

Responses to Final Report Draft Review Comments

Team 34 | A Vision-Integrated Robot for Autonomous Book Classification in Library Environments

Opening response: We thank the reviewers for identifying the two areas that most needed clarification in the final report draft: the missing overall block diagram and the remaining final-demo, BOM, schedule, and citation cleanup. This rebuttal responds directly to those comments using the final demo evidence from May 21, 2026.

Response to Reviewer 1 Comments (Professor Timothy Lee)

1. Summary

We sincerely thank Professor Timothy Lee for pointing out that the overall block diagram was not clear enough in the draft. Although the draft included a figure labeled as a block diagram, this feedback made clear that the overall system architecture was not presented prominently or self-containedly enough for review.

2. Point-by-point response to Comments and Suggestions

Comments 1: Missing overall block diagram.

Response 1: We agree that the overall architecture needed to be made clearer. In the response package, we therefore provide a self-contained system dataflow/block diagram and clarify the final data and command path. The updated figure shows the complete final-demo pipeline from trigger and startup scan through bin/shelf perception, world-model update, decision-making, target-sequence generation, raw ASCII/PWM command output, and ESP32/servo execution. It also clarifies the relationship among the three final subsystems: perception, decision, and control.

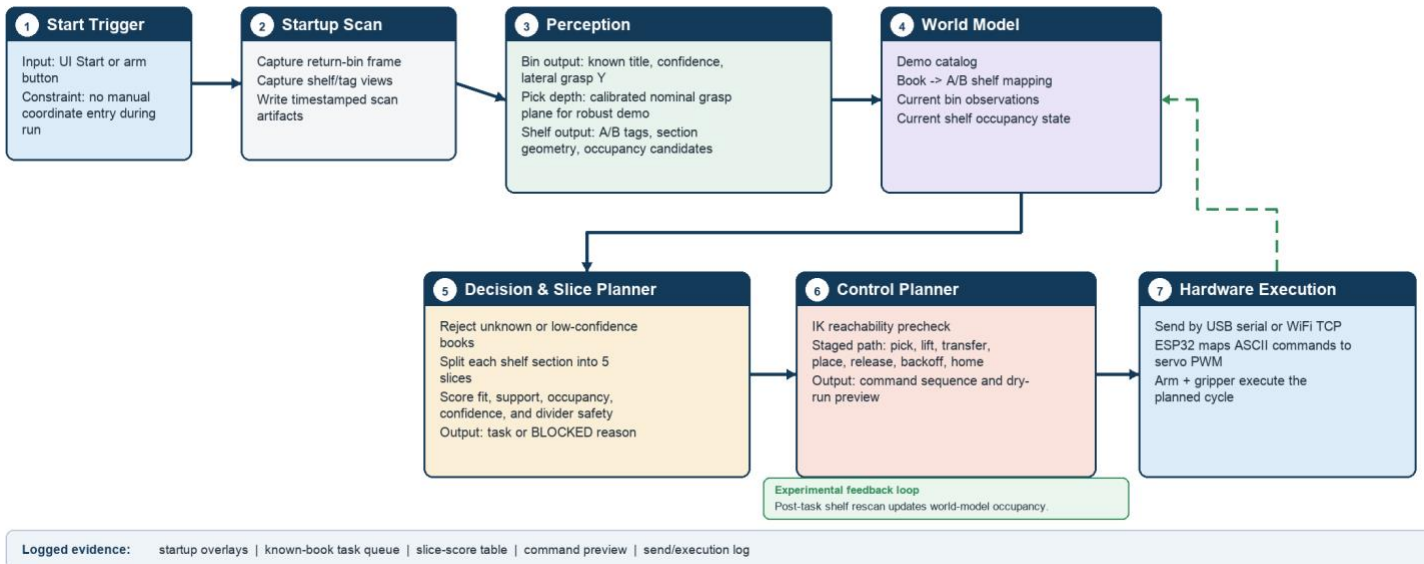


Figure 1. Overall final-demo dataflow: trigger, startup scan, perception, world model, decision, control planning, and raw ASCII/PWM hardware execution.

