Educational robotic arm with support for artificial intelligence algorithms

LABOTRIX ARM R1

PRODUCT PASSPORT

Kyiv

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Contents

1. General Information about the Product

1.1. **Product name** — Educational Robotic Manipulator with Artificial Intelligence Algorithm Support.

1.2. **Trademark** — Labotrix.

1.3. **Model** — Arm R1; full trade designation — LABOTRIX ARM R1.

1.4. **Manufacturer** — Labotrix Group Limited, China.

1.5. **Intended use:** robotic arm Labotrix Arm R1 — a desktop multifunctional robot for practical study of the fundamentals of robotics, automation and artificial intelligence algorithms in educational institutions. The product is used in computer science and technology lessons and in club and project activities for teaching block-based and text-based programming, and for studying coordinate systems and the kinematics of the manipulator. The built-in machine vision camera, together with the software, implements artificial intelligence algorithms for recognizing objects, colors and gestures, and the manipulator performs movement based on the result of such recognition. The Python text programming environment additionally allows implementing and testing custom motion control algorithms — conditional logic, decision trees, action sequence planning — as part of an in-depth study of computer science. Through the interface unit, the manipulator works paired with a personal computer or tablet — via a wired USB connection or a wireless Bluetooth channel — transmitting data about its state and receiving motion control and process display commands in real time.

1.6. **Design features:** The robotic arm has four controlled joints — a rotating base, shoulder, forearm and end effector unit, as well as a manual drive-unlock button for teaching points by hand movement. End effectors (a suction cup with a built-in air pump, a pneumatic gripper, a holder for a pen or marker) are installed into the socket at the end of the forearm without tools, until the latch clicks. The operating mode is shown by the LED indicator on the base. For extended capabilities, a separate interface unit with ports for sensors, stepper motors and other external modules is provided.

1.7. **Digital learning support:** together with the product, the right of access to an online teaching support course is transferred; the course is hosted in a learning management system (LMS) and is designed for 70 academic hours of lessons. The course is compiled to match the current curricula of general secondary education institutions of Ukraine. The materials are grouped into research modules in the subjects of physics, biology, chemistry, STEM and robotics, and every topic contains a lesson plan, a list of the required equipment, an experiment scenario, a step-by-step laboratory work instruction with an explanation of the expected result, a video demonstration of working techniques, interactive exercises and tasks for independent study, suitable both for individual and for group work. All modules are compiled for this very equipment and have been tested on it, therefore the course works along the direct chain "equipment → methodology → learning outcomes". A language-model-based assistant with retrieval over the course knowledge base (Retrieval-Augmented Generation) is built into the course: for the topic of the lesson it selects appropriate tasks, sets out the sequence of conducting the study in methodological terms, examines typical student errors and gives personal

advice on how to get rid of them, changes the level of difficulty to match the preparation of a particular class and helps to draw up a report on the study and to organize the conclusions. The knowledge base of the assistant is localized and aligned with the Ukrainian curriculum. The license for the course and the accompanying software is valid for 12 months from the date on which access is transferred; the content, the interface and the answers of the assistant are provided exclusively in Ukrainian.

2. Technical Specifications

- Brand — Labotrix
- Model — Arm R1
- SKU — LTX-ARM-R1
- Product type — desktop multifunctional educational robot-manipulator
- Number of degrees of freedom (piece) — 4 (joints J1–J4: base, shoulder, forearm, rotation of the end effector unit)
- Rotation range of joint J1, base (degree) — from −135 to +135
- Rotation range of joint J2, shoulder (°) — from −5 to +80
- Rotation range of joint J3, forearm (°) — from −10 to +85
- Rotation range of joint J4, end effector (°) — from −135 to +135
- Maximum reach, working area radius (mm) — 340
- Maximum payload (g) — 250
- Positioning repeatability (millimeter) — ±0.2
- Mains supply voltage — 100–240 V AC (50/60 Hz)
- Power input — 12 V DC, up to 5 A
- Connection to a personal computer or tablet — USB, virtual serial port (wired connection)
- Maximum power consumption (W) — 60
- Additional communication channel of the interface unit — Bluetooth (wireless connection to a computer or tablet)
- Microcontroller of the switching unit — 32-bit, ARM Cortex-M4 architecture
- Text programming language — Python
- Programming methods — block-based programming and text scripts
- Controlled 12 V power interfaces on the interface unit (pcs) — 2, current up to 3 A
- Multifunctional 10-pin communication connectors on the interface unit (pcs) — 2
- Universal input/output interfaces on the interface unit (pcs) — 6
- Interfaces for stepper motors on the interface unit (pcs) — 2
- Joint drive overload protection — in the event of a prolonged excess of the permissible force, the interface unit controller automatically reduces or cuts off power to the corresponding drive
- Detection of a link collision with an obstacle — by deviation of the actual position from the set trajectory, with automatic drive stop and an indicator signal on the manipulator's base
- Limit position indication — LEDs on the manipulator's base signal that a joint has gone beyond the working area
- Motion preview in the software environment — the set sequence of commands can be played back on a digital model of the manipulator on the computer screen before running it on the product itself

