Test Project

Module 3 – Vision-Guided Autonomous Logistics System Calibration

Optoelectronic Technology

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Introduction

Professional project context

For WorldSkills Shanghai 2026, the venue operations team is piloting a compact autonomous logistics support vehicle to improve the transfer of lightweight tools, replacement parts and consumables between service points within controlled competition workshops. Before this prototype is ready for operation, its optoelectronic vision system must be configured and calibrated for the test environment, integrated with the operator APP and the intelligent traffic-light device, and verified on a scaled venue service route.

Occupational context

Camera-based optoelectronic sensing systems are increasingly used in autonomous logistics vehicles, mobile service platforms, smart factories, warehouses, exhibition venues and other controlled operating environments. In these applications, the vision module captures optical information along the route, software processes the image data, and the control system converts recognized traffic-light states and traffic signs into vehicle movement instructions. Reliable operation depends on correct software deployment, stable communication between devices, optical calibration for the conditions at the site, selection of an appropriate recognition model, and systematic verification of the complete system.

In this module, the Competitor acts as the optoelectronic systems technician responsible for deployment, configuration, calibration, optimization and commissioning of the prototype. The mobile vehicle is used as a system-verification platform. The core technical work comprises ESP32-S3 vision-module configuration, image-recognition parameter adjustment, establishment of communication links, AI recognition-model integration, and the interaction between recognized optical information and vehicle-control functions.

Description of project and tasks

Competition time: 180 minutes.

- 3.1 Vision-controller development-environment preparation and project verification
- 3.2 Multi-device software configuration, firmware deployment, APP integration and communication commissioning
- 3.3 Traffic-light image acquisition and HSV colour-recognition calibration
- 3.4 AI traffic-sign model integration, recognition optimization and route acceptance testing

The Competitor shall commission a vision-guided autonomous logistics support system comprising an ESP32-S3 vision module, an Arduino UNO-based mobile platform, an Android operator tablet, an intelligent Bluetooth traffic light and the supplied test-route environment.

Workstation identification

Throughout this Test Project, **XX** represents the Competitor's assigned two-digit workstation number, within the range 01–20. Replace XX in project names and required file names with the number allocated to you by the workstation draw. For example, workstation 01 uses Vision01.ino and Red_01.png.

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Special assessment procedure after the module

All development work and required file submissions shall be completed within the 180-minute module. The supervised static-recognition assessment takes place after the module, using the procedure in section Task 3.4. It provides **one three-minute recognition period for all seven targets**, not additional time to edit the Competitor's work.

Drawings and materials information

The following drawings and tables form part of the Test Project requirements. Interpret and use them throughout your work, together with the supplied system resources.

Index of drawings, materials lists and supplied references

Table 3-1. Vision-guided autonomous logistics system materials

Figure 3-1. System communication architecture

Figure 3-2. Traffic-light image acquisition and HSV calibration workflow

Figure 3-3. AI recognition-model integration and optimization workflow

Figure 3-4. Static-recognition vehicle and target positions

Figure 3-5. Dynamic route and designated target locations

Table 3-2. Operational acceptance-test sequence

Table 3-3. Supplied file resources

Table 3-4. Dynamic-route traffic-sign and traffic-light positions

Table 3-5. Required submission files

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Supplied system and materials

No.	Item	Material / specification / model	Unit	Quantity
1	Intelligent vehicle assembly kit	Four wheels / mecanum wheels	Set	1
2	Vision module	ESP32-S3	Set	1
3	Tablet computer	Android operating system	Unit	1
4	Light-sensing intelligent-driving application map	2.0 × 1.4 m	Set	1
5	Light-sensing intelligent-driving operating table	2.0 × 1.44 m	Set	1
6	Router	TL-WR841N	Unit	1
7	Intelligent Bluetooth traffic light	Intelligent Bluetooth version	Unit	1
8	Traffic-sign cards	65 × 65 mm	Set	1
9	Vehicle batteries	3.7 V	Piece	2 per set
10	Traffic-light batteries	3.7 V	Piece	2
11	Traffic-sign supports	8 × 12 × 15 cm	Set	6
12	Data cable	2 m	Piece	1
13	Data cable	2 m	Piece	1
14	Network patch cable	5 m	Piece	1
15	3M double-sided adhesive tape	Width: 5 mm	Roll	1
16	Electrical insulating tape	Black; width: 18 mm	Roll	1

Table 3-1. *Vision-guided autonomous logistics system materials*

One additional set of vehicle batteries is provided, giving **two sets in total**. One set may be used while the other is charged. Normal rotation of these already supplied sets is distinct from replacement of defective equipment or materials; see the safety and equipment requirements under Other.

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Supplied file resources

Use the supplied project and library resources listed below. The selected traffic-sign model shall be correctly referenced in the final working source. Retain the resource names as supplied.

