ARTIQ

ARTIQ - AI Centres of Excellence

Application for a Host Institution

Institution	National Centre for Research and Development, National Science Centre
Project Joint National Project:	ARTIQ – AI Centres of Excellence
Deadline for the submission of applications	8th of April-11th of May 2021

I. HOST INSTITUTION DATA

Identification data of the Host Institution

Name (full)	*Sieć Badawcza Łukasiewicz - Przemysłowy Instytut Automatyki I Pomiarów PIAP*
Name (short)	*Łukasiewicz – PIAP*
Name of the main organisational unit (where applicable)	
Address of the registered office	
Street	Aleje Jerozolimskie
Building No.	*202*
Office No.	
Postal code	*02-486*
City/district	*Warsaw / Włochy*
Post office	*Warsaw*
Municipality	*Warsaw*
County	*Poland*
Province	*Mazovian*

Correspondence address (if different than the address of the registered office)	
Street	
Building No.	
Office No.	
Postal code	
City/district	
Post office	
Municipality	
County	
Province	
EPUAP [Electronic Platform for Public Administration Services] mailbox	*/Lukasiewicz-PIAP/SkrytkaESP*
Legal form	*Research Institute*
The person appointed for contact with NCBR and with the potential Leader/Project Manager	
First name	*Bartosz*
Last name	*Blicharz*
Position	*Engineer*
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The person authorised to represent the applicant	
First name	*Piotr*
Last name	*Szynkarczyk*
Function/Position	*Director*

II. CAPACITY OF THE HOST INSTITUTION TO PERFORM THE PROJECT

1. Description of major research achievements in the scope of implementation of R&D projects, as well as the commercialisation of deliverables of such projects regarding artificial intelligence for the last 5 years

List of the most significant projects:

1. *Autonomous system for off-road land vehicles with Atena target tracking function*
2. *Development of a highly mobile unmanned hybrid vehicle for rapid response tasks (acronym: Hunter)*
3. *A system of intelligent, mobile shooting cells with an advanced hit detection system and modern composite protective armor. (acronym: MOBI-TARGET)*
4. Advanced holistic detection, identification and neutralization of harmful drones - Advanced hoListic Adverse Drone Detection, Identification and Neutralization (acronym: ALADDIN)
5. Open Framework for Embedded Robot Applications *(acronym: OFERA)*

List of the most significant publications:

1. Mateusz Maciaś, Adam Dąbrowski, Jan Fraś, Michał Karczewski, Sławomir Puchalski, Sebastian Tabaka, Piotr Jaroszek: „*Measuring Performance in Robotic Teleoperation Tasks with Virtual Reality Headgear*",Springer International Publishing, Automation 2019/Springer, Vol. 920;
2. Bigaj P., Bartoszek J.: „*On Automatic Metric Radio Map Generation for the Purpose of WiFi Navigation*", PIAP, Journal of Automation, Mobile Robotics & Intelligent Systems – JAMRIS, 2017, Vol. 11, nr 3, str. 62-73;
3. Czarnowski J.,Dąbrowski A., Maciaś M., Główka J., Wrona J.: "*Technology gaps in Human-Machine Interfaces for autonomous construction robots*", Automation in Construction, Volume 94, October 2018, Pages 179-190;
4. J. Fras, Y. Noh, M. Macias, H. Wurdemann and K. Althoefer, "Bio-Inspired Octopus Robot Based on Novel Soft Fluidic Actuator," 2018 IEEE International Conference on Robotics and Automation (ICRA), 2018, pp. 1583-1588;
5. Maciaś M. et al. (2020) Measuring Performance in Robotic Teleoperation Tasks with Virtual Reality Headgear. In: Szewczyk R., Zieliński C., Kaliczyńska M. (eds) Automation 2019. AUTOMATION 2019. Advances in Intelligent Systems and Computing, vol 920. Springer;
6. Słomiany M., Gemza P., Jędrzejczyk F., Maciaś M., Główka J.: "System for Detection of Vehicles in Multiple Video Streams in Road Infrastructure Monitoring", Automation 2020: Towards Industry of the Future. AUTOMATION 2020. Advances in Intelligent Systems and Computing, vol 1140. Springer;
7. Sprońska A., Główka J., Maciaś M., Rokosz T. (2014) TALOS – Mobile Surveillance System for Land Borders and Large Areas. In: Szewczyk R., Zieliński C., Kaliczyńska M. (eds) Recent Advances in Automation, Robotics and Measuring Techniques. Advances in Intelligent Systems and Computing, vol 267. Springer.