- Operating temperature (°C) — from −5 to +45
- Machine vision camera sensor and resolution — 1/4 inch, 1 MP
- Camera video signal quality — up to 1280 × 720 pixels at 30 frames per second, supported frame sizes 240 × 320, 640 × 480 and 1280 × 720, YUV or MJPG compression
- Camera rotation angle relative to the mount (°) — from 0 to 135
- Interface for connecting the camera to the interface unit — USB 2.0
- Camera supply voltage (V) — 5, DC
- Camera operating temperature range (°C) — from 0 to +50
- Camera overall dimensions (mm) — 50 × 44 × 25; additionally — a built-in microphone and a lens that produces an image without geometric distortion
- Camera-based recognition — artificial intelligence algorithms for recognizing objects, colors and gestures, with subsequent manipulator motion control based on the recognition result
- Product marking — trademark, model and a space for the inventory number
- Packaging — an individual hard case with fixing foam inserts for the manipulator and accessories
- Documentation supplied — product passport with warranty card and operating manual
- Ready-to-use condition — supplied assembled, requires only installation of the end effector
- Care of the surfaces — wiping with a dry or slightly damp cloth is permitted
- Language of the operating documentation — Ukrainian
- Digital learning support — online course in a learning management system (LMS)
- Course volume (academic hour) — 70
- Course subjects — physics, biology, chemistry, STEM, robotics
- Composition of the materials — research modules, experiment scenarios, step-by-step laboratory work instructions, video demonstrations, interactive exercises and tasks
- Compatibility of the materials with the equipment — full, along the chain "equipment → methodology → learning outcomes"
- Language-model-based assistant — built into the course, with retrieval over a localized knowledge base (Retrieval-Augmented Generation)
- Validity period of the license for the course and the software (month) — 12
- Language of the course, of the interface and of the answers of the assistant — Ukrainian
- Service life (year) — 5
- Warranty period (month) — 12
- Product weight (kg) — 2.4

3. Package Contents

- Robotic arm with a built-in air pump — 1 pcs
- Interface unit — 1 pcs
- Suction cup set (default end effector), suction cup diameter 20 mm — 1 pcs
- Pneumatic gripper set, maximum jaw opening distance 50 mm — 1 pcs

- Interchangeable holder for a pen or marker (rod diameter 8–12 mm) complete with a handle — 1 set
- Power supply unit 12 V / 5 A with mains cable — 1 pcs
- USB cable for connection to a computer — 1 pcs
- Power cable for connecting the manipulator to the interface unit — 1 pcs
- Communication cable for connecting the manipulator to the interface unit — 1 pcs
- Machine vision camera with a connection cable — 1 set
- Right of access to the online course with a language-model-based assistant (license) — 1 pcs
- Operating instructions — 1 set
- Product Passport and Warranty Card — 1 pcs
- Individual transport packaging — 1 pcs

The guide rail for extending the working area, additional sensors, conveyor, joystick and other ecosystem modules are not included in the minimum set and are supplied separately. The product does not require assembly, except for installing the selected end effector into the socket on the forearm and connecting the camera to the interface unit.

4. Safety Precautions

4.1. General requirements

- Before using the robotic arm for the first time, read this passport, this section first of all, and thereafter keep the document together with the product.
- Work with the robotic arm is permitted for the teacher or another staff member who has undergone occupational safety instruction; students work with the product only under the supervision of an adult.
- After unpacking, inspect the manipulator, interface unit, cables and end effectors for the absence of mechanical damage; using a damaged product is prohibited.
- Use the robotic arm only within the declared technical specifications and loads: exceeding them shortens the service life of the product and may put it out of order.
- The package contains small parts — keep them in a place out of the reach of children.
- Do not leave the robotic arm switched on unattended; switch the power off immediately after the end of the lesson.