Revision/clarification made: The clarified diagram explicitly includes the physical/user trigger, startup scan, bin and shelf views, barcode/OCR book recognition, A/B shelf tag recognition, shelf slicing, world-model initialization, decision-layer shelf-slice selection, target_sequence.py command generation, USB/WiFi-TCP transmission, and ESP32 bus-servo execution.

Location: Section 3.1 System Overview / Block Diagram and Data Flow, and Figure 1 in this response package.

Response to Reviewer 2 Comments (Professor Arne Fliflet)

1. Summary

We sincerely thank Professor Arne Fliflet for identifying the remaining items that needed final-demo confirmation, teammate-provided counts, BOM and schedule completion, and citation cleanup. Because the rebuttal is the final visible response package, we include the concrete May 21 final-demo evidence, itemized BOM, 13-week schedule, and cleaned reference list directly here.

2. Point-by-point response to Comments and Suggestions

Comments 1: Incorporate items still requiring final demo confirmation, teammate-provided counts, BOM/schedule data, or citation cleanup.

Response 1: We agree. The final response now uses the May 21 final demo as the primary evidence source. That run demonstrates the updated barcode/OCR-priority perception path, A/B shelf tag anchoring, world-model-backed placement selection, target_sequence command generation, TCP hardware transmission, and an explicit record of all commands being sent.

2.1 Final demo confirmation

Aspect addressed: final demo confirmation. The draft treated final-demo confirmation as an open item and still relied on older evidence. We therefore grounded this response in the May 21, 2026 final demo. The evidence package records a completed startup scan at 2026-05-21 11:08:17, an auto-demo run with status sent, and a hardware console log showing TCP transmission through TX 54/54 with the sequence completed. The supporting raw console excerpt is provided in Appendix A.3.

2.2 Final counts and perception/decision evidence

Aspect addressed: teammate-provided counts and final subsystem evidence. We brought the concrete bin perception, shelf perception, decision, and hardware-transmission counts into the response package rather than only citing internal file names.

Draft issue identified	Revision / clarification made	Final demo evidence used
Final-demo confirmation was still treated as unresolved.	We changed the response to use the May 21 final demo as the primary confirmation evidence.	Final demo date: May 21, 2026.
The perception section lacked final confirmed counts.	We added final bin-perception counts from the May 21 startup scan.	Startup scan 20260521_110758: 4 barcode hits, 4 OCR-linked book entities, 8 pick candidates, 0 unknown titles.
Shelf perception was not clearly tied to the final demo.	We clarified that A/B shelf tag recognition anchored the shelf coordinate frame and initialized placement slots.	2 shelf template label hits, 10 shelf placement candidates, and 10 initialized shelf world slots.
The result section relied on older May 15 evidence.	We updated the final-demo planning evidence to the May 21 auto-demo run.	Auto-demo 20260521_110842: 4 planned books, 0 human-attention items.
The control section did	We added hardware-link completion evidence	TCP link opened; TX 01/54

not show final hardware transmission completion.

from the final-demo console log.

through 54/54; sequence completed; run status sent.