No.	File name	Description
1	Vision_Demo.ino	Vision application example
2	esp32.zip	ESP32 development-environment resource package
3	IntelligentDriving.hex	Mobile-platform main driving-control program
4	ArduinoJson.zip	Supplied library resource package
5	ColorDetector.zip	Supplied library resource package
6	TrafficDetector.zip	Supplied library resource package
7	WebSockets.zip	Supplied library resource package
8	WiFiManager.zip	Supplied library resource package
9	esp32cam.zip	Supplied library resource package
10	Exchange	Supplied library resource package
11	TrafficSignA_inferencing.zip	AI traffic-sign recognition model
12	TrafficSignB_inferencing.zip	AI traffic-sign recognition model
13	TrafficSignC_inferencing.zip	AI traffic-sign recognition model

Table 3-3. Supplied file resources

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Instructions to the Competitor

Project brief from the client

You have been assigned to commission a prototype autonomous logistics support vehicle for a controlled service route within the WorldSkills venue. The client requires the prototype to provide a stable live video image, maintain communication with the operator APP and intelligent traffic light, recognize the specified traffic-light states and traffic signs, execute the corresponding movement instructions, and complete the prescribed route without unauthorized manual intervention.

You may use only the supplied equipment, software, firmware, source files, AI model files, traffic signs, test map and accessories. Observe all required file names, SSID/password requirements, saving locations and operating procedures. XX denotes your assigned two-digit workstation number as defined at the beginning of this document.

Sections Task 3.1–3.4 describe the required work and outcomes. **You may organize the order of your work within the allocated module time.** The section sequence does not impose a mandatory order for every task. Necessary safety and operational prerequisites still apply, including switching off equipment before hardware removal or installation, and starting the route recording before the vehicle moves.

Save all required source-code files and recorded evidence before the module ends. Incorrect file names or saving locations, missing files, compilation errors, unsuccessful uploads, unstable communication, missed or incorrect recognition, or unauthorized intervention may affect the relevant assessment results. Repeated correct recognition is governed by the specific dynamic-recognition rules in section Task 3.4; repetition alone is not a separate assessment criterion.

This work comprises the following stages:

1. Prepare and verify the vision-controller development environment and establish a working source-code project for the supplied ESP32-S3 vision module.
2. Configure the multi-device software and communication links, deploy the required firmware, and verify integration between the vision module, mobile platform, operator APP and intelligent traffic light.
3. Acquire representative traffic-light images, determine and apply suitable red and green HSV recognition parameters, and retain the required calibration evidence.
4. Integrate and optimize the supplied traffic-sign AI recognition model, complete the required static and dynamic recognition verification, and save the required source files, screenshots and selected route recording for assessment.

Technical requirements and conventions

Workstation identification and file naming

Throughout this Test Project, XX represents the Competitor's assigned two-digit workstation number, within the range 01–20. Replace XX in project names and required file names with the number allocated to you by the workstation draw.

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Module-time and post-module assessment boundary

All development work and required file submissions shall be completed within the 180-minute module. The supervised static-recognition assessment takes place after the module and provides one continuous three-minute recognition period for all seven targets. It does not provide additional time to edit the Competitor's work.

Recognition and evidence conventions

Recognition results used for assessment must be based on the current physical traffic light or traffic-sign target viewed by the live camera. Required source files, screenshots and route-recording evidence must use the specified names, formats and saving locations stated in this Test Project.

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Task 3.1 Vision-controller development-environment preparation and project verification

Client requirement

The client requires the vision-controller development environment to be prepared and verified so that the supplied project can be compiled successfully and used as the reliable starting point for subsequent configuration, calibration and deployment work.

Work instructions

Before configuring and deploying the source program, prepare the Arduino development environment required by the vision controller. Use the supplied resources to complete the following work.

1. Open Arduino IDE and open the supplied project file **Vision_Demo.ino**.
2. Check the header files referenced by Vision_Demo.ino and install or add the corresponding libraries required by the project.
3. In the Arduino IDE **Tools** menu, select the ESP32-S3 board option that corresponds to the supplied vision module. Where required, select the communication port associated with that module.
4. Compile the project using the Arduino IDE **Verify** function. Verification shall complete successfully, with no compilation errors.

Technical and quality requirements

The completed development environment shall support subsequent source-code configuration and program uploads. This stage establishes a consistent software starting point for all Competitors. You remain responsible for choosing the correct supplied resources and confirming that the project has been verified successfully.

Retain and submit the required **Vision_Demo.ino** source file, as well as your final **VisionXX.ino** working source file, using the submission locations specified under Other. The prepared environment on the competition computer shall remain available for assessment. No additional development-environment archive or separate library submission is required.

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Task 3.2 Multi-device software configuration, firmware deployment, APP integration and communication commissioning

Client requirement

The client requires the vision module, mobile platform, intelligent traffic light and operator APP to operate as an integrated system with stable communication and the required manual verification functions available before optical calibration and route acceptance testing.

Configure and commission the communication links between the vision module, mobile platform, intelligent traffic light and operator APP. The required operational communication architecture is shown in **Figure 3-1**.