4.2. Working area and safety during movement

- Install the manipulator on a level, stable surface; the entire working area within the maximum reach must be free of foreign objects, tools and personal belongings.
- While the program is running, students and bystanders must stay outside the manipulator's working area.
- Do not keep your hands in the working area while the links are moving — this may lead to bruising or pinching of the fingers.
- Keep a personal watch on the manipulator's movement: if a link encounters an obstacle and cannot complete its movement, immediately turn off the power with the button on the base — prolonged resistance against the drive may cause it to overheat.

- If a joint moves beyond the permissible range of motion, the indicator lights up red and the movement stops; before continuing operation, manually move the link back within the working area using the unlock button.
- During shutdown, the forearm continues moving to the final position for some time — do not keep your hands in the working area until the indicator goes out completely.
- Before connecting or disconnecting cables or the end effector, completely turn off the manipulator.

4.3. Electrical safety

- Connect the manipulator and the interface unit only to the standard power supply unit — input voltage 100–240 V AC (50/60 Hz), output voltage 12 V DC; using other power sources is prohibited.
- Protect the power supply unit and the cables from mechanical damage, moisture and heating; do not use the product with a damaged cable or plug.
- Do not connect or disconnect the power and communication connectors while the product is switched on.
- Do not immerse the manipulator, interface unit or power supply unit in water, and do not allow liquid to get inside the housings and connectors.

4.4. It is strictly prohibited

- Disassembling, repairing or modifying the manipulator and interface unit on your own — in case of malfunction, contact the seller or service center.
- Exceeding the maximum payload on the end effector and forcing the links beyond the limits of the working area.
- Leaving children unattended with the manipulator switched on, or allowing them to install or remove end effectors on their own.
- Directing the compressed air jet of the pneumatic gripper or suction cup at people and animals.
- Cleaning the product with aggressive (corrosive) agents or immersing anodized parts in liquid.
- Operating the product outside the declared operating temperature range or in conditions of elevated humidity.

5. Preparation for Use

5.1. Unpack the manipulator, interface unit and accessories, remove the transport locks and protective film. We recommend keeping the packaging for further transportation.

5.2. Check the completeness of the package contents against section 3 of this passport, and inspect the manipulator, interface unit, cables and end effectors for the absence of mechanical damage.

5.3. Install the manipulator on a level, stable, horizontal surface so that the entire working area, with a radius of up to 340 mm, remains free of foreign objects.

5.4. Connect the manipulator to the computer with a USB cable directly, or through the interface unit using separate power and communication

cables; if necessary, install on the computer the equipment driver utility program supplied together with the software environment.

5.5. Connect the standard power supply unit to the manipulator or to the interface unit and plug it into the mains; turn on the product with a short press of the power button and wait until the indicator lights up green.

5.6. Before the first task, remove the end effector, make sure that the working area is clear and perform the return to the initial point so that the coordinates of the robotic arm become correct.

5.7. Install the required end effector — a suction cup, gripper or writing holder — into the socket at the end of the forearm until the latch clicks; for pneumatic effectors, connect the air tube to the pump.

6. Operating Procedure

6.1. Connection and switching on

- The manipulator is connected to the computer directly with a USB cable, or through the interface unit — in that case, the manipulator is connected to the interface unit with power and communication cables, and so is the computer or tablet (via a wired connection or a wireless Bluetooth channel).
- Turn on the product with a short press of the power button: a short sound signal will be heard, the yellow start-up indicator will light up, and after startup is complete — the green normal-operation indicator.
- If, after power-on, the indicator is lit red, the manipulator is in the limit position: press and hold the unlock button on the forearm, smoothly move the manipulator back within the working area, and release the button.
- If the drive of one of the joints is overloaded for a prolonged period, or a link encounters an obstacle and cannot complete its movement, the indicator likewise lights up red, and power to that drive is automatically reduced: remove the obstacle or reduce the load, and only then resume operation.

6.2. Return to the initial point

- Before the first movement and after any impact or malfunction, perform a return to the home point: remove the end effector, make sure there are no obstacles in the working area, and run the corresponding command in the software environment, or hold the function button on the manipulator's base for more than 2 seconds.
- During the procedure, the indicator blinks blue; after successful completion, a sound signal is heard, and the indicator lights up green. Typical position after the return — the forearm centered in front of the base.