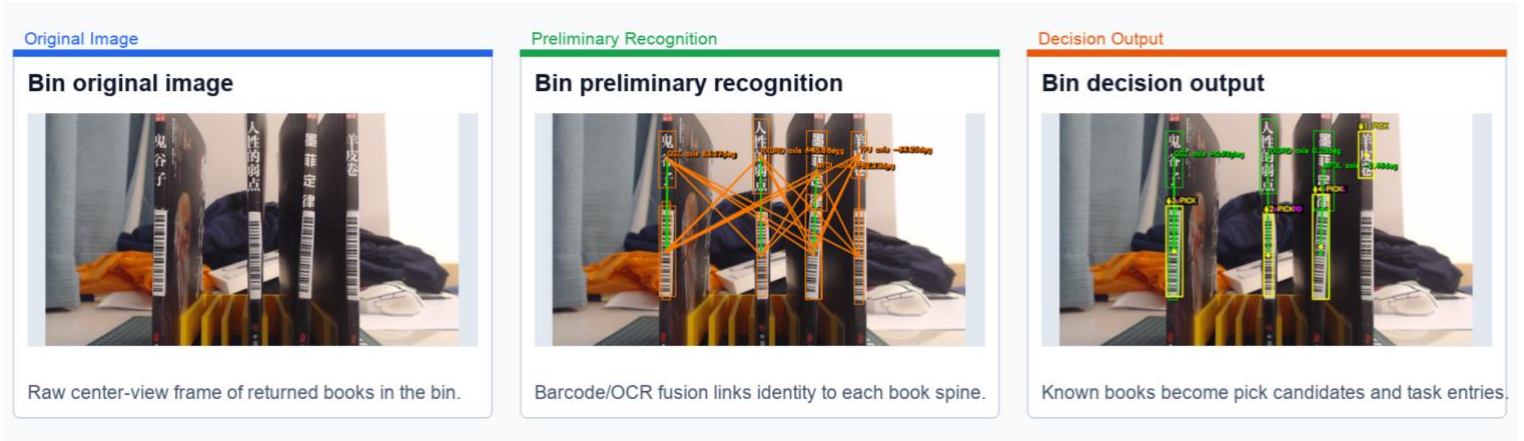
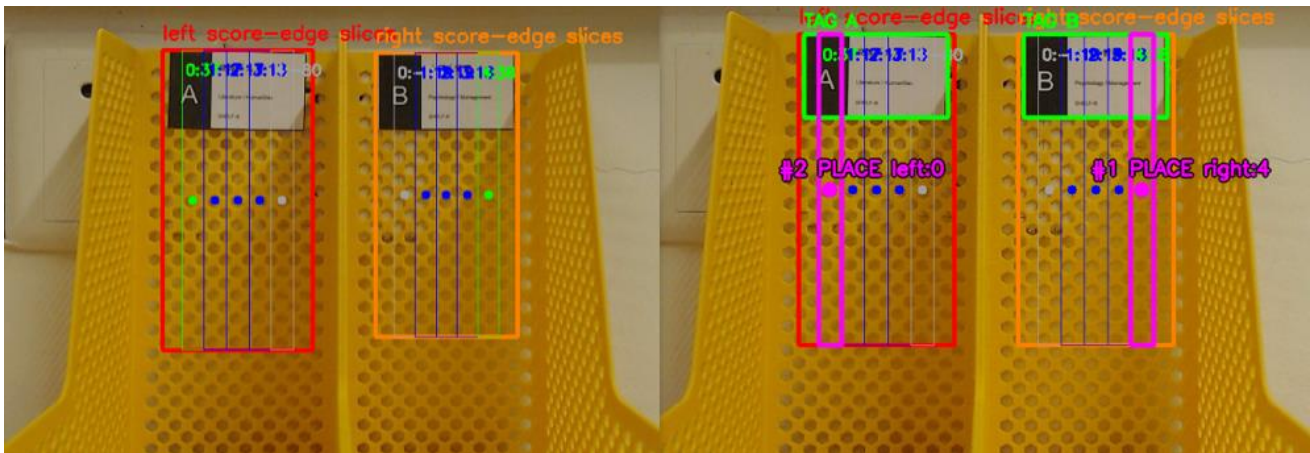


Figure 2. Bin-side perception and decision evidence: original bin view, barcode/OCR recognition, and the final pick-candidate output used by the May 21 final demo.



Example: right-edge placement updates later slice scores



Figure 3. Shelf-side A/B tag and slicing evidence: tag-bound shelf coordinate anchoring and placement-slice output used before decision-making.

Specific final-demo updates incorporated in this response:

- The final demonstrated recognition path uses barcode identity priority with OCR fallback/association and a fixed nominal grasp plane around $X = 278$ mm and $Z = 120$ mm.
- The shelf path uses A/B shelf tag recognition and tag-bound shelf slicing to initialize candidate shelf slots before decision-making.
- The decision layer records selected shelf slices and updates the world model after planned placements.
- The control layer remains accurately described as raw ASCII/PWM hardware execution through `target_sequence.py` and the ESP32 parser; ROS2 is not claimed as the final demonstrated controller.

The startup-scan report excerpt supporting these perception and world-model counts is provided in Appendix A.1, and the auto-demo task-queue excerpt is provided in Appendix A.2.

2.3 BOM completion

Aspect addressed: BOM data. We replaced the draft-stage placeholder cost description with the actual demonstration build and supporting materials: arm frame, six bus servos, ESP32S3 controller board, Logitech C920e camera, 7.4 V 2000 mAh battery/charger, mock books, 3D-printing material, fasteners, push-button module, and jumper wires. The itemized purchased/material cost totals approximately RMB 947.74.