List of patents:

In 2016-2021, PIAP obtained 130 patents and 3 protection rights for utility models, 10 trademarks and 4 industrial designs, and submitted 37 inventions, 9 trademarks and 4 industrial designs. PATENTS, including:

- Device for monitoring transport conditions, no: PAT.223626, date of granting: 11.01.2016.
- Control console, patent no .: PAT.223562, date of granting: 13.01.2016.
- Mobile device for transporting vehicles, patent no .: PAT.223988, date of granting: 23.03.2016.
- Information system about the possible time of travel by car on a selected road section, patent number: PAT.224569, date of granting: 09.06.2016.
- Quick replacement system for electric vehicle power unit, patent number: PAT.224319, date of granting: 18.07.2016
- Device for measuring forces and force moments transmitted by the road wheel of the vehicle, patent number: PAT.224944, date of granting: 16.08.2016.
- Control device with 6 degrees of freedom, patent no .: PAT.225105, date of granting: 02.09.2016
- Vehicle traffic control system, patent no .: PAT.225453, date of granting: 08.11.2016
- Outdoor Object Detection System, No: PAT.225517, date of granting: 09.11.2016
- System for servicing autonomous mobile stations, patent no .: PAT.225559, date of granting: 18.11.2016.
- Portable control console, patent no .: PAT.226059, date of granting: 20.12.2016.
- Tire punching device, patent no .: PAT.231042, granted on: 01.10.2018

2. A list of 5 research and development projects within national and international competitions in the area of artificial intelligence and implemented within the last 5 years

Title: Autonomous system for all-terrain ground platforms with target tracking function (acronym ATENA)
Institution (Project Manager): *Łukasiewicz - PIAP (Rafał Więckowski)*
Financing Source: Scientific research program for the defense and security of the state titled: "Future Technologies For the Defense - Competition of Young Scientists", number DOB-2P/02/13/2018
The amount of the grant / duration of the project: 3 670 000 PLN / 07.2018 – 01.2021
Purpose of the project: development of an autonomous system for mobile land vehicles that will enable autonomous following of the selected object. ATENA can be installed on a variety of mobile platforms such as cars, robots and quads. Vehicles equipped with the ATENA system can operate in off-field terrain, without the need to use maps or navigation, based on learning algorithms and machine vision

Title: ***Open Framework for Embedded Robot Applications (acronym OFERA)***
Institution (Project Manager): *Łukasiewicz - PIAP (Tomasz Kołcon)*
Financing Source: *Horyzont 2020 –* "Advanced robot capabilities research and take-up"
The amount of the grant / duration of the project: 2.940.920 EUR / *01.01.2018-31.12.2021*
Purpose of the project: creating a micro-ROS environment that will extend the ROS (Robot Operating System) ecosystem to microcontrollers, enabling easy integration of sensors and other devices with robotic systems.

Title: Development of a highly mobile unmanned hybrid platform for rapid response tasks (acronym HUNTeR)
Institution (Project Manager): *Łukasiewicz - PIAP (Tomasz Krakówka)*
Financing Source: Operational Program Innovative Development 2014-2020 co-financed by the European Union under the European Regional Development Fund; Measure 1.2 "Sectoral R&D Programs"
The amount of the grant / duration of the project: 7.835.598,91 PLN / 01.2017 – 12.2019
Purpose of the project: Development of a robotic mobile vehicle (UGV) to support interventions, e.g. incursions at the state border. The platform achieves high speeds of approx. 50 km/h and is characterized by the ability to overcome various terrains and provide the possibility of silent operation.

Title: System of smart mobile shooting targets with an advanced hit detection system and composite protective armour (acronym MOBI-TARGET)
Institution (Project Manager): *Łukasiewicz - PIAP (Sebastian Pawłowski)*
Financing Source: Operational Program Innovative Development 2014–2020 co-financed by the European Union under the European Regional Development Fund; Measure 1.2 "Sectoral R&D programs"
The amount of the grant / duration of the project: 5 273 040,70 PLN / 01.2017– 12.2019
Purpose of the project: Product development in the form of a system of mobile shooting targets with a hit detection system and protective armor for the implementation of various shooting scenarios. The system was built on UGV vehicles with an automatic route planning system based on the entered points on the scenario map.