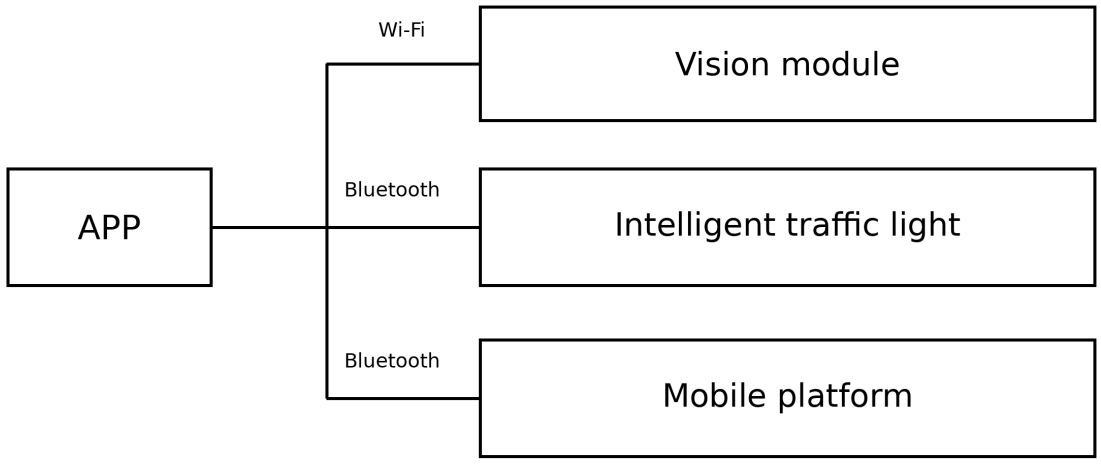


Figure 3-1. System communication architecture

The TL-WR841N router is used only to establish the local network for image acquisition and HSV calibration. It is not a required communication link during final vehicle operation.

Work instructions

1. Use **Save As** to save Vision_Demo.ino as the working copy **VisionXX.ino**, replacing XX with your assigned workstation number.
2. Modify the wireless access-point configuration in VisionXX.ino. The SSID and password may each be chosen by the Competitor. Each shall contain letters and numbers and shall be at least eight characters long.
3. Compile the configured VisionXX.ino and upload it to the ESP32-S3 vision module. After a successful upload, the module shall operate in access-point mode using the SSID and password configured in the source program.
4. Use the supplied **Arduloader** programming tool to upload **IntelligentDriving.hex** to the mobile platform's Arduino UNO controller. Before uploading the firmware, switch off the relevant equipment and remove the BLE Bluetooth module from the expansion board. After the upload is complete, switch off the relevant equipment before reinstalling the BLE module in the correct orientation. Do not remove or install the BLE module while the controller is energized. IntelligentDriving.hex provides the vehicle's basic movement and control functions. You are not required to rewrite the Arduino UNO vehicle-motion program. The supplied APP provides the operating and control interface; you are not required to program or modify the APP.

5. Open the vision-guided logistics APP on the supplied Android tablet and establish all three required communication connections:
   The Wi-Fi connection between the APP/tablet and the ESP32-S3 vision module.
   The Bluetooth connection between the APP and the mobile-platform controller.
   The Bluetooth connection between the APP and the intelligent traffic light.
6. Verify the integrated system by confirming each of the following functions:
   The APP displays the live video image transmitted by the vision module.
   The APP displays the mobile platform's battery status.
   The speed-setting and ambient-lighting controls respond correctly.
   The mobile platform responds correctly to manual forward, reverse, left-turn and right-turn commands.
   The APP can switch the intelligent traffic light between red, yellow and green.

Technical and quality requirements

The yellow state is used only to verify control communication between the APP and the traffic light. The visual colour-recognition tasks assess **red and green only**; yellow recognition is not required.

All communication links shall remain connected and stable during functional verification. Retain the validated communication settings and device connections for the work in sections **3.3 and 3.4**.

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Task 3.3 Traffic-light image acquisition and HSV colour-recognition calibration

Client requirement

The client requires reliable red and green traffic-light recognition under the specified test conditions. The recognition parameters must be calibrated from representative camera images and retained in the final working source together with the required evidence files.

The prototype shall recognize traffic-light colours in the specified test environment. Use the supplied image-acquisition firmware and colour-threshold tool to capture representative images, determine suitable HSV thresholds and optimize the recognition parameters in VisionXX.ino. The required workflow is shown in **Figure 3-2**.

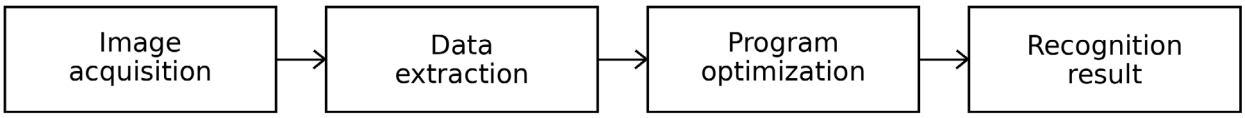


Figure 3-2. *Traffic-light image acquisition and HSV calibration workflow*

HSV denotes **Hue, Saturation and Value**. This colour representation separates colour information from brightness information; this task uses it to improve the distinction between the red and green traffic-light states.

Traffic-light colour recognition uses HSV thresholds, whereas traffic-sign classification uses the supplied pre-trained AI models. These are separate recognition processes for different visual tasks.

