Nizhny Novgorod State Technical University

Nizhny Novgorod

An unmanned vehicle based on a Russian-made electric bus

The on-board computer features an autonomous temperature maintenance system, lidars, long- and short-range radars, cameras, a stereo camera, ultrasonic sensors, and a navigation system. The system is capable of controlling the main vehicle components (electric motor, brake pedal, steering rack)

Duration of Project:

2 years

Team Composition:

The team is comprised of automotive engineers, software engineers, as well as electronic components experts. Students, graduate students and young scientists of NNSTU are also actively involved in the project. Among the main team members there are several PhDs. The team members collectively have published over 100 articles in international journals indexed by Scopus and WoS databases on intelligent transport systems.

The names of key team members - Dmitry Tyugin, Dmitry Porubov, Pavel Beresnev, Ksenia Shashkina, Vladislav Mishustov, Valery Filatov

15 Participants

Average Age:

28 years

Brief Team History:

Our team was created at the Initiative of Young Scientists in 2017. A few years ago, work began on an unmanned vehicle project in the interests of the Gorky Automobile Plant (GAZ). Currently, the team is one of the leading developers of intelligent systems (ADAS) and innovative transport for GAZ. Work is carried out both within the framework of government subsidies and commercial contracts. For the team, participation in the Winter City competition is an opportunity to assess the level of development at the federal level, identify their own competitive advantage and determine the future direction of development.

Base Vehicles Used:

GAZelle Next

Competitive Advantages:

A possibility to carry out tests on a specially-equipped test field area simulating urban conditions

Main Technologies Used:

An electric platform based on the GAZelle NEXT has been selected as the chassis of the unmanned vehicle. The components used include an onboard computer, lidars, long-range and short-range radars, cameras, a stereo camera, ultrasonic sensors, and a navigation system. The system can control the main elements of the car - electric motor, brake pedal, and the steering rack. The navigation systems (GPS+IMU) allow us to determine the exact coordinates of the vehicle in space. With insufficient accuracy or lack of navigation data, the system uses a lidar. The vision system works on the basis of artificial neural networks, using special databases with

marked data. When detecting obstacles in the car's path, the console displays a warning as well as the coordinates and distance to it. This data is used to build a route which is carried out using the ROS module. Information from the navigation system and lidar enters the module, which makes the decision to adjust the vehicle's trajectory. All software modules, including algorithms of the control unit of executive mechanisms of the car, were made by team members.

Future Plans for Technology Advancement:

At the moment, we are working on improving the hardware and software of the vehicle to ensure higher reliability and accuracy. In addition, we are actively developing and looking for new directions. This includes work on finding automation solutions not only for the car, but also, for example, for municipal road cars or trains.

Needs:

We are actively seeking partners; one options may be to find sponsors which we will display on the car, as a form of PR. We are also interested in interacting with leading companies in our field to exchange experience and, possibly perform individual tasks that are within our competence.

Additional Team Information:

More information can be found about us in the media under "UpGreat Winter City".

Problems:

The finalist of the competition (NNSTU) currently uses 16-beam velodyne lidars for building digital maps and positioning a self-driving vehicle. In the process of testing and qualification races, we faced the problem of positioning when using 16-beam lidars (low accuracy). We would like to improve the quality of positioning, using this or other technology.

This will allow us to more accurately determine the location of the self-driving vehicle and the boundaries of static and dynamic obstacles, which will increase our chances of winning the competition.

Contact Information:

Our website can be found here.

Our promo video can be found here.

Auto-RTK

Rostov and Kursk Oblasts

The unmanned vehicle contains a prototype control system based around a Korean-made car.

The car is equipped with modern vision sensors, navigation tools, computer systems. Production samples of the unmanned vehicles will differ from the prototype.

Duration of Project:

1 year

Team Composition:

Engineers, designers, software developers, researchers from the "Research and Development Bureau of Computing Systems" JSC, "Research and Production Complex "Onboard Intelligent Systems" JSC (Taganrog), "Innovative Control Systems" LLC (Kursk), as well as students and post-graduate students of the Southern Federal University and South-Western State University

The team includes:

5 machine vision specialists (with 1 Ph. D and 4 Ph. D candidates from the consortium of universities)

4 machine learning specialists (3 Ph. D and 2 Ph. D candidates)

6 robotics and mobile object control systems specialists (4 Ph. D);

4 millimeter-range radar specialists (2 Ph. D and 1 Ph. D candidates);

4 geoinformation systems specialists;

2 design engineers.

