Germany effectuated an Act to implement an amendment to the “Vienna Convention on Road Traffic” in December 2016, which served as a basis for legalizing autonomous vehicles.

- The proposed Amendment to the “Road Traffic Act” of Germany that permits the operation of vehicles with Level 3 or Level 4 automation in public streets was approved by the German Bundesrat on May 12, 2017 and became effective as of June 2017.

  - The purpose of the Amendment was to permit the commercialization of Audi A8 which has completed Level 3 development.

  - The driver and the automated vehicle system are equally deemed to be in control of driving; if an accident occurs, the vehicle’s black box will be used to determine liabilities.

  - The German Bundesrat agreed to review and amend such Amendment within two years in consideration of the fact that the autonomous vehicle technologies are advancing rapidly.

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3) Korea

- The Korean government selected autonomous vehicles as one of its nine National Strategic Projects on August 10, 2016 and has been actively supporting the development of such vehicles.

- Relevant ministries are mutually cooperating with one another to support the development of autonomous vehicles based on their work areas. Details thereof are provided in the following table.

<table>
<thead>
<tr>
<th>Ministry of Trade, Industry and Energy</th>
<th>Classification</th>
<th>Details</th>
</tr>
</thead>
</table>
| Development of core technologies       |                | • Develop 9 key components and systems (2017–2021, KRW 145.5 billion)  
                                         |                | • Develop awareness algorithm (software) and establish public database necessary for performance evaluation |
| Support for test beds                  |                | • Expand test driving grounds and establish dedicated platforms: establish monitoring facilities for demonstration on real roads  
                                         |                | - Establish platforms for advanced driver-assistance systems (ADAS): 2017–2020, test driving ground for intelligent vehicles in Daegu |
| Training of human resources            |                | • Plan to train R&D level experts (with masters/doctorate degree level) for future vehicles as a part of training human resources to develop autonomous vehicles (2017–2021)  
                                         |                | - Plan to hold 3rd contest for autonomous vehicles for (under)graduate students (October 2017) |
| Alliance                               |                | • Operate networks (such as forums and seminars) to promote partnerships among relevant industries including finished vehicles, parts and ICT industries and discover/promote convergence R&D |
| Ministry of Science, ICT and Future Planning | Promotion as future growth engine | • Pursue cooperation among ministries, continuously invest in R&D and conduct performance assessment (among others) by selecting the industry as a future growth engine (in 2014)  
                                         |                  | - Total budget for smart vehicles as a future growth engine: KRW 61.9 billion in 2016 → KRW 91.3 billion in 2017 |
| Council on development of unmanned vehicles | R&D            | • Established (June 2016) and plan to implement the "5-Year Plan for Development of Unmanned Vehicles" through joint cooperation of ministries to boost industrial competitiveness of unmanned vehicles (such as autonomous vehicles and drones) |
|                                         | Support for commercialization | • Support the development of software and communications technologies related to autonomous driving (2017–2020, total of KRW 53 billion)  
                                         |                  | - Pursue development of 100Mbps 2X communications technologies as a new 7-year development project (2017–2020, total of KRW 4.6 billion) |

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### Legal update

| Ministry of Land, Infrastructure, and Transport | Temporary Operation Permit for Test-driving | • Implemented test-driving system for testing/research purpose (February 2016); currently, 21 vehicles in total have acquired the temporary operation permit for test driving (as of July 2017) since the first permit was granted in March 2016 |
| --- | Conversion to negative legislation | • Converted the method of designating test-driving sections (i.e., positive approach which prohibits in principle and permits as an exception) to “negative approach” so that the vehicles are in principle permitted throughout the country (excluding the safety zone for vulnerable people) (November 2016) |
|  | Forums/seminars | • Commenced “Convergent Future Forum for Autonomous Vehicles”, a public-private council for discussing future policies (June 2016); hold seminars and meetings at the National Assembly |
|  | R&D | • Completed planning research on the “development of safety evaluation technologies for autonomous vehicles and establishment of real road evaluation environment” including the establishment of K-City (August 2015 – May 2016)  
• Research on “safety evaluation technology for the transfer of control between driver and autonomous vehicle” in 2017 for new business (2017–2020, KRW 26.5 billion in total) |
|  | Others | • Plan to secure budget for establishing data sharing centers; repealed speed limit for automatically commanded steering function (ACSF) (10km/h) of autonomous test vehicles (amendment of the Vehicle Safety Standard, July 2016) |

Source: Office for Government Policy Coordination, Ministry of Land, Infrastructure, and Transport (February 2017)

### 3. CONCLUSION

On July 11, 2017 in Barcelona, Audi unveiled its new A8 which was the world’s first to utilize the “Audi AI Traffic Jam Pilot” function corresponding to Level 3 automation. Further, Audi announced its plan to launch the new A8 with such function deactivated at early stages of its sales and thereafter introduce it “gradually” in accordance with the amendment status of applicable laws of the countries of sale.

This Article exemplifies the alarming pace at which automated driving technologies are being developed and the subsequent need to revise the existing legal systems that have been established on the premise that vehicles are driven by humans, such as road traffic and insurance laws.

The next newsletter will discuss the recent Legislations of advanced countries on autonomous vehicles.

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