The BOM is included here as a self-contained response item because it was one of the requested completion items.

Updated BOM evidence from the final response materials:

Component	Specification / Notes	Qty	Unit Cost(RMB)	Subtotal(RMB)
Aluminum gripper	Aluminum alloy claw	1	28	28
ZX15S bus servos	15 kg cm serial bus servo	5	55.2	276
ZX30S bus servo	30 kg cm serial bus servo	1	97	97
Lithium battery + charger	7.4V 2000mAh power system	1	65	65
ESP32S3 Groom1 board	Includes switch, buzzer, USB cable	1	209	209
Robotic arm frame	Open-source arm mechanical frame	1	105	105
Logitech C920e webcam	Used/second-hand purchase	1	99	99
Simulated books	4 mock books for demonstrations	1 set	19.78	19.78
3D printing material	Bambu PLA Basic, ~680 g used	0.68 kg	53.6/kg	36.45
Fastener set	M3x12 screws x4, M2x10 screws x3	1 set	8.81	8.81
Push-button module	Hardware button module	1	1.75	1.75
DuPont wires	Male-female jumper wires	1 set	1.95	1.95
Total	Purchased/material cost represented in BOM			947.74

2.4 Schedule completion

Aspect addressed: schedule data. Because this rebuttal is the final visible response package, the schedule is included directly here rather than deferred to an unsubmitted report revision. The first eight weeks follow the earlier draft schedule; the later five weeks are reconstructed from the project logs and final-demo artifacts.

Complete 13-week division of labor:

Period	Xinrui Xiong	Zhecheng Lou	Zehao Bao	Zhenxiong Tang
Weeks 1-2	Hardware feasibility, robotic-arm interface study, control-risk analysis, early command-path planning.	Mechanical feasibility, arm/gripper support design, early assembly planning.	Vision approach research, book-recognition stack evaluation, camera/OCR feasibility.	Decision subsystem design, state-machine outline, database/task-flow planning.
Weeks 3-4	Camera mounting, raw arm setup, serial/PWM command exploration, safety-risk checks.	Mechanical supports, gripper/camera fixture support, physical assembly refinement.	Book-recognition pipeline development, OCR/catalog matching, early localization tests.	Main program structure, book database, adapter boundaries, early task-flow implementation.
Weeks 5-6	Hardware-software integration, target-sequence generation, prototype tests, control diagnostics.	Hardware debugging, support structure adjustment, gripper/mechanical fit support.	Shelf occupancy perception, slice/scoring logic, visual overlay evaluation.	World model, task queue, planning integration, runnable baseline support.
Weeks 7-8	Final arm calibration, serial/PWM execution, failure analysis, repeated hardware tests.	Camera positioning verification, physical debugging, fixture/demo support.	Perception validation, bin/shelf detection evidence, final-report perception contributions.	End-to-end integration, decision refinement, report support, validation workflow.
Weeks 9-10	Vendor material review, MuJoCo model, IK/PWM export, raw ASCII hardware sender, startup/home pose safety.	Mechanical fit checks around the purchased frame, gripper release behavior, fixture clearance and assembly support.	C920e calibration, fixed-depth bin localization, OCR-first book-spine detection, shelf section/slice perception.	PickPlacePlan contract, perception/decision/control adapter boundaries, Auto demo shell, world-model snapshot flow.
Weeks 11-12	Button-triggered startup scan, calibration workflows, TCP/USB hardware-link handling, target sequence hardware execution and failure diagnosis.	Physical setup tuning, return-bin/shelf fixture adjustments, gripper-slip observations, demo support during hardware trials.	Barcode/OCR fusion, A/B shelf-tag detection, tag-stability gates, bin and shelf overlay evidence, unknown-title handling.	WorldModel occupancy updates, shelf-slot assignment, task queue deduplication, hardware-preview schedule and auto-demo integration.
Week 13	Final demo execution path, TCP command transmission, 54-command May 21 run evidence, BOM verification, rebuttal evidence packaging.	Final physical setup support, fixture/gripper checks, mock-book and material cost confirmation, demo logistics support.	Final barcode-priority perception counts, A/B tag/slicing evidence panels, presentation/rebuttal figure assets.	Final title-to-section mapping, four-book task queue, decision evidence, source-log packaging and rebuttal integration.