In addition, our team includes students of the MIPT–SDB CS Intelligent Transport Laboratory, created on the basis of the Applied Mathematics and Physics Science School in the Moscow Institute of Physics and Technology.

25 Participants

Average Age:

32 years

Brief Team History:

AUTO-RTK consortium was created to enter into the "Winter City" competition and currently includes engineers, designers, programmers and researchers from the Scientific Design Bureau of Computing Systems JSC (SDB CS JSC, Taganrog), Research and Production Complex "Onboard Intelligent Systems" JSC (RPC OIS JSC, Taganrog), Innovation Control Systems LLC (ICS LLC, Kursk), as well as students, graduate students and Ph. D candidates of the Southern Federal University and the Southwest State University. Development of intelligent transport components is a multidisciplinary field at the front edge of science and engineering. Furthermore, it is a rapidly developing market. Participation in this competition is a catalyst for development of unique competence centers in the companies and universities that are members of the consortium, which in our view will help create marketable innovative products and services for the autonomous vehicle market and related sectors. These factors were the driving force behind the creation of our consortium and our participation in the "Winter City" competition.

Base Vehicle Used:

KIA Soul

Competitive Advantages:

Wide range of participants' knowledge and experience

Main Technologies Used:

The unmanned vehicle (UV) developed for the competition actively uses the competences of the companies of our consortium in fields such as - machine stereovision (based on visible and IR range cameras), millimeter-range radar signals processing, light detection and ranging device data processing (LIDAR), and geoinformation data processing.

Future Plans for Technology Advancement:

We are planning on creating and commercializing a series of products and services intended for unmanned vehicles, which includes a line of "smart sensors" for intelligent transport, incorporating visible range stereo camera and millimeter-range radar which solve the challenges of road users, as well as traffic infrastructure object detection and recognition.

Needs:

The key problem of the project is the development of the control system components – it is limited by knowledge. Today there are no trained specialists which have worked on incorporating such projects into the market. We are open for collaboration with both individual specialists and development teams interested in establishing/breaking through to a market.

Applicable solutions and problems:

Member companies of AUTO-RTK consortium participating in the contest are involved in R&D efforts aimed at the creation of machine vision smart sensors intended for advanced driver assistance systems (ADAS), smart and autonomous transport.

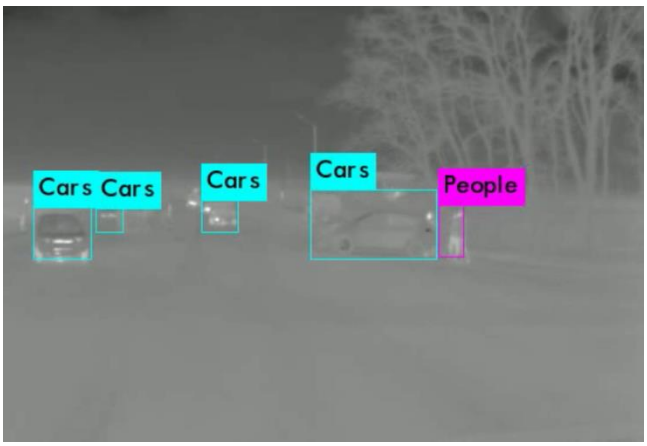
Particularly they are developing stereo camera prototype for obstacle detection, road infrastructure objects recognition (road signs, traffic lights and road markings), visual odometry (see the prototype in the figure below).

Visible range stereo camera prototype for smart and autonomous transport

Project challenges include:

- Search for the partner companies engaged in the development of the automotive-oriented video sensors with wide dynamic range capabilities;
- Search for the partner companies engaged in the development of the task oriented and power efficient ASICs for machine vision (including efficient implementation of artificial neural networks);
- Search for the partner companies interested in project results implementation.

Algorithms for the similar LWIR stereo camera prototype intended for traffic obstacles detection in low visibility conditions (fog, snow, rain, dust) are also under development.