Work instructions

1. Use the supplied **Flash Download Tool** to upload the image-acquisition firmware **EN_Imagecollection.ino.merged.bin** to the ESP32-S3 vision module.
2. Use the supplied router to establish the required local network. Capture traffic-light images at the prescribed test position and under the operating conditions used for system verification.
3. Capture image samples of the traffic light in its red and green states. The images shall be sufficiently clear for threshold analysis and representative of the conditions under which the system will be verified.
4. Open **Color Threshold Tool.exe** and process the captured images to determine HSV threshold ranges suitable for red and green recognition.
5. Open **VisionXX.ino** and update the red and green HSV ranges and the associated colour-block parameters used by the recognition logic.
6. Compile the optimized VisionXX.ino and upload it to the ESP32-S3 vision module.
7. Verify that the vision module distinguishes the red and green traffic-light states correctly under the prescribed test conditions and does not produce avoidable colour misidentification.

Technical and quality requirements

Retain the final red and green HSV ranges and associated colour-block parameters in the submitted VisionXX.ino as evidence of the calibration work. Within the allocated module time, you may repeat image acquisition, parameter adjustment, compilation, upload and verification.

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HSV calibration evidence

Save the red and green source images captured by the ESP32-S3 vision module, and the corresponding binary threshold-result screenshots from Color Threshold Tool.exe, in the following folder:

C:\Users\Competitor\Desktop\Module3\HSV\

1. Save the red traffic-light source image as **Red_XX.png**.
2. Save the green traffic-light source image as **Green_XX.png**.
3. Save the screenshot of the red traffic-light binary threshold result as **Red_Threshold.png**.
4. Save the screenshot of the green traffic-light binary threshold result as **Green_Threshold.png**.

Replace XX in the source-image names with your assigned two-digit workstation number. All four files are required submission evidence and shall be saved before the module ends.

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Task 3.4 AI traffic-sign model integration, recognition optimization and route acceptance testing

Client requirement

The client requires the supplied vision system to recognize the specified traffic signs and traffic-light states from live camera input and to translate those recognition results into the required vehicle responses during static verification and the prescribed dynamic route.

The client has supplied several pre-trained traffic-sign recognition models for evaluation. Select the model that performs most appropriately in the supplied test environment, integrate it into VisionXX.ino, optimize the permitted recognition settings, and complete the final operational acceptance tests. **Figure 3-3** shows the model-integration and optimization workflow.



Figure 3-3. AI recognition-model integration and optimization workflow

Work instructions

1. Examine the supplied AI model files and select the model that provides the most suitable recognition results in the test environment.
2. Correctly reference and integrate the selected model in **VisionXX.ino**.
3. Position the supplied traffic-sign cards as specified by the route drawings and task instructions. Static verification uses one target at a time at the designated static position. Dynamic verification uses all route targets installed at their designated positions.
4. Adjust the permitted recognition settings to improve stability and reduce missed or incorrect recognition. Repeated correct recognition is permitted under the dynamic-recognition rules below.
5. Compile the final program and upload it to the ESP32-S3 vision module.
6. Verify the complete system before commencing the route-recording attempts.

Technical and quality requirements

You may modify the program content in VisionXX as required for communication configuration, HSV calibration, AI-model integration and recognition optimization. The supplied APP and **IntelligentDriving.hex shall not be modified or replaced**.

Vehicle responses to traffic-light and traffic-sign events during an automatic route attempt shall be triggered by recognition of the physical targets in the **live camera image**. Fixed timing sequences, preset route-action tables, hard-coded logic that bypasses live visual recognition, and other substitutes for actual optical recognition are not permitted.

Static recognition shall likewise use the current physical traffic light or traffic-sign target viewed by the camera, not a stored image or a preset recognition result. The supplied system's recognition display, voice prompts and vehicle-action mapping are existing functions; the Competitor's work is to establish correct recognition and stable communication so that these functions respond correctly.

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Static visual recognition and submitted screenshots

Complete static recognition of the seven specified traffic-light states and traffic-sign targets. Position the vehicle and the current target as shown in **Figure 3-4**. The vehicle shall remain stationary while recognition is performed.