2.5 Citation cleanup

Aspect addressed: citation cleanup. We separated formal external references from internal evidence artifacts. The formal list below cites external ethics, safety, standards, and software documentation. Internal project logs and generated May 21 reports are included as evidence artifacts in Appendix A, not as external literature citations.

Formal external reference list used for cleanup:

- [1] IEEE, "IEEE Code of Ethics," IEEE. [Online]. Available: <https://www.ieee.org/about/corporate/governance/p7-8.html>. Accessed: May 27, 2026.
- [2] Association for Computing Machinery, "ACM Code of Ethics and Professional Conduct," ACM. [Online]. Available: <https://www.acm.org/code-of-ethics>. Accessed: May 27, 2026.
- [3] National Society of Professional Engineers, "NSPE Code of Ethics for Engineers," NSPE. [Online]. Available: <https://www.nspe.org/resources/ethics/code-ethics>. Accessed: May 27, 2026.
- [4] International Organization for Standardization, ISO 10218-1:2025, Robotics -- Safety requirements -- Part 1: Industrial robots, 3rd ed. Geneva, Switzerland: ISO, 2025.
- [5] International Organization for Standardization, ISO 10218-2:2025, Robotics -- Safety requirements -- Part 2: Industrial robot applications and robot cells, 2nd ed. Geneva, Switzerland: ISO, 2025.
- [6] International Organization for Standardization, ISO 12100:2010, Safety of machinery -- General principles for design -- Risk assessment and risk reduction. Geneva, Switzerland: ISO, 2010.
- [7] Occupational Safety and Health Administration, "Machine Guarding eTool," U.S. Department of Labor. [Online]. Available: <https://www.osha.gov/etools/machine-guarding>. Accessed: May 27, 2026.
- [8] Occupational Safety and Health Administration, "Control of Hazardous Energy (Lockout/Tagout), 29 CFR 1910.147," U.S. Department of Labor. [Online]. Available: <https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.147>. Accessed: May 27, 2026.
- [9] PaddlePaddle Authors, "PaddleOCR," GitHub repository and documentation. [Online]. Available: <https://github.com/PaddlePaddle/PaddleOCR>. Accessed: May 27, 2026.
- [10] OpenCV Team, "Camera Calibration and 3D Reconstruction," OpenCV documentation. [Online]. Available: https://docs.opencv.org/4.x/d9/d0c/group__calib3d.html. Accessed: May 27, 2026.
- [11] OpenCV Team, "cv::barcode::BarcodeDetector Class Reference," OpenCV documentation. [Online]. Available: https://docs.opencv.org/4.x/d6/d25/tutorial_barcode_detect_and_decode.html. Accessed: May 27, 2026.
- [12] KM1 robotic-arm vendor materials and ESP32 serial command-protocol notes, local vendor reference files and command manuals, accessed May 2026.

Limitations Kept Explicit

We also kept the final claim bounded. The project demonstrates a supervised tabletop prototype, not a fully unattended library robot. The remaining limitations are physical manipulation reliability, gripper slip, waypoint/transition collision risk, RGB-only depth limitations, and network/hardware-link sensitivity during setup. These limitations are consistent with the final demo logs and should remain visible rather than hidden.

Closing

These responses address the two reviewer comments by adding a clearer overall architecture view and by grounding the final rebuttal in the May 21 final-demo evidence rather than earlier design-stage assumptions.