6.3. Manual movement and recording of points

- Press and hold the release button on the forearm — the drives are released and the robotic arm can be moved freely by hand; after the button is released, the current position is fixed and can be saved as a program point.

- A point can also be set using the step-by-step movement buttons in the rectangular (X, Y, Z, R) or joint (J1–J4) coordinate system on the control panel in the software environment.
- Recorded points are used to compose a sequence of movements — moving objects, writing, drawing, or other learning tasks.

6.4. Program launch

- Choose a motion control method: block-based programming for the beginner level, or text scripts in Python for in-depth study.
- Compose a sequence of commands — movement to a point, end effector control, pauses, loops — and start the program with the launch button; the finished program can also be uploaded to the interface unit and run autonomously, without a computer, with a short press of the function button on the base.
- Before running a new sequence of commands on the manipulator itself, it can be played back in motion preview mode on the computer screen, on a digital model of the manipulator — this way, trajectory errors are noticed without risking link collisions with obstacles or drive overload.
- For machine vision tasks, use the built-in algorithms for recognizing objects, colors and gestures: based on the recognition result received from the camera, the program generates the corresponding manipulator motion command.

6.5. Finishing the work

- Wait for the program to finish, turn off the end effector (suction cup or gripper) and, if necessary, perform a return to the home point.
- Turn off the manipulator with the power button, wait until the forearm smoothly lowers into the defined position and the indicator goes out completely, and only then disconnect the power.

6.6. Work with the online course

- Obtain an account at the educational institution and activate the right of access to the course; the validity period of the license is counted from the date on which access is transferred.
- Select the topic of the lesson in the course list: every topic is accompanied by a plan, a list of equipment, an experiment scenario, a step-by-step instruction, a video demonstration and interactive tasks.
- Formulate a query to the assistant on the topic of the lesson — it will suggest appropriate tasks, set out the sequence of actions, examine typical errors and advise how to correct them.
- Set the level of difficulty of the tasks to match the preparation of the class; on the basis of the results of the work the assistant will help to draw up the report and to organize the conclusions.

7. Care, Maintenance and Troubleshooting

7.1. Cleaning

- Before cleaning, switch off the robotic arm and disconnect the power supply unit from the mains.
- Wipe the housing, links and interface unit with a dry or slightly damp soft cloth.

- Do not use aggressive (corrosive) cleaning agents; do not immerse anodized parts in liquid.
- Clean the suction cup and gripper jaws of dust — a contaminated effector holds objects less securely.
- Do not allow liquid to get into the connectors, housing openings, or the air path of the pneumatic effectors.

7.2. Periodic inspection

- Regularly check the integrity of the cables, the secure attachment of the end effector, and the tightness of the air tube connection at the fittings.
- Watch that the coordinate readings are correct; after an impact or malfunction, press the unlock button and perform a return to the home point.
- The product does not require lubrication or other maintenance operations by the user, except for software updates; repair and replacement of components is performed only by an authorized service center.

7.3. Possible malfunctions and methods of their elimination

Symptom	Possible cause	User actions
The indicator glows red, the return to the initial point is not performed	The joint is in the limit position	While holding the release button, move the robotic arm within the limits of the working area, release the button and repeat the command
The robotic arm stopped during movement, the indicator turned red	The joint has reached the limit of its permissible range of motion	Using the unlock button, move the link back within the working area, perform a return to the home point, and repeat the launch
The suction cup or the gripper does not hold the object	Contaminated effector, a loose air tube connection, or the object's mass exceeds 250 g	Check the cleanliness of the effector and the connection of the tube, make sure that the mass of the object is within the norm
One of the joints does not move	The manipulator has moved beyond the working area, or the drive unlock button has been pressed	Release the unlock button, perform a return to the home point; if the fault recurs, contact the service center
The computer does not detect the manipulator or the interface unit	The USB cable is damaged or poorly connected, the equipment driver utility is not installed	Check the cable and the connector, reinstall the equipment driver, make sure that the product is switched on

8. Storage and Transportation Conditions

- Store the manipulator, interface unit and accessories in a dry room at a temperature from +5 to +40 °C, protected from dust, direct sunlight and sudden temperature fluctuations.
- Before long-term storage, disconnect the cables, remove the end effector, and turn off the power.
- Carry the robotic arm holding it by the base with both hands; do not lift or carry the product by the links or by the end effector.
- Transport the product in the original or a similar rigid packaging, placing it smoothly and in the direction of the arrow on the box, by any type of closed transport.
- Do not place heavy objects on the packaging with the product.
- The storage period before commissioning is unlimited provided that the stated requirements are observed.