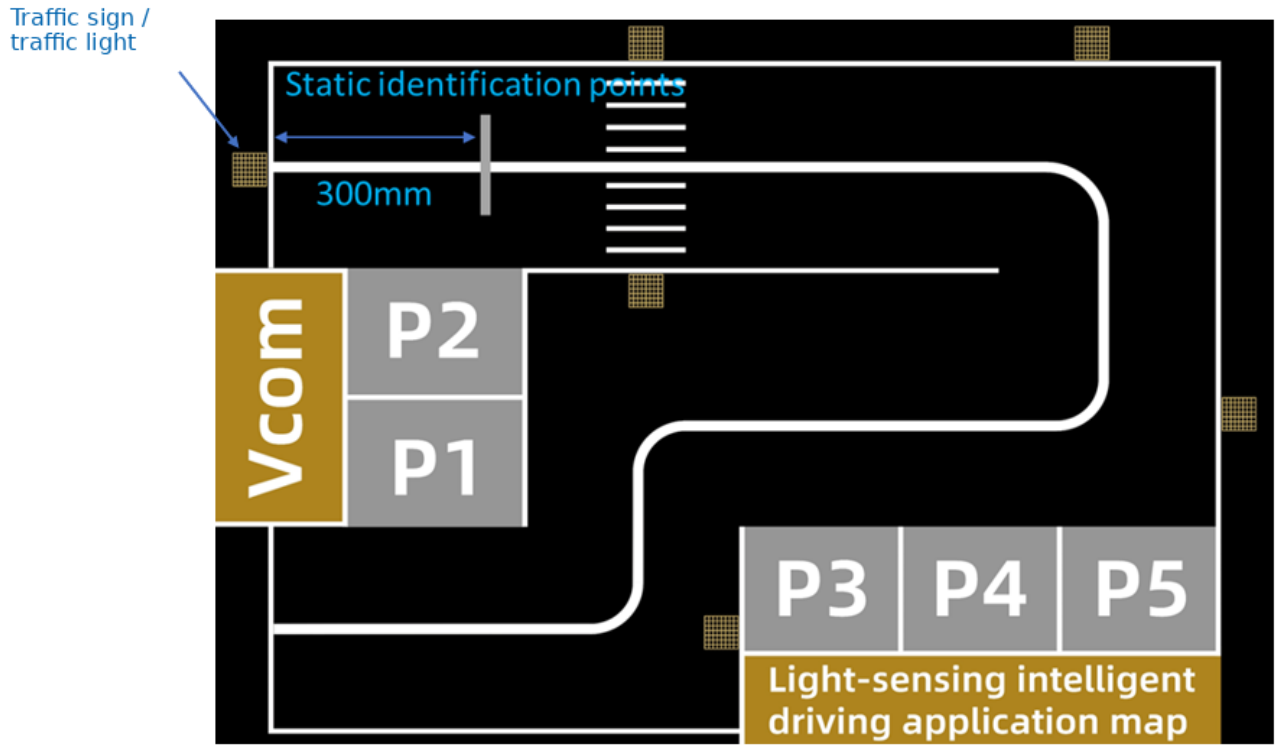


Figure 3-4. Static-recognition vehicle and target positions

Place the vehicle with its **front wheels touching the marked static positioning line**. Once positioned, the vehicle shall not be moved. Place the current traffic-sign or traffic-light assembly on the designated target area in front of the vehicle. Its position may be offset, provided that part of the assembly remains in contact with the marked target area; it does not need to be exactly centred.

The camera angle and the target position may be adjusted, subject to the vehicle remaining fixed and the target remaining in contact with the designated area. The specific timing and adjustment rules for the supervised assessment after the module are stated below.

The P1–P5 labels on the supplied map represent simulated parking spaces. They are pre-printed reference areas, **not separate recognition positions or assessment points**.

Seven required static-recognition screenshots

During the allocated module time, present the following seven targets individually. When each target is recognized correctly, capture its recognition result in the APP and save it with the specified name. Each screenshot shall retain the complete APP recognition interface and show both the current live image and the corresponding recognition result. **Do not crop or otherwise edit the screenshot.**

1. With the vehicle stationary, capture the recognition result for the **red traffic light** and save the image as **RedLight.png**.

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2. With the vehicle stationary, capture the recognition result for the **green traffic light** and save the image as **GreenLight.png**.
3. With the vehicle stationary, capture the recognition result for the **Left Turn** traffic sign and save the image as **Turn_Left.png**.
4. With the vehicle stationary, capture the recognition result for the **Right Turn** traffic sign and save the image as **Turn_Right.png**.
5. With the vehicle stationary, capture the recognition result for the **Go Straight** traffic sign and save the image as **Go_Straight.png**.
6. With the vehicle stationary, capture the recognition result for the **Turn Around** traffic sign and save the image as **Turn_Around.png**.
7. With the vehicle stationary, capture the recognition result for the **Stop** traffic sign and save the image as **Stop.png**.

Save all seven static-recognition images on the competition computer before the module ends, in:

C:\Users\Competitor\Desktop\Module3\Picture\

The static-recognition images are submitted evidence. The on-site static assessment also verifies recognition using the submitted final source program, under the supervised procedure that follows.

Supervised static-recognition assessment after the module

After the module, the Expert assessment team will conduct a supervised static-recognition assessment for each Competitor. This uses the final submitted **VisionXX.ino** and is separate from the dynamic route-video assessment.

1. Before the module ends, complete the development and debugging work and save all required source files and recognition images. **Leave Arduino IDE and the relevant programming/upload software open** on the competition computer.
2. When the end of the module is announced, **stop work immediately**, leave the workstation and return to the Competitor Room to wait. Do not continue editing, uploading, capturing images or recording video after the end signal.
3. The Expert assessment team will invite Competitors back to their workstations individually. When invited, the **Competitor shall personally compile and upload the submitted final VisionXX.ino** to the vision module in the Experts' presence, using the prepared development environment. This is a supervised assessment operation, not an extension of competition time. Do not edit or replace the submitted program, model or recognition parameters, and do not create or amend submission evidence.
4. Place the vehicle with its front wheels on the positioning line in **Figure 3-4** and place the first target in the designated target area. **Do not move the vehicle after it has been positioned.**
5. The Experts start the timer when the current target has been positioned and the system is in recognition mode. Each Competitor has **one continuous period of three minutes in total to complete recognition of all seven targets**. The period is not restarted for each target. Compilation and upload take place before this recognition period begins.
6. During the three-minute recognition period, the **camera angle and the position of the recognition target may continue to be adjusted**. The vehicle shall remain stationary and the target shall remain in contact with the designated marked target area. No other recognition program content or parameters may be modified.
7. Present the seven required targets for recognition within the same three-minute period. Target changes and the permitted camera/target adjustments take place within that period. The Experts record the distinct targets successfully recognized within the time limit.
8. When the three minutes expire, the Competitor's live static test ends. If not all seven targets have been recognized successfully, the result is recorded according to the number successfully recognized before time

expired. **Recognition achieved after the time limit is not accepted.** Repeated recognition of a target already completed does not count as another distinct target.