Appendix A: Final Demo Evidence Used

A.1 Startup scan / bin perception

Integrated Algorithm/sim_output/startup_scan/20260521_110758/startup_scan_report.md

```
# Startup Scan Result

Status: complete
Timestamp: 2026-05-21T11:08:17
Output directory: /Users/xinruixiong/Desktop/ME470/Integrated
Algorithm/sim_output/startup_scan/20260521_110758

## Captured Views
- Center view role: `bin`; only the OCR/book/bin-grid pipeline should run here.
- Left view role: `shelf`; only the shelf edge/slice pipeline should run here.
- View role is supplied by the control scan plan, not inferred by vision.

## Detected Books
1. 羊皮卷 (confidence=1.050, pick=(278.0, 55.9, 120.0) mm,
source=nominal_book_grasp_plane_no_bin_depth+barcode_identity_priority)
2. 鬼谷子 (confidence=1.050, pick=(278.0, 10.1, 120.0) mm,
source=nominal_book_grasp_plane_no_bin_depth+barcode_identity_priority)
3. 人性的弱点 (confidence=1.050, pick=(278.0, 28.1, 120.0) mm,
source=nominal_book_grasp_plane_no_bin_depth+barcode_identity_priority)
4. 墨菲定律 (confidence=1.050, pick=(278.0, 110.1, 120.0) mm,
source=nominal_book_grasp_plane_no_bin_depth+barcode_identity_priority)
5. 羊皮卷 (confidence=0.998, pick=(278.0, 55.2, 120.0) mm,
source=nominal_book_grasp_plane_no_bin_depth)
6. 人性的弱点 (confidence=0.956, pick=(278.0, 28.3, 120.0) mm,
source=nominal_book_grasp_plane_no_bin_depth)
7. 鬼谷子 (confidence=0.973, pick=(278.0, 10.6, 120.0) mm,
source=nominal_book_grasp_plane_no_bin_depth)
8. 墨菲定律 (confidence=0.999, pick=(278.0, 107.6, 120.0) mm,
source=nominal_book_grasp_plane_no_bin_depth)

## World Snapshot
- Book entities linked to OCR: 4
- Pick candidates: 8
- Book barcode hits: 4
- Shelf/category barcode hits: 0
- Shelf template label hits: 2
- Shelf placement candidates: 10
- Initialized shelf world slots: 10
- Bin grid depth estimate: arm X=314.9 mm (camera depth=234.9 mm);
overlay=/Users/xinruixiong/Desktop/ME470/Integrated
Algorithm/sim_output/startup_scan/20260521_110758/center_bin_grid_overlay.png

## Unknown Titles
None.

## Run Notes
```

- No blocking issues recorded.
- This is a demo/user-facing summary, not an external library-system update.
- Startup scan initializes the world snapshot; it does not execute pick/place hardware.

A.2 Auto-demo task queue and command generation

Integrated Algorithm/sim_output/detected_books_loop/20260521_110842/detected_books_loop_report.md

```
# Auto Demo Result

Run status: sent
Mode: auto_demo
Books planned: 4
Books needing attention: 0
Dry run: False

## What The Robot Plans To Do
1. Move **羊皮卷** from +Y/right-side of the bin to shelf A slice 0 (lean_left) at X=-35 mm. Book is nearly vertical. Confidence 1.05.
2. Move **鬼谷子** from +Y/right-side of the bin to shelf A slice 3 (center) at X=-18 mm. Book is nearly vertical. Confidence 1.05.
3. Move **人性的弱点** from +Y/right-side of the bin to shelf B slice 4 (lean_right) at X=42 mm. Book is nearly vertical. Confidence 1.05.
4. Move **墨菲定律** from +Y/right-side of the bin to shelf B slice 1 (center) at X=25 mm. Book is nearly vertical. Confidence 1.05.

## Needs Human Attention
None.

## Technical Files
- Output directory: /Users/xinruixiong/Desktop/ME470/Integrated
Algorithm/sim_output/detected_books_loop/20260521_110842
- Combined command file: /Users/xinruixiong/Desktop/ME470/Integrated
Algorithm/sim_output/detected_books_loop/20260521_110842/loop_hardware_command_sequence.txt
- Combined command count: 54
- Visual plan overlay: /Users/xinruixiong/Desktop/ME470/Integrated
Algorithm/sim_output/detected_books_loop/20260521_110842/bin_plan_overlay.png
- Visual plan overlay: /Users/xinruixiong/Desktop/ME470/Integrated
Algorithm/sim_output/detected_books_loop/20260521_110842/shelf_plan_overlay.png

## World Model Summary
- Detected bin books: ['羊皮卷', '鬼谷子', '人性的弱点', '墨菲定律']
- Planned shelf positions: ['羊皮卷 -> demo shelf slot 1', '鬼谷子 -> demo shelf slot 2', '人性的弱点 -> demo shelf slot 3', '墨菲定律 -> demo shelf slot 4']
- Occupied demo shelf slots: ['demo shelf slot 1 (羊皮卷)', 'demo shelf slot 2 (鬼谷子)', 'demo shelf slot 3 (人性的弱点)', 'demo shelf slot 4 (墨菲定律)']
```

