

Educational set for studying artificial intelligence and computer vision systems

LABOTRIX VISION R2

PRODUCT PASSPORT

Kyiv

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1. General Information about the Product

- 1.1. **Product name** — Educational Kit for Studying Artificial Intelligence and Computer Vision Systems.
- 1.2. **Trademark** — Labotrix.
- 1.3. **Model** — Vision R2; full trade designation — LABOTRIX VISION R2.
- 1.4. **Manufacturer** — Labotrix Group Limited, China.
- 1.5. **Intended use:** the Labotrix Vision R2 kit — technical-vision equipment that, paired with an external educational robotic arm (4 degrees of freedom), enables in-depth study of the practical applications of computer vision and automatic motion control algorithms. The kit's camera recognizes objects directly on itself — both by color and by a printed symbol (graphic mark) on a card or on packaging — the kit's controller converts the coordinates of the detected objects into the robotic arm's coordinates, and the robotic arm performs their pickup and transfer. Based on this "image — coordinate — action" chain, learning scenarios for counting, sorting and inventory of objects are modeled. The kit is used in computer science, technology and robotics lessons, and in club and project work.
- 1.6. **Design features:** the core of the system is an intelligent camera module with its own onboard processor — it independently detects trained objects in the image — color blobs and printed symbols (graphic marks) — and sends the controller only the result (object class, coordinates, size), without loading it with video processing. The camera is mounted with a bracket on the rotary servo drive of the robotic arm's end effector. The controller board with the expansion board receives data from the camera, controls the movement of the robotic arm, and additionally has sockets for button and LED modules, a joystick, and a voice-command recognition module. The kit includes its own suction cup, which is powered by the robotic arm's air pump.
- 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 — Vision R2
- SKU — LTX-VISION-R2
- Product type — technical-vision and artificial-intelligence kit, an accessory for an educational robotic arm
- Object recognition method — detection of objects directly in the camera by trained signatures: color signatures (object color) and graphic signatures (printed symbol or mark on a card or on packaging)
- Number of simultaneous color signatures (pcs.) — up to 7
- Colors implemented in the kit's library (pcs.) — 4 (red, green, blue, yellow)
- Data that the camera returns about an object — signature number, coordinates of the object's center in the image, length and width of the object
- Camera data transmission interface — I2C
- Connection of the camera to the computer for setup — Micro USB cable
- Camera mounting on the robotic arm — bracket on the rotary servo drive of the end effector
- Adjusting the camera's focus — by rotating the lens
- Kit controller — a board with an AVR-architecture microcontroller, compatible with an open programming environment, supplied with an expansion board
- Power supply of the controller board — from the computer's USB port, no separate power supply unit is required
- Connection between the controller and the robotic arm — 10-pin communication interface based on the robotic arm
- Connection between the controller and the computer — USB
- Controller's text programming language — C/C++ with ready-made libraries of vision and motion control functions
- Calibration — based on three reference points; links the image coordinate system (pixels) with the robotic arm's coordinate system (millimeters)
- Kit's end effector — suction cup powered by the robotic arm's air pump
- Additional control and indication modules — button modules, LED modules (3 pcs of each type) and a joystick module
- Voice-command recognition module — fixed set of 22 commands, available in English or Chinese (one version is supplied per order)
- Recognition objects included (pcs.) — 16 (EVA cubes in four colors)
- Materials of the thematic cards, mockups and mat — paper (cardboard), plastic, silicone; suitable for long-term use in educational institutions
- Compatibility with external equipment — robotic arms equipped with 4 controlled joints and a matching 10-pin communication connector

- Product marking — trademark, model and a space for the inventory number
- Packaging — individual box with compartments for small parts and content fixation
- Documentation supplied — passport with warranty card and connection instructions
- Ready-to-use condition — before first use requires connection and calibration with the robotic arm
- Care of the boards — cleaning with a dry soft brush or a stream of compressed air is allowed
- 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

3. Package Contents

- Camera module with a bracket for mounting on the robotic arm — 1 set
- Camera cable — 1 pcs
- Controller board with expansion board — 1 set
- Cable for connecting the controller board to the robotic arm — 1 pcs
- Voice command recognition module (in English or in Chinese to order) — 1 pcs
- Cable of the voice command recognition module — 1 pcs
- Button modules — 3 pcs
- LED modules — 3 pcs
- Joystick module — 1 pcs
- Fixing plate for mounting the modules — 1 pcs
- Cables of the digital modules — 12 pcs
- 3-pin adapter cables — 4 pcs
- 4-pin adapter cables — 4 pcs
- USB cable — 1 pcs
- Micro USB cable — 1 pcs
- Socket head cap screws for fastening the camera — 2 pcs
- Suction cup — 1 pcs
- Nylon rivets for mounting the modules — 18 pcs
- EVA cube in four colors (objects for recognition) — 16 pcs

- Set of thematic recognition cards (printed symbols for warehouse inventory, images for waste-sorting) — 1 set
- Product mockups and containers for warehouse and retail scenarios — 1 set
- Specialized fields (mats) for modeling work scenarios — 2 pcs
- Right of access to the online course with a language-model-based assistant (license) — 1 pcs
- Product Passport and Warranty Card — 1 pcs
- Individual transport packaging — 1 pcs

The robotic arm, its power supply unit and air pump are a separate product and are not included in the kit — they are ordered separately; without the robotic arm the kit performs only part of its functions.