The example of traffic obstacles detection algorithm operation based on LWIR stereo camera data processing

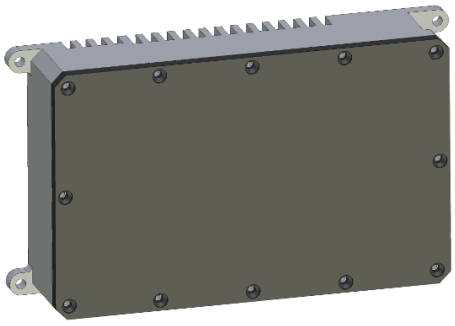
Project challenges include:

- Search for the partner companies engaged in the development of uncooled microbolometers having the price providing cost effective solution;
- Search for the partner companies interested in project results implementation.

The results of the work in the field of machine vision in visible and LWIR range are planned for integration into the unmanned vehicle prototype and for trials during the contest.

In the framework of these research efforts we would like to discuss the possibility of cooperation with such Israeli companies as AdaSKY (https://www.adasky.com/), Foresight (https://www.foresightauto.com).

Member companies of AUTO-RTK also develop MMW high-resolution radar intended for traffic obstacles detection.



MMW high-resolution radar prototype for traffic obstacles detection (under development)

Project challenges include:

- Search for the partner companies engaged in the development of the task oriented and power efficient ASICs for MMW radiolocation; we have the team of the experienced specialists in radiolocation signals digital processing and we look for unique solutions for our element base;
- Search for the partner companies interested in project results implementation.

In the framework of these research effort, for example, we would like to discuss the possibility of cooperation with Arbe Robotics (http://arberobotics.com/) Israeli company.

Another challenge for our consortium is virtual computer simulation for testing of algorithms used in our design solutions. There are many open projects but they don't match the requirements for realness of the synthesized scene image and for realness of various machine vision sensors (cameras, LUDARs, radars) characteristics simulation, and also for realness of vehicle dynamics simulation. Here we would like to discuss the possibility of cooperation with such Israeli companies as Cognata (https://www.cognata.com/).

Additional Information:

An introduction video can be found here.

StarLine

Saint Petersburg

Unmanned vehicle based on a car of Czech origin.

Thanks to smart technology, the car moves along the given route in autonomous mode, stays in its lane, assesses distances to surrounding objects, recognizes them, and can automatically brake during an emergency situation.

Duration of Project:

2 years

Distance Travelled During the Development Phase:

18,000 kilometres

Prototype Development Budget:

RUB 20M

Team Composition:

The main team members are comprised of specialists and academics who have internationally published works on their respective subjects.

Boris Ivanov – Head of Autonomous Driving Department

Andrey Alekseev – R&D Engineer

Anton Baburov — Sr. R&D Engineer

Dmitriy Demidov — System Architect

The working group includes experts in robotics, computer vision, embedded systems, and automotive electronics. Upon request, our team can get help from more than 800 StarLine employees with expertise in different areas, such as user interface development, manufacturing of electronics, plastic, and metal products.

Employees of the Russian-based NPO "StarLine"

8 Participants

Average Age:

28 years

Brief Team History:

The idea of the project was born in 2016 and was supported by the absolute majority of StarLine's employees and an initiative group was formed. During the year 2017, the team performed market research, formed a working group, and selected a platform for building the StarLine self-driving car. Thanks to the unique competencies of the company, the well-coordinated team, and the integration of unique equipment and technologies, by 2018 the car had already learned how to follow a given route in autonomous mode, stay in its lane, calculate the distance to objects, recognize them, and to slow down at once. In May 2018, the StarLine self-driving car participated in a test drive of self-driving cars on a specially prepared section of the Russian Federal highway, A-290. In the summer of 2018, many test drives were conducted, and in the autumn of the same year, the StarLine self-driving car participated in a 2,500-kilometer-long motor journey from Saint-Petersburg to Kazan. In February 2019, the team passed the qualification stage of the "Winter City" technological competition for self-driving cars, the purpose of which was to develop technologies for the safe

automatic control of self-driving cars in difficult climatic and road conditions. In June 2019, after the modernization of the car, repeated regional tests were carried out in 7 different cities of Russia with the view to verify the technologies implemented in the car and to collect data for a highly accurate map of Russian roads for self-driving cars. In July 2019, the team presented its project at the Skolkovo Institute of Science and Technology as part of the "Island 10-22" forum and organized a master class for participants of the Ice Vision international hackathon.

Base Vehicle Used:

Skoda Superb

Competitive Advantages:

An automatic control system enables high-speed data exchange/separation of control functions on different computers and successful "teaching" of the unpiloted vehicle.