Only the supervised operations expressly described above are permitted after the module ends. The submitted files remain unchanged. This live test does not provide an opportunity to correct the program or replace missing or unsuccessful screenshots.

Dynamic route recognition and acceptance

The dynamic test verifies the complete chain from real-time optical recognition to APP response and vehicle movement. Install the traffic signs and traffic light at the locations shown in **Figure 3-5** and **Table 3-4**, then operate the vehicle along the prescribed route.

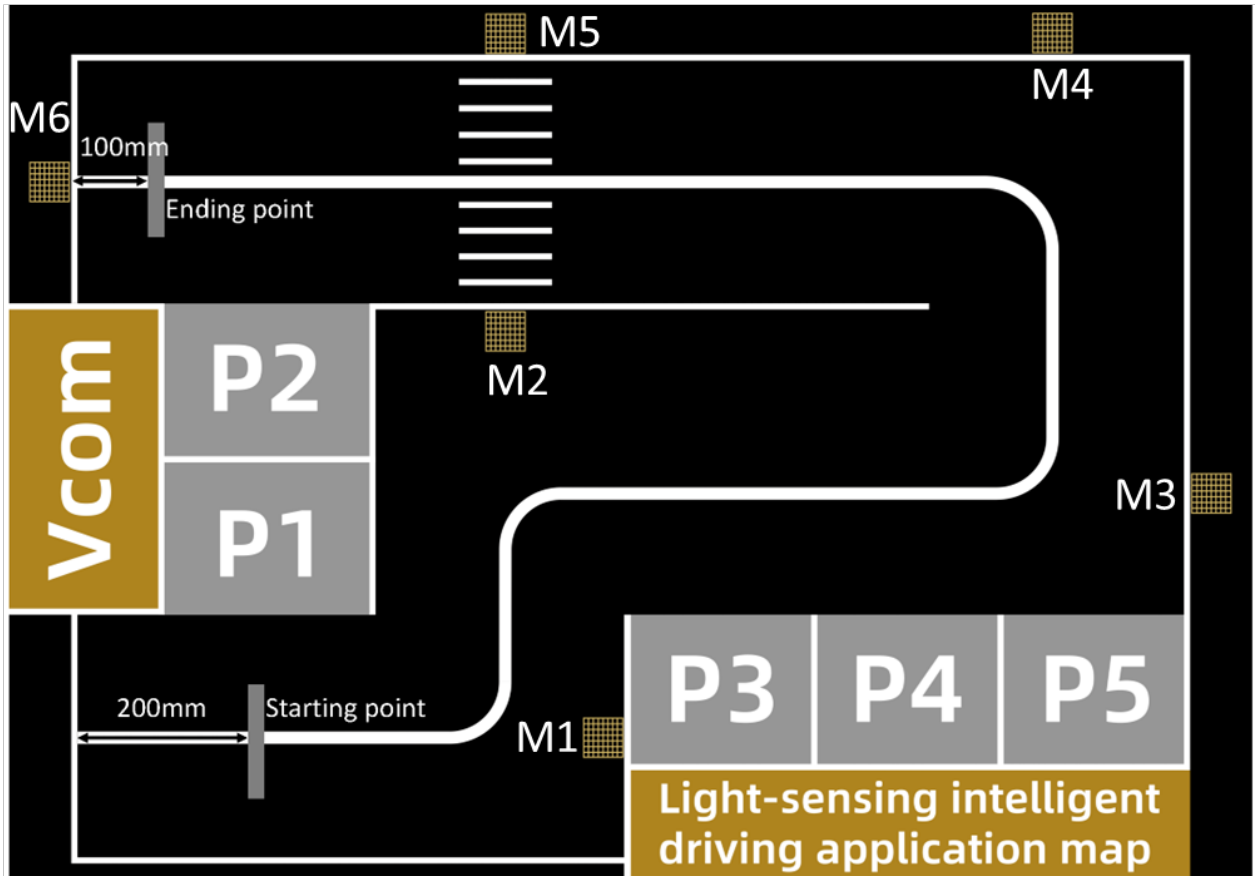


Figure 3-5. Dynamic route and designated target locations

A target may be offset from the centre of its designated bracket/target position, provided that part of the target assembly remains in contact with the marked area. It shall not be moved completely away from that area. Install all dynamic-route targets at their required positions before the run begins.

The P1–P5 parking-space labels are reference features of the map, not additional targets or separate assessment points. In this module, **M1–M6 identify route target locations**, not separate Test Project modules.