Title: ***Advanced hoListic Adverse Drone Detection, Identification and Neutralization (acronym ALADDIN)***
Institution (Project Manager): *Łukasiewicz - PIAP (Jakub Główka)*
Financing Source*: Horyzont 2020 – SEC-12-FCT-2016-2017 - "Technologies for prevention, investigation, and mitigation in the context of fight against crime and terrorism"*
The amount of the grant / duration of the project: 4.998.240 EUR / 01.09.2017 – 31.12.2020
Purpose of the project: As part of the ALADDIN project, research, elaboration, development and evaluation of the drone neutralization system were carried out, based on available systems and enriched with innovative technologies and functionalities, including: 1) paired 2D / 3D radars; 2) innovative panoramic, opto and thermal imaging using AI techniques; 3) specially designed acoustic sensors.

3. Available research equipment, apparatus/infrastructure and intangible assets held in the context of implementation of a project regarding artificial intelligence

The Łukasiewicz Research Network - Industrial Institute for Automation and Measurements PIAP has complete research equipment necessary for the implementation of research and development works related to the development of broadly understood autonomy of mobile vehicles and cars as well as the creation and training of neural networks. The key research equipment, apparatus and infrastructure include:

- Two autonomous cars based on FORD Ranger vehicles. The vehicles are equipped with a proprietary Drive-by-Wire system and an autonomy controller, each equipped with 4 VLP 16 LiDAR sensors, 7 Basler cameras with dedicated lenses, road-class Delphi (mmWave Radar) microwave radar, IMU Xsens inertial navigation system, edge computing unit, autonomy driver equipped with a computing accelerator using nVidia GPU technology (GPU, edge computing);
- High-mobility Hunter unmanned vehicle with a weight of 3.5 tons and a maximum speed of 50 km/h, with hybrid power (electric drive and combustion generator) and equipped with an autonomy system consisting of 3 LiDAR VLP 16 sensors, vision and thermal imaging cameras, precise GNSS navigation module. The vehicle is characterized by great off-road reliability, allowing for research, e.g. in off-field and unstructured terrain.;
- 4 pieces of mobile vehicles with removable bulletproof armor, each equipped with an efficient computing unit and Intel GPU co-processor, depth and stereoscopic cameras, a precise GPS system connected to an external RTK station and a module for planning the passage of many robots in one scenario based on the points indicated on the map;
- Own design of the mobile control console based on the INTEL i7 architecture with HMI interface: voice control and gesture detection function;
- Computing server equipped with 4 high-performance nVidia graphics processors designed to work with neural networks;
- Mobile Robot Operators Center, in a container construction on a DAF LF truck, equipped with a closed working space resistant to weather conditions and equipped with a local and external radio communication system, along with an additional communication mast and an electricity generator, for conducting research in the field, independent of access to the electricity network.
- Test stand for mobile robots developed in accordance with the guidelines developed by the NIST institute in the USA. The stand allows to measure and compare the efficiency of autonomous and teleoperated solutions in performing typical tasks for small mobile robots.
- A server base for research and development in the field of software with the use of Continuous Integration techniques (CI stands for Continuous Integration process) and Continuous Delivery (CD stands for a “continuous delivery” process) when operating in an environment in which the developed solutions are continuously tested.
- Industrial manipulators, including those with many degrees of freedom, adapted to work in an environment shared with operators, the so-called "Cobots". The open test stand is equipped with a robot with 7 degrees of freedom, a reach of 700 mm, a precision better than 0.1 mm and load capacity of 5 kg.
- Cubert Q285 - FireflEYE QE hyperspectral shutter camera

4. Facilities or incentives to establish an AI Centre of Excellence in the entity

Łukasiewicz - PIAP is a member of the Łukasiewicz Research Network - the third largest research network in Europe. The research network brings together 33 Institutes, employing a total of 4,500 employees, 270 of whom are employed by Łukasiewicz - PIAP.