Main Technologies Used:

The company's 30 years of experience in the field of development and production of electronics based on advanced world-class technologies, its considerable expertise in the field of automobile safety, automation, robotization, CAN, telematics and big data allowed to create an automatic control complex with the possibility of high-speed data exchange and distribution of control functions among different computers, it also made possible to successfully "train" of the self-driving car. We have realized comprehensive self-driving car localization method using sensor fusion of the information from different sensors; developed technology, storage format and tool set for creation and usage of high precision road map; detection and classification of rad infrastructure objects as well as obstacle detection and classification.

Future Plans for Technology Advancement:

The short-term plans include:

1. Further development of a localization system, including the improvement of complex algorithms for the integration of the information obtained from sensors and inertial navigation, introduction of visual and laser odometry.

2. Development of competences in the field of digital high-precision maps for laying-out itineraries and movements along them, development of a unified mapping system for self-driving cars.

3. Development of a system for situational assessment and prediction of the behavior of other participants in the traffic flow.

4. Adaptation of the solution for any platform (any type of car).

5. Integration of ADAS technologies into car security and telematic systems for the protection of any types of vehicle.

Problems:

We are looking for solid state LiDARs suitable for automotive applications. We have investigated and tested lot of different LiDARs available on the market and come to conclusion that conventional scanning LiDARs are not robust enough for the hard environmental and road conditions - high vibrations, low temperature, blooming effects on some road signs (material specific), etc. Our team is ready to test and validate new products, provide a comprehensive reporting.

Another point we are looking for is different ADAS systems (such as MobilEye) which we are planing to use as reference to counter check and benchmark our solutions.

Contact Information:

Our company website can be found here.

Dedicated site for our autonomous vehicle project can be found here.

BaseTracK

Moscow

Unmanned vehicle which executes set commands.

The car boasts unique technologies which prevent it from making independent decisions but allows the care to execute given commands and tasks.

Duration of Project:

10 months

Distance Travelled During the Development Phase:

10,000 kilometres

Team Composition:

Andrei Vavilin – Founder, Project Leader, Geo-map Specialist. 8 years in geoinformatics.

Anatoly Terskiy - Geoinformation Expert, Topographer with expansive experience in navigation and map resource creation. 35 years in geoinformatics.

Sergey Shadrin - R&D, Automation. Doctor of Technical Science (Expert in unmanned vehicle automation). 15 years in vehicle automation.

Ilya Klyuev - Product Developer, Head of Public Relations, Content Creator, and Business Developer. Has been the team manager for 5 years.

We are speakers and participants of the biggest automotive and CAD conferences - Autonomous Vehicle Technologies (Stuttgart) and FISITA (Chennai). BaseTracK has also been published in some international CAD magazines and in Scopus.3

Average age:

37 years

Brief Team History:

With expertise in geoinformatics from our previous business, we decided to implement our knowledge in a new area because we've found a new way to control vehicles. This new system addresses some major problems of classical approaches to autonomous driving.

Base Vehicles Used:

Chevrolet Cruze and Gazelle NEXT

Competitive Advantages:

System simplicity, the possibility of both partial and full vehicle automation, reliability and all-weather capability, low computing power requirements

Main Technologies Used:

The technology BaseTracK created does not use any sensors for visual recognition – only cameras. BaseTracK is based on sophisticated hybrid navigation which uses different high-accuracy positioning methods. A visually inconspicuous automation kit controls BasetracK; it is as if the cars drives on high-precision "railways". Driving routes that contain additional information provide optimal control of the vehicle based on requested transport tasks and traffic conditions. The methods and algorithms used to control the BaseTracK vehicles are patented.

Needs:

We need to collaborate with OEM or Automakers to implement our technology into vehicle control systems - for automation, fuel economy, and increased cybersecurity features. Technology can be used without deep integration, just like MobilEye - by providing warnings for lane keeping, or providing fuel economy, fleet management, and intelligent driver's KPI features. We need to work with a government to implement our solutions into public transport for increased safety and lane-keeping features.

Additional Team Information:

The BaseTracK delegation is heading to Israel (Tel Aviv & Herzliya) August 5th-20th and we would suggest conducting a meeting there. We would like to propose different kinds of projects for governments such as public transport safety and autonomous shuttle construction

Vehicle Demonstration

Problems:

BaseTracK develops the vehicle control technology that is based on our patented sophisticated hybrid navigation. That means that we can control any type of vehicles in adverse weather conditions even without sensors like cameras or LiDAR, while just computing power of a smartphone will be enough to make all the calculations for automated driving. We address the problem of localization.

