ITS-Intelligent Transport Systems projects and road safety policies in the Russian Federation

Prof., Dr. Sultan V. Zhankaziev
Moscow State Automobile and Road Technical University (MADI)
Head of Department "Traffic management and road safety"

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DEVELOPMENT PROCESS ITS (ITS-C-ITS-ATS) in Russian Federation

Autonomous vehicles

- Autonomous vehicle traffic:
  - single Autonomous vehicle in the traffic flow;
  - channeled on a linear section of road;
  - Autonomous vehicle groups in a conflict-free closed transport network;
  - mixed (conflict) on a linear road section;
  - mixed (conflict) on an open intersected urban network.

Cooperative ITS:

- driver assistance system (ADAS):
  - external technical vision (active vehicle safety);
  - inner vision (the psychophysiology of the driver).
- cooperation (V2X):
  - vehicle to vehicle (V2V),
  - vehicle to infrastructure (V2I),
  - vehicle to driver's personal device (V2P),
  - other.

Intelligent transport system (ITS) – development of transport network infrastructure, including:

- automated system traffic management (directive, indirective);
- dispatching systems on transport (passenger, cargo, special, municipal);
- control systems for road conditions (precipitation, temperature);
- rapid response systems for accidents and emergencies.
Highly Automated Vehicles and cooperative environment of road traffic safety and traffic management

Making decisions based on data
(View obstruction conditions)

Making decisions based on aggregated data
(Full view conditions)

Consistent making decisions
(View obstruction conditions)

Synchronous making decisions
(Full view conditions)
Perspective development of safety roads in the Russian Federation

State level

Regional level

Local level

Safe Road Development Technologies

Safe roads (SR) of the Russian Federation

SR of the region 1

SR of the region n

SR of the city 1.1

SR of the city 1.n

SR of the city n.1

SR of the city n.n

Comprehensive road traffic management scheme

Digital model of the road

4
# STAGES OF CREATING A DIGITAL ROAD MODEL

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Creating a network of base stations of differential corrections</td>
</tr>
<tr>
<td>2</td>
<td>High-precision digital road survey</td>
</tr>
<tr>
<td>3</td>
<td>Creating a digital road double</td>
</tr>
<tr>
<td>4</td>
<td>Equipment installation of cooperative intelligent transport system</td>
</tr>
<tr>
<td>5</td>
<td>Collecting traffic flow parameters and traffic conditions data</td>
</tr>
<tr>
<td>6</td>
<td>Strategic movement management of Vehicles, Highly Automated Vehicles: Road Traffic Safety, Traffic Management, services</td>
</tr>
</tbody>
</table>

**Mobile laser scanning laboratory**

- Provides digital road model information for customers, including Highly Automated Vehicles, ITS
- Uploading laser scanning data, calculating the coordinates of the "cloud" of laser scanning points
Analysis of positioning accuracy on a road section

<table>
<thead>
<tr>
<th>Accuracy</th>
<th>Average</th>
<th>Maximal</th>
<th>Minimal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Horizontal alignment</strong></td>
<td>4.4мм</td>
<td>5.2мм</td>
<td>3.3мм</td>
</tr>
<tr>
<td><strong>Height</strong></td>
<td>5.6</td>
<td>6.1</td>
<td>3.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>8.4</td>
<td>9.2</td>
<td>6.1</td>
</tr>
</tbody>
</table>

Registration of road surface elements and description of object parameters with Russian special software
Set of Highly Automated Vehicle technologies

External technical vision
- Active sensors: radar, lidar
- Stereoptical devices
- Combined

Internal technical vision
- Transport psychology
- Vehicle internal environment
- The system of making decisions in emergency situations

Cooperative ITS
- Multiservice platform
- IoT, LTE-V
- DSRC, G5

Road digital model; V2I; I2V
- High-precision positioning
- Aggregated data of the transport situation condition (Road Status)
- The system of making decisions at macro level

Traffic safety
- Services (restrictions)

Traffic safety Services (case)

Traffic management Services (case)

Highly automated vehicle services

Traffic safety

Solvable problems

BASIC TECHNOLOGICAL DIRECTIONS IN DEVELOPMENT OF HIGHLY AUTOMATED VEHICLES
1. Obtaining a high-precision map with the current traffic management scheme. (direction of traffic, road signs, road marking)
2. Building a route of movement.
3. Getting traffic information while driving: weather, accidents, traffic congestions, safe driving speed.
4. The ability to avoid static and dynamic obstacles using technical stereo vision.
5. The ability to exchange information on V2X technologies (DSRC, G5, LTE-A).
6. The protection against unauthorized access and vehicle cybersecurity.
ADVANTAGE OF USING A DIGITAL ROAD MODEL

Условие: Condition: lack or impossibility of inter-side interaction (V2V)

The lack of a digital road model

Digital Road Model Application

V2I (I2V)

Digital Road Model

Video surveillance subsystem

ADVANTAGE OF USING A DIGITAL ROAD MODEL
ADVANTAGE OF USING A DIGITAL ROAD MODEL

Direct obstacle detection

Analysis of the environment

Optimal trajectory development

Determining the parameters of deceleration, acceleration, and steering angle

Maneuvering with a minimum level of comfort

Early warning of obstacles from a digital road model

Using a digital road model

The time required to complete the operation

Extra time for maneuvering

Using a digital road model

Without a digital road model
Creation of the MADI Research center for justification and development of life cycles of local ITS projects based on national specifics