The Łukasiewicz Research Network - Industrial Institute for Automation and Measurements PIAP has unique research equipment in terms of the development of artificial intelligence systems for the purposes of broadly understood vehicle autonomy, mobile robotics, image processing and industrial applications. A good base for development are modified FORD Ranger vehicles, equipped with an object tracking system, developed at the TRL 6 technology readiness level. The vehicles have a proprietary drive by wire system. The autonomy module works here based on the construction of a 3D map of the environment and real-time obstacle detection. The second vehicle ready for development is the highly mobile Hunter vehicle, equipped with hybrid power, a teleoperation module in the form of a 6 DoF vehicle (Degrees of Freedom), increasing the operator's situational awareness and providing a feeling of movement occurring on the vehicle, and an autonomy module at the level of crossing points indicated in combination with GNSS navigation and obstacle detection. On the other hand, the Mobi-Target vehicle has the function of automatic route planning using GPS and visual distance measurement and avoiding of collisions between robots moving in the same area of operation. In addition, the institute has extensive experience with the use and integration of the most modern robotic manipulators in industrial applications, as well as with the use of distributed and dedicated sensor systems built during research and commercial orders.

Łukasiewicz - PIAP together with a market partner implements an autonomous vehicle system for lighting inspection at the airport. Solution tests are conducted in a separate research area for testing mobile platforms located at the Institute. Larger tests are carried out on an external testing ground, with a varied terrain equipped with obstacles and a 1.5 km long straight road belt. To ensure comfort during the tests, the Mobile Robot Operator Center is used. It is a truck, equipped with a built-in container, space for transporting robots and positions for operators, and its own electricity generator.

Projects implemented by the Institute concern both civil and military fields. The group of recipients includes both production plants (in the case of robotization of consumer processes or devices) and uniformed services (including the army, police, fire brigade, border guard).

The location of Łukasiewicz - PIAP in Warsaw, ensures access to the largest companies involved in the development of artificial intelligence. Most of the large concerns have their research and development centers in Warsaw.

Łukasiewicz - PIAP has its own Conference Center, where it is possible to organize meetings of working groups and conduct scientific conferences. The international Automation conference is held here every year, the publishing partner of which is the Springer publishing house. The tele-conference is held during the Automaticon automation fair, organized by Łukasiewicz - PIAP. The fair is an ideal opportunity to meet and expand cooperation between science and business. Łukasiewicz - PIAP also has its own scientific publications, including the national magazine Pomiary Automatyka Robotyka and the international JAMRIS.

5. Other information concerning internationalisation of the entity, foreign scientists employed in this institution, availability of seminars in English, etc.

Łukasiewicz - PIAP has extensive experience in cooperation with partners in the European arena. Among the most important centers with which projects were submitted, we should mention VTT, FGI, Future Compta, AIRBUS, BOEING, BOSCH, BAE Systems, Thales, GMV, Shadow Robot Company, DFKI, FFI, TNO, IIT, Scola Superiore Santa Anna oraz Tecnalia.

Research and development projects were obtained with many of the above-mentioned entities. The largest international projects implemented include projects implemented in the ICT (Information and Communication Technologies) path under the recent FP7 and H2020 programs conducted by the European Commission. These are projects such as: IRPS, R5COP, Stiff-Flop, RobotUnion, OFERA, April, Vojext. In all these projects, the institute's budget ranged from EUR 240 thousand to over EUR 500 thousand, and the institute carried out and carries out tasks related to the implementation of artificial intelligence technologies in various practical applications of robots. In addition, the institute participated in international projects related to the subject of security (the "Security" path in FP7 and H2020) and defense as part of projects run by EDA. Among some of them, Łukasiewicz - PIAP acted as a coordinator.

Łukasiewicz - PIAP actively participates in European research groups, especially in the field of industrial and mobile robotics. The most significant groups include: NATO STO IST-179 on Interoperability for Semi-Autonomous Unmanned Ground Vehicles, NATO STO AVT-341 on Mobility Assessment Methods and Tools for Autonomous Military Ground Systems, NATO STO SCI-342 RTG Explosive Ordnance Disposal (EOD) Tele-manipulation Robot Technology Roadmap Development oraz NATO STO AVT-308 on Cooperative Demonstration of Technology (CDT) for Next-Generation NATO Reference Mobility Model (NG-NRMM), where representatives of Łukasiewicz - PIAP act as panel members and experts in the field of robotics.

Łukasiewicz - PIAP is an active member of the partnership of the eu-Robotics association. The aim of the work of this group is to develop effective action plans for the development of European robotics as well as to exchange experiences and establish effective international cooperation between scientific and research entities as well as small and large companies. Currently, this association plays a key role in co-creating the AI, Data and Robotics partnership, which cooperates with the European Commission in planning the research program at Horizon Europe.