4. Safety Precautions

4.1. General requirements

- Before using the set for the first time, read this passport, as well as the passport of the robotic arm with which the set is used, and keep both documents together with the products.
- Work with the set is permitted for the teacher or another staff member who has undergone occupational safety instruction; students work with the equipment only under the supervision of an adult.
- Immediately after unpacking, inspect the boards, camera and cables for absence of mechanical damage; pay special attention to the camera lens — it must have no scratches or fingerprints.
- The package contains small parts — screws, nylon rivets, cubes. Keep them in a place out of the reach of children.
- Do not leave the powered-on equipment unattended; all processes during program execution require human supervision.
- A product that has exhausted its service life is to be disposed of in accordance with the applicable legislation, protecting the environment.

4.2. Safety during operation of the robotic arm with the camera

- Do not keep your hands in the robotic arm's working area while it is moving. Keep in mind: in recognition mode the robotic arm moves on its own as soon as the camera detects an object, without a separate operator command.
- Before starting the recognition scenario, make sure there are no extraneous objects, tools, or hands in the working area, and that all objects lie within the camera's field of view.
- Before performing the return of the robotic arm to its home point, make sure the camera and the camera cable will not catch on the fixtures, and the end effector does not press against the work surface.
- Route the camera cable so that it does not wind around the robotic arm's links and does not become taut at the extreme positions: a taut cable shifts the camera and invalidates the calibration.
- Do not keep extraneous bright objects of the same colors as the recognition objects in the camera's field of view — the system may mistake them for an object and direct the robotic arm there.
- Do not point the camera at the sun or powerful light sources — this damages the camera sensor and recognition.

4.3. Electrical safety and handling of the boards

- Before connecting or disconnecting any module, cable or camera, switch off the power of the robotic arm completely and disconnect the USB cable from the computer: "hot" connection damages the equipment.
- Hold the controller board, the expansion board and the camera module by the edges or by the housing; do not touch the traces, connector contacts or chip leads — static electricity damages the electronics.
- Do not place the boards on a metal surface or on a damp table: a short circuit is possible.
- Watch for correct connector orientation: connecting a cable to the wrong socket, or the reverse, puts the module out of order.
- Do not immerse the boards, camera and cables in water, and do not allow liquid to get on them.
- Do not use the product with a damaged cable or connector.

4.4. It is strictly prohibited

- Disassemble or repair the boards and the camera module yourself — in case of malfunction, contact the seller or the service center.
- Leaving children alone with the equipment switched on or allowing them to connect or disconnect live cables on their own.
- Directing the jet of compressed air of the suction cup at people and animals.
- Clean the camera lens with alcohol, solvents or abrasive agents.
- Install the boards or the camera on a robotic arm with which they are clearly incompatible in mounting type or communication interface.
- Operate the kit with damaged camera optics or with chipped or damp boards.

5. Preparation for Use

- 5.1. Unpack the kit, check the completeness against section 3 of this passport, and inspect the boards, camera and cables for absence of mechanical damage. We recommend keeping the packaging for further storage and transportation.
- 5.2. Connect the expansion board to the controller board, aligning the pin headers evenly, without skewing.
- 5.3. Install the end effector on the robotic arm — a suction cup from the kit's set or from the robotic arm's set — and connect it to the robotic arm's air pump according to the robotic arm's passport.
- 5.4. Attach the camera bracket to the rotary servo drive of the end effector, and the camera module — to the bracket; the lens must face downward, toward the work surface, next to the suction cup.
- 5.5. Connect the camera to the expansion board with a signal cable, the controller board — to the robotic arm with a separate cable, and the controller board and camera — to the computer with USB and Micro USB cables respectively; if necessary, install the button modules, LED modules, joystick, and voice-command recognition module on the mounting plate.

- 5.6. Turn on the robotic arm and perform a return to the home point — without this the coordinates will be incorrect, and further calibration will be pointless.
- 5.7. Prepare the workstation: cover it with a solid-color matte surface that contrasts with the recognition objects, provide uniform diffuse lighting without glare or harsh shadows, and clear the working area and the camera's field of view of extraneous objects.

6. Operating Procedure

6.1. Connection and switching on

- Set up the workstation as described in section 5: the controller board with the expansion board connects the camera, the robotic arm and the computer.
- Perform all connections and disconnections of the cables only with the equipment switched off.
- Turn on the robotic arm and perform a return to the home point according to its passport.