9. Warranty Obligations

9.1. The warranty period of operation of the product is 12 months from the date of sale specified in the warranty card.

9.2. The manufacturer guarantees that the product conforms to the declared technical specifications provided that the transportation, storage and operating rules set out in this passport are observed.

9.3. During the warranty period, defects of the product that have arisen through the fault of the manufacturer are remedied free of charge. The method of remedy (repair, replacement of a component or replacement of the product) is determined by the service center.

9.4. Warranty service is provided on presentation of a correctly and completely filled-in warranty card and of a document confirming the fact and the date of purchase.

9.5. The warranty does not cover cases where the malfunction is caused by:

- mechanical damage, in particular cracks, chips and deformation of the housing and of the components of the product;
- violation of the operating, storage or transportation rules set out in this passport;
- ingress of liquid or foreign objects into the product, and also the action of insects and animals;
- independent disassembly, repair or modification of the product, in particular repair at unauthorized workshops;
- use of the product other than for its intended purpose;
- force majeure circumstances (fire, flood, earthquake, etc.).

9.6. The warranty does not cover the natural wear of the coating and of the appearance of the product, nor consumables.

10. Product Disposal

- The product must not be disposed of together with unsorted municipal waste. This is indicated by the marking in the form of a crossed-out container on the product or its packaging.

- After the end of the service life, hand the product over to a collection point for the corresponding waste or to an organization holding the appropriate permit.
- Hand over the packaging elements (cardboard, polymer materials) to the corresponding streams of recyclable materials.

Contacts

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Conditions of use and storage of the product

The product is intended for educational work in general secondary education institutions and is used only under the control and supervision of a teaching staff member; the recommended age of students — from 10 years, that is, students of grade 5 and of higher grades. Keep the product in a dry, clean and ventilated room at a temperature from +5 to +40 °C and relative air humidity up to 80 % without condensation, separately from heat sources and out of direct sunlight, moisture and dust. Use the product exclusively for its intended purpose and do not allow drops, impacts or other mechanical damage. If you notice damage, a crack or any malfunction, stop working with the product immediately and inform the teacher or the responsible person of the educational institution; repairing the product on your own is prohibited.

WARRANTY CARD

Name:	Educational robotic arm with support for artificial intelligence algorithms
Product model:	LABOTRIX ARM R1
Serial number:	
Date of sale:	
Warranty period:	12 months from the date of sale
Trading organization:	
Signature of the seller:	

The goods have been received in working order, without visible damage, complete, and have been checked in my presence. I have no claims regarding the quality of the goods; I have read and agree to the operating and warranty service conditions.

Full name of the buyer _____

Telephone of the buyer Signature of the buyer _____

Dear Customer!

Thank you for choosing Labotrix products. After-sales service of this product is provided in accordance with the regulations of the company and the legislation of the country of sale. So that we can serve you quickly and without unnecessary formalities, check that this warranty card is filled in correctly at the moment of purchase and keep it together with the payment document throughout the entire warranty period. When applying for repair, hand the product over to the seller or to the service center together with the filled-in card.

Procedure for applying

1. The right to free warranty service of the product is valid for 12 months from the date of sale specified in the warranty card. Within this period, components that have failed because of a manufacturing defect are repaired or replaced at no cost to the buyer.
2. Before applying, make sure that the malfunction is not caused by the reasons listed in section 9 of this passport and, if possible, use the table of possible malfunctions in subsection 7.3.
3. After the end of the 12-month warranty period, repairs are performed on a paid basis; the cost of the work and of the spare parts is determined depending on the nature of the malfunction.

Grounds for refusal of warranty service

The company reserves the right to refuse free service or to perform the work on a paid basis if at least one of the following circumstances is established:

- absence of the warranty card, its incomplete or corrected completion, and also the absence of a document confirming the purchase;
- non-conformity of the serial number of the product with the number specified in the card, or damage to the factory marking;
- traces of independent disassembly, repair or modification of the product;
- damage caused by violation of the operating rules, connection to an unsuitable power source or external mechanical impact;
- damage as a result of force majeure circumstances.

Service Records

Date of entry	Description of the malfunction	Work performed	Position, signature, full name of the responsible person