No.	Location	Required target	Required response	Materials
1	M1	Left Turn	Turn left	Support and traffic-sign card
2	M2	Right Turn	Turn right	Support and traffic-sign card
3	M3	Left Turn	Turn left	Support and traffic-sign card
4	M4	Left Turn	Turn left	Support and traffic-sign card
5	M5	Green traffic light	Recognize green and proceed	Intelligent traffic light
6	M6	Stop	Stop	Support and traffic-sign card

Table 3-4. *Dynamic-route traffic-sign and traffic-light positions*

Left and right turns are defined relative to the vehicle's direction of travel. **M3 and M4 both require a left turn.** The Turn Around sign is part of static recognition only and is not used as a vehicle action on the dynamic route. Go Straight and proceed both refer to continuing straight ahead; the dynamic target arrangement is the one specified in **Table 3-4**.

Before each dynamic run, set the traffic light at M5 to **green**. Once the vehicle starts the dynamic run, the Competitor shall not operate the APP or traffic light to change that state.

Movement, recognition and repeated attempts

Vehicle speed may be selected by the Competitor within the system's available settings. **Speed itself is not a separate assessment criterion.** The selected speed shall allow safe, stable operation and completion of the required recognition events and route.

While the same target remains within the camera's field of view, the system may produce multiple consecutive correct recognition results. **The repetition count itself is not a separate assessment criterion.** The system shall still complete the prescribed automatic movement and corresponding actions. Manual pauses, converting the dynamic test into static recognition, or using recognition results that do not match the actual target are not permitted.

Except for the prescribed Stop response and safety intervention, dynamic recognition shall take place while the vehicle is moving automatically. Neither manual control nor programmed stop-and-recognize operation at successive targets may replace the required recognition in motion. The prescribed stop at M6 is a required action, not an unauthorized pause.

During a recorded route attempt, physical or manual intervention that changes the visual-recognition result is not permitted, except when required for safety or instructed by an Expert. Incorrect or missed recognition affects the relevant assessment requirements; it does not automatically mean that the entire module has failed.

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Within the allocated 180-minute module time, **there is no fixed maximum number of route attempts**. You may repeat the route and select the one recording you consider to represent your best result. Before the module ends, export and submit **one selected route recording only**. You are not required to export or submit every attempt. Route-performance assessment is based on the selected recording submitted by the Competitor.

Start and finish references

Set up the starting and ending positions as shown in **Figure 3-5**. The diagram indicates a starting reference 200 mm from the left boundary and an ending reference 100 mm from the left boundary. Use the **centreline of the vehicle's front-wheel axle** as the vehicle-position reference and align the vehicle with its direction of travel.

These references establish the intended route setup and general starting and ending locations. **Precise stopping distance is not assessed and is not checked with a ruler.** The recorded scene shall correspond logically to the indicated general positions. This does not remove the requirement to recognize the Stop sign and respond correctly at M6, or the requirement to keep the vehicle safely within the designated test area.

Route-recording requirements

Use the **built-in recording function of the VCOM APP**, not the Android operating system's screen recorder. The selected recording shall be a single continuous recording from before the vehicle starts moving until after its final stop. It shall not be edited, spliced, sped up, slowed down, cropped or otherwise altered.

Save the selected video on the competition computer under the base name **LSXX**, replacing XX with the assigned workstation number. Retain the original video file format and extension produced by the APP. No particular tablet-side storage path is an assessment requirement.

Final video submission folder:

C:\Users\Competitor\Desktop\Module3\Video\

Operational acceptance-test sequence

Table 3-2. Operational acceptance-test sequence

Step	Acceptance-test stage	Required operation	Expected condition
1	Initial positioning	Set up the start reference shown in **Figure 3-5**, 200 mm from the left boundary. Use the front-wheel axle centreline as the vehicle reference, align the body with the route and keep the vehicle stationary until the run starts.	The vehicle is positioned at the intended general starting location, aligned and ready to start. Precise placement is not a separate measured stopping-performance criterion.
2	Power-up and device status	Switch on the mobile platform, vision module, tablet APP and intelligent traffic light. Establish the required communication links. In the APP, enable ultrasonic ranging, driving-view display, speed control, direction control and ambient-lighting functions. Set the M5 traffic light to green before the run.	Required connections and function indicators are active. The traffic light is green. Enabling a direction-control function does not authorize manual steering during the automatic run.

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Step	Acceptance-test stage	Required operation	Expected condition
3	Operating-mode selection	On the APP main screen, change the vehicle movement-control mode from Manual to Automatic.	The APP shows Automatic mode. No manual control is used during the run except for authorized safety intervention.
4	Video recording	Start the APP's built-in recording function before the vehicle begins to move. Retain the recording for later selection and submission.	Recording is running before vehicle movement and will capture the continuous route attempt.
5	Automatic route operation	Start the vehicle. Recognize and respond to M1–M6 as specified in Table 3-4. For each recognized event, the APP provides the corresponding voice prompt, records recognition information and commands the required vehicle response. Do not change the traffic-light state after movement starts.	The actual target, recognition result, APP response and vehicle action correspond. Recognition occurs in automatic motion, with no unauthorized intervention or stop-and-recognize workaround.
6	Final stopping condition	After completing the required events, respond to the Stop sign at M6 and stop in the general ending area shown in **Figure 3-5**, using the 100 mm reference as a scene-setup guide.	The required Stop response and general ending scene are demonstrated. Exact stopping distance is not measured for scoring.
7	End recording and retain evidence	Stop the APP recording after the final stop and confirm that the complete video is readable. Before the module ends, select one attempt and copy it to the Video folder under Module3 on the competition computer, using the base name LSXX and retaining the original extension.	One complete, continuous, unedited and readable route video is submitted in the required folder. No submission of all attempts or tablet-side scoring path is required.