As our pure technology doesn't require any visual recognition systems, we don't have enough expertise in visual recognition and AI, so we are forced to create our own AI-based solutions to win the "Winter City" challenge. We spend now a lot of time on creating something that some companies already developed.

For the "Winter City" challenge we are seeking for companies experienced in visual recognition systems and decision making algorithms. We are interested in partnership with those companies with "ready to go" solutions that can be quickly implemented in our shuttle bus to address the problem of obstacles detection and the vehicle's behavior in case of detecting such obstacles.

From our side we have a fully automated shuttle bus which is controlled by our algorithms based on "virtual rails" concept, also we can provide a data set that is necessary for understanding of the Russian road situation.

In case of successful collaboration in December we are ready to scale our partnership on other projects in Europe.

Contact Information:

www.basetrack.net

Winter City MADI (Moscow State Automobile and Road University of Technology)

Moscow

Unmanned vehicle with embedded optical stereo vision.

The unmanned vehicle features an automatic control system based on the concept of digital road modeling and optical stereo vision.

Duration of Project:

2.5 years

Distance Travelled During the Development Phase:

30,000 kilometres

Team Composition:

The team includes experts from the "Russian Institute of Radio-Navigation and Time" (RIRT), Design Bureau "Panorama", Skoltech, Laboratories of Microdevices, Axis, and NPO "Region".

9 Participants

Base Vehicles Used:

Ford Focus 2

1. The number of information channels - 10.

2. The frequency of control actions is 1-10 Hz.

3. The maximum speed in automated mode - up to 90 km / h.

4. Recognition of: road signs, road markings and other technical means of traffic management, cars, with their classification by classes (4 classes of vehicles), cyclists, pedestrians, large animals.

Competitive Advantage:

Advanced digital road modeling, different environment simulation, and we also have our own test field as well as material and technical facilities.

Main Technologies Used:

Self-driving technology includes:
1. Domestic technology of high-precision positioning of automated vehicles, providing automatic operation from a distributed network of base stations (automatic switching between base stations), optimized for high-speed ground objects;
2. Inertial navigation technology adapted for automated vehicles, operating on its own vehicle model;
3. Technology of high-precision positioning according to lidar data;
4. The technology of the “Digital Road Model”, which provides traffic management and situational awareness in the mixed traffic flow;
5. Technology of technical stereo vision;
6. Model of the road scene;
7. Predictive model of the automated vehicle movement, with a prediction depth of 15 sec. offline and up to 15 min. in conjunction with «Digital Road Model»;
8. The author’s technology for taking into account the human factor in the automated vehicle movement model, which ensures safe movement in a mixed traffic stream consisting of vehicles of various levels of automation

9. The technology of protection against unauthorized access, working on the author's model of threats and a risk matrix.
Car design.
2 high-resolution cameras designed to recognize traffic situations, a 64-beam Velodyne Lidar lidar, ultrasonic sensors of near-radius detection, a high-precision positioning system based on a GNSS receiver and an inertial navigation system. All data is sent to a server rack located in the luggage compartment and consisting of several servers based on Intel Zeon and video accelerators Nvidia.

Future Plans for Technology Advancement:

We plan to scale up production and test our systems on other vehicles before bringing our unique technology to the autonomous car market.

Additional Team Information:

An article on our team's participation in the "Winter City" contest can be found on the MADI website. The website also provides a more detailed description of the car and its hardware.

Problems:

To improve our result, we need a hardware-software complex for obtaining a colored cloud of dots using cameras. It is also desirable to recognize points by color cloud (no worse than F / HD) with an accuracy of no worse than 10 cm (position, dimensions) no worse than 15 frames per second of the following objects:

- Road signs;
- Road marking;
- Traffic lights;
- elements of the road (roadway, pavement, curbstone, curb, etc.);
- vehicles (at least 4 classes);
- cyclists;
- pedestrians;
- large animals.

For stationary objects, their position and dimensions are necessary.
For mobile objects are necessary: position, dimensions, direction and speed. Providing mutual positioning of objects is desirable.
In any case, any strengthening of our positions within the framework of the "Winter City" or the automated vehicle industry as a whole, as well as any joint work in the field of automated vehicles, is very interesting to us.

Contact Information:

Our website can be found here.