6.2. Training of signatures: color and symbol signatures

- In the camera setup program on the computer, adjust the lens focus so that the object boundaries are sharp, and in turn select the area of each sample color in the image — the camera will store it as a separate signature.
- Check the training quality: each object must be outlined with a frame showing the correct signature number, and the background — must remain clean; adjust the signature range and brightness if necessary.
- The signature for each color is set once; training performed under one lighting condition must be repeated if the workstation's lighting has changed significantly. The signature of a printed symbol is trained the same way: place the card with the symbol in the working area, select the area containing just the symbol in the image, and save it under a separate number — the camera then returns to the controller the number of the recognized symbol together with the coordinates, which is used in warehouse-inventory scenarios (optical character recognition, OCR).

6.3. Calibration of the "camera — robotic arm" system

- Move the robotic arm to a position from which the camera sees the entire working area, and record these coordinates as the shooting point.
- Place three reference objects in the working area, positioned not on a single straight line; record their coordinates in the image, and then — the coordinates of the same points in the robotic arm's system, always in the same order.
- Set the coordinate of the plane on which the objects lie, the unloading points for each color, and the height of the objects, then start the calculation of the matrix linking the two coordinate systems.
- Check the calibration: place one object at an arbitrary location in the working area and make sure the end effector lowers exactly onto its center; after any shift of the camera or the work field, the calibration is repeated.

6.4. Launching the recognition scenario

- Compose the program from the ready-made vision and motion control functions: frame recognition returns the number, colors and coordinates of the detected objects, after which the program sequentially picks up and transfers the objects of each color to the corresponding zone.
- Based on object counting, learning tasks of inventory and sorting are modeled: the object's class can be either its color or a printed symbol on a card or on packaging — the camera is trained on the image of the symbol, and then it returns to the controller the number of the recognized symbol together with the coordinates, which makes it possible to practice optical character recognition (OCR) technologies in warehouse scenarios; the button modules, LED modules and the voice-command module can be used to launch the scenario and indicate its status.
- While the program is running, make sure there are no hands or extraneous objects in the working area: the robotic arm starts moving toward a just-recognized object on its own.

6.5. Finishing the work

- Wait for the program to finish and for the end effector to switch off.
- Turn off the robotic arm according to its passport, then disconnect the USB and Micro USB cables from the computer.

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, turn off the robotic arm and disconnect all the kit's cables.
- Clean the camera lens only with a dry optics wipe or a soft lint-free cloth using light circular motions; alcohol, solvents and abrasive agents are prohibited for use.
- Clean dust off the boards with a dry soft brush or a stream of compressed air; wet cleaning of the boards is prohibited.
- Wipe the cubes with a dry or slightly damp cloth and dry them thoroughly — moisture and wear change the color of the object and disrupt recognition.

- Clean dust off the suction cup: a soiled suction cup holds the object less well.

7.2. Periodic inspection

- Check the tightness of the camera and bracket mounting screws — vibration loosens them, and the calibration gradually loses accuracy.
- Check the tightness of the cables in the expansion board connectors and the integrity of the camera cable at the robotic arm's extreme positions.
- The product does not require lubrication or other maintenance by the user; repair of the boards and the camera module is performed only by an authorized service center.

7.3. Possible malfunctions and methods of their elimination

Symptom	Possible cause	User actions
No image in the camera setup program	The camera is not connected to the computer, or the Micro USB cable is damaged	Check the cable and connector, restart the setup program
Objects are not recognized by the camera	The color signatures have not been trained, or they have been deleted	Retrain the signatures for each color of objects
The matrix linking the coordinates cannot be calculated	The order of the three reference points in the image and in the robotic arm's coordinates does not match, or the points lie on a single straight line	Set the three points again in the same order, not on a single straight line
The robotic arm systematically fails to reach the center of the object	The camera or the work field has shifted after calibration, the bracket screws have loosened	Tighten the camera mount and repeat the calibration
The suction cup does not hold the object	The suction cup is dirty, or the air tube is loosely connected	Clean the suction cup, check the tube connection, if necessary replace the suction cup with another one from the kit
The controller is not receiving data from the camera	The I2C interface is not set in the camera settings, or the cable is poorly connected	Check the data transmission interface settings and the camera cable
Two objects are recognized as one	Objects of the same color are lying flush against each other	Lay out the recognition objects with spacing between them

8. Storage and Transportation Conditions

- Store the set in a dry room protected from dust, direct sunlight and sharp temperature changes.

- Store the camera lens-down or in its case, so that dust does not settle on the optics.
- Store the boards in antistatic bags or in the factory foam insert; do not place heavy objects on them.
- Before extended storage, disconnect the camera and all cables from the robotic arm and the controller board.
- Keep the small parts — screws, rivets, cubes — in a closed box so that they do not get lost.
- Transport the product in its original packaging; the storage period before commissioning is unlimited, provided 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 set for studying artificial intelligence and computer vision systems
Product model:	LABOTRIX VISION R2
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