Required deliverables for Module 3

The client will inspect completion of this project on the basis of the commissioned vision-guided logistics system, the submitted source files and calibration evidence, the seven static-recognition screenshots, the selected dynamic-route recording and the supervised post-module static-recognition assessment. The Competitor must ensure that the required deliverables remain complete and available for verification.

Before the module ends, confirm that all required source files, image evidence and the selected route video have been saved on the competition computer and are available for assessment. Use the following root folder:

C:\Users\Competitor\Desktop\Module3\

Use the **Source**, **HSV**, **Picture** and **Video** subfolders below this root. Replace XX in the required file names with your assigned two-digit workstation number. File names, including underscores and extensions, shall be consistent with the list below.

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Subfolder	Required file name	Required content
Source	Vision_Demo.ino	The supplied baseline source file. The prepared development environment can Verify it successfully.
Source	VisionXX.ino	Final working source, with the selected AI model correctly referenced and the final red/green HSV ranges and associated colour-block parameters retained. Used for the supervised static assessment.
HSV	Red_XX.png	Red traffic-light source image captured by the vision module.
HSV	Green_XX.png	Green traffic-light source image captured by the vision module.
HSV	Red_Threshold.png	Red traffic-light binary threshold-result screenshot from Color Threshold Tool.exe.
HSV	Green_Threshold.png	Green traffic-light binary threshold-result screenshot from Color Threshold Tool.exe.
Picture	RedLight.png	Complete APP interface showing red traffic-light recognition.
Picture	GreenLight.png	Complete APP interface showing green traffic-light recognition.
Picture	Turn_Left.png	Complete APP interface showing Left Turn recognition.
Picture	Turn_Right.png	Complete APP interface showing Right Turn recognition.
Picture	Go_Straight.png	Complete APP interface showing Go Straight recognition.
Picture	Turn_Around.png	Complete APP interface showing Turn Around recognition.
Picture	Stop.png	Complete APP interface showing Stop recognition.
Video	LSXX + original video extension	One selected continuous, unedited route-recording video generated by the VCOM APP. Retain the APP's original file format.

***Table 3-5.** Required submission files*

The Source subfolder contains the required .ino source-file submissions; no additional archive of the entire development environment or separate library package is required. The existing prepared environment on the competition computer remains available for the supervised assessment.

In addition to the files, leave the commissioned system available for assessment with the required APP, vision-module, vehicle-controller and traffic-light communication established. Retain the vehicle and test environment in the required final condition. Leave Arduino IDE and the relevant programming/upload software open, as instructed in the post-module assessment procedure.

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Other

General operating, safety and equipment requirements

Handle all circuit boards, connectors, batteries, modules and cables carefully. Switch off the relevant equipment before installing or removing hardware modules or reconnecting cables, except where the project instructions expressly require a powered diagnostic operation. **The BLE module shall not be removed or installed while the controller is energized.**

Keep the mobile platform within the designated test area. If the vehicle may leave the route, collide with equipment or create a safety risk, use the approved emergency-intervention procedure or follow the Expert's instruction. Safety intervention is distinct from pausing or manipulating the vehicle to obtain a recognition result.

If supplied equipment or materials are suspected to be defective or damaged, raise your hand and notify an Expert immediately. The Sponsor Technician checks the fault and carries out an approved replacement. **Faulty equipment or materials may be replaced only within the first 30 minutes after the module begins. After that period, no further equipment or material replacements are permitted.** This replacement window applies to each module.

Equipment damaged through incorrect connection, incorrect orientation, unsafe handling, unauthorized modification or other Competitor error remains subject to the applicable Competition Rules. The 30-minute replacement window does not authorize unsafe operation or unauthorized replacement.

The two battery sets issued for the task may be rotated during the module, with one set in use and the other charging where necessary. **Normal use of an already supplied spare battery set is not additional issue or replacement of defective equipment**, and is not prohibited by the 30-minute replacement limit. Follow the required power-off procedure when changing batteries.

End condition for assessment

At the end signal, stop work and leave for the Competitor Room. No further editing, debugging, new evidence capture or submission changes are permitted. Return only when invited by the assessment team, and perform only the supervised compilation, upload and static-recognition operations specified in section Task 3.4.

Complete all development work, required file saving and route-video selection before the 180-minute module ends. When instructed to stop, cease work immediately and leave the workstation as directed. The sole subsequent operational exception is the **supervised post-module static-recognition assessment** in section Task 3.4. This does not authorize further program editing, parameter changes, debugging or amendment of the submitted evidence.

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