Scientific and methodical complex

Test and polygon complex

Scientific Research Complex

Functions:
- testing, certification
- standardization
- training

Scientific and methodical complex

Test and polygon complex

Functions:
- micro modeling of the ITS object
- psychophysiological analysis of driver behavior
- отработка межбортового взаимодействия

Project crisis

Indicator monitoring of local ITS projects

Introduction of local ITS projects

Without a feasibility study

New ITS project

Project degradation

Life cycle of a local ITS project
STUDY OF BEHAVIORAL STANDARDS ON THE ROAD

Complex of psychophysiology
The main stages of the development of highly automated vehicles and digital infrastructure, requiring testing at digital polygon test sites

Development of experimental samples (R&D)
- Testing scientific hypotheses and mathematical models

Standardization of elements ВТС и ЦИ
- Experimental substantiation of standardized parameters

Creation of industrial designs (OCD)
- Tests for the required accuracy, reliability and reliability

Certification of items ВТС и ЦИ
- Regulatory Tests

Polygon-test complex MADI "Smart Road"
ТК 057 по ИТС Росстандарта

Test Center "NAMI"
(ТК 056 Росстандарта)
The designation of the pilot section of the ITS road at the MADI testing ground (Moscow region, 34 km of the Leningradskoye highway):

- creation of a reliable prototype of integrated ITS in the experimental section of the road;
- development of requirements for technical solutions and software products developed and applied in ITS scope;
- creation of polygon conditions for the development of technical requirements for hardware and software for all types of ITS systems offered on the market by various operators;
- creating conditions for research, testing, calibration and other operations in the complex of tasks of developing standards in ITS scope;
- formation of a research base required for a wide range of types of scientific and research work in ITS scope;
- development of an educational laboratory base designed to prepare students in a specialized field, as well as to conduct continuing education courses and specialized retraining of specialists.

Systems installed on the test site complex:

- Vehicle Identification subsystem by three technologies
- Integrated system for radio frequency identification of transport infrastructure and traffic
- Information transfer subsystem in the V2V, V2I, I2V formats, including using dynamic information boards, variable information signs, on-board information systems
- A subsystem for assessing the weight and size parameters of vehicles, which allows collecting values of target parameters without stopping or significantly reducing the speed
THE PHYSICAL STRUCTURE OF THE MADI TEST BAD "SMART ROAD»

The upper level of management of the MADI «Smart road» testing complex

- ITS integration platform
- Digital model of the road

Complex subsystems

- Cooperative ITS (V2X, C-V2X)
- Highly automated vehicle

Tool subsystems

- Promising transport systems

ITS elements, equipment

Level of management subsystems

Information and communication system
Modeling and testing advanced technological and technical solutions in the field of digital road model, ADAC, autonomous vehicle technologies, etc.

A system for reporting weather conditions

Getting information from a vehicle in front

Short term

Implementation:
• Autonomous traffic in mixed traffic on highway;
• 22 conflict scenarios on the urban road network.
An algorithm for driving cars in an automated column has been developed.

Image processing system for recognizing road conditions and road elements using video cameras.

Results of testing of automatic braking and lane keeping systems based on data from external machine vision systems.

Project of vehicles equipment with servo system for automatic control of driver assistance systems.

TECHNOLOGIES OF HIGHLY AUTOMATED VEHICLES IMPLEMENTED ON THE MADI TEST BAD «SMART ROAD»

17
THE PROCESS OF DEVELOPING REGULATORY DOCUMENTS

Government initiative

Federal target program

Conducting R&D

Road map, ways of research

Private initiative

Test site system

Development of regulatory documentation

Pilot site system

Revision of regulatory documents

Implementation of regulatory documents

Advantages of this system:
- High rate of formation of the regulatory framework;
- High quality of the regulatory framework due to full-scale testing;
- Minimization of inefficient investments;
- Maintaining a high level of road safety;
- Early access to international markets.
### Current state of regulatory regulation in the field of Intelligent transport systems

<table>
<thead>
<tr>
<th>Category</th>
<th>ITS</th>
<th>Highly automated vehicle, cooperative intelligent transport system, ADAS</th>
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</thead>
<tbody>
<tr>
<td>National standards and preliminary national standard</td>
<td>&gt;20</td>
<td>9</td>
</tr>
<tr>
<td>Current national standards and a preliminary national standard that will enter into force in 2019</td>
<td>&lt;10</td>
<td>2</td>
</tr>
<tr>
<td>Projects preliminary national standards</td>
<td>&gt;20</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(in related fields)</td>
</tr>
</tbody>
</table>

### Promotional activities

- **Resolution Of the government of the Russian Federation No. 1415 "on conducting an experiment on trial operation of highly automated vehicles on public roads"**

  - National competitions, test sites («Karavan», «Zimniy gorod» и т.д.)

  - Testing of prototypes-formation of the best solutions to the tasks set

  - Development of regulatory documents
Thank you for your attention!