Every year, an international conference AUTOMATION is organized in Łukasiewicz - PIAP, held in Polish and English. The conference is under the scientific patronage of the Automation and Robotics Committee of the Polish Academy of Sciences and the scientific and technical patronage of the Polish Association of Measurements, Automation and Robotics POLSPAR. Conference materials are published by Springer and indexed in Web of Science. Over 100 scientists and engineers from Poland and abroad (incl. Lithuania, Ukraine, Great Britain, USA, Greece, Denmark) participate every year. During the conference, the topics of automation are discussed, including control theory, robotics, signal processing systems and measurement techniques, broadly understood new technologies and artificial intelligence. Łukasiewicz - PIAP has its own scientific journals Pomiary Automatyka Robotyka PAR (ISSN 1427-9126) published in Polish and Journal of Automation, Mobile Robotics and Intelligent Systems JAMRIS (ISSN 1897-8649) published in English, publishing reviewed articles in the field of automation, robotics and intelligent systems, including artificial intelligence.

The institute employs not only Polish, but also European scientists. This group includes 3 people from Ukraine or France. Employees have often developed their competences at the institute and defended their doctoral dissertations. One of the aforementioned team currently holds the position of team leader.

6. Other significant information confirming the experience and resources of the institution

Łukasiewicz - PIAP employs in its teams specialists with extensive experience in many engineering specializations, including mechanics, electronics and programmers, as well as research staff. The institute's staff is competent in creating complete products. For example, mobile robots, both in the area of mechanical and electronic structures, control systems, communication and power supply, and accessories, are entirely created by a team of engineers employed at the institute. Complementarity of competences enables the effective implementation of even the most complex research and commercial projects. Łukasiewicz - PIAP employees are often authors of specialist studies and training courses for entrepreneurs in Poland and abroad, including research done for well-known global corporations.

If necessary, the team can count on the support (hardware and human resources) of the other 32 institutes that are part of the Łukasiewicz Research Network, in particular Łukasiewicz - Institute of Innovative Technologies EMAG and Łukasiewicz - Institute of Logistics and Warehousing (ILIM), and external partners. The Łukasiewicz Research Network - Institute of Innovative Technologies EMAG operates in the field of ICT, in particular, it carries out research and implementation works in the following areas: building decision support systems, medicine, natural language processing, predictive maintenance and event forecasting, including cybersecurity. The Łukasiewicz Research Network - Institute of Logistics and Warehousing is a leader in logistics, warehousing and optimization, including the supply chain. The Łukasiewicz Research Network institutes develops solutions in the field of research on AI applications in the above-mentioned areas, and the results of their work often end with implementation. Łukasiewicz - PIAP, within the Łukasiewicz Research Network, is albo a member of the Digital Transformation and Smart Mobility research group, which focus on digitalization of all processes pending in the group.

Thanks to effective cooperation in Research and Development as well as commercial projects, Łukasiewicz - PIAP also has a wide network of contacts among entrepreneurs and uniformed services. This is confirmed by nearly one hundred completed orders for robotization of production processes in enterprises and large orders for the supply of mobile robots for the army (including Balsa - 52 robots and RPP - 35 robots). The value of the contracts implemented often exceeds EUR 15 million. In addition to products in the form of mobile robots, Łukasiewicz - PIAP effectively provides CBRNE and forensic accessories for services, produces railway tachographs and the universal UDAM measurement module, compliant with Industry 4.0 standards.

The Institute also has its own shooting range. It carries out activities related to testing the use of firearms. Łukasiewicz - PIAP is authorized to conduct licensed activities. In addition to the shooting range, test works are carried out on a test site intended for the safe testing of mobile vehicles, equipped with terrain obstacles in the form of hills and ditches, ramps and various surfaces. Tests requiring more space are carried out on an external testing ground.

Products manufactured by Łukasiewicz - PIAP win many prestigious awards at national and international fairs and exhibitions. The most important of them include: the "Crystal Brussels 2018" Award 20 years of Poland in the EU Research and Innovation Framework Programs in the Science Research Institutes category awarded by the Minister of Science and Higher Education - Jarosław Gowin), Honorary badge for special merits in the field of invention awarded by the Prime Minister Mateusz Morawiecki , Gold Medal of the International Exhibition of Intellectual Property, Inventions, Innovation and Technology in Bangkok for the IBIS® robot or the EUROINVENT Gold Medal - European Exhibition of Creativity and Innovation for the Autonomous Air Defense System ASBOP-PERKUN.