A.3 Console log / hardware transmission

Integrated Algorithm/sim_output/ui_console_runs/20260521_110758/console.log

Note: this excerpt preserves raw stability-check console lines as well as the final mapped barcode-priority candidates. The final semantic counts are summarized in A.1 from the generated startup-scan report.

```
[UI] started_at=2026-05-21T11:07:58
[UI] command=.venv/bin/python 主程序代码/main.py --auto-demo --bin-depth-profile stable-278 --
hardware-port tcp://192.168.4.1:3333 --hardware-baud 115200 --fixed-step-delay 2.5 --startup-scan-
settle-seconds 4 --wait-trigger button --keyboard-trigger both
[AUTO] Full-flow start trigger: physical button, Enter, or Space. One trigger starts startup scan
and the later pick/place run without a second wait.
[TRIGGER] Opened button trigger serial tcp://192.168.4.1:3333 @ 115200
@BUTTON:1!
[TRIGGER] Button start trigger received.
[STARTUP-SCAN] Shelf tag check attempt 1/until-ok: ok=True labels=2 shelves=['A', 'B']
stable=False stable_frames=1/3 window=4 reason=not_enough_stable_tag_frames
[STARTUP-SCAN] Shelf tag check attempt 2/until-ok: ok=True labels=2 shelves=['A', 'B']
stable=False stable_frames=2/3 window=4 reason=not_enough_stable_tag_frames
[STARTUP-SCAN] Shelf tag check attempt 3/until-ok: ok=True labels=2 shelves=['A', 'B'] stable=True
stable_frames=3/3 window=4 reason=None
[STARTUP-SCAN] Bin barcode check attempt 1/until-ok: ok=True raw=4 objects=4 book_barcodes=0
ocr_fallbacks=0 titles=['barcode_object_01', 'barcode_object_02', 'barcode_object_03',
```

```
'barcode_object_04'] stable=False stable_frames=1/3 window=4
[STARTUP-SCAN] Bin barcode check attempt 2/until-ok: ok=True raw=4 objects=4 book_barcodes=0
ocr fallbacks=0 titles=['barcode_object_01', 'barcode_object_02', 'barcode_object_03',
'barcode_object_04'] stable=False stable_frames=2/3 window=4
[STARTUP-SCAN] Bin barcode check attempt 3/until-ok: ok=True raw=4 objects=4 book_barcodes=0
ocr fallbacks=0 titles=['barcode object 01', 'barcode object 02', 'barcode object 03',
'barcode_object_04'] stable=True stable_frames=3/3 window=4
[LATERAL] barcode-priority candidate: '羊皮卷' payload=YPJ-A pick=(+278.0, +55.9, +120.0) mm
depth_fusion=+0.0mm lateral_x_bias=+0.0mm
[LATERAL] barcode-priority candidate: '鬼谷子' payload=GGZ-A pick=(+278.0, +10.1, +120.0) mm
depth_fusion=+0.0mm lateral_x_bias=+0.0mm
[LATERAL] barcode-priority candidate: '人性的弱点' payload=RXDRD-B pick=(+278.0, +28.1, +120.0) mm
depth_fusion=+0.0mm lateral_x_bias=+0.0mm
[LATERAL] barcode-priority candidate: '墨菲定律' payload=MFDL-B pick=(+278.0, +110.1, +120.0) mm
depth_fusion=+0.0mm lateral_x_bias=+0.0mm
[RUNTIME] Auto demo: reusing bin pick candidates from startup_scan_snapshot; building a world-
model-backed queue, then generating target_sequence commands.
[LOOP] Combined command sequence: /Users/xinruixiong/Desktop/ME470/Integrated
Algorithm/sim_output/detected_books_loop/20260521_110842/loop_hardware_command_sequence.txt (54
commands for 4 feasible book(s))
Loaded 54 command(s).
Opened TCP hardware link 192.168.4.1:3333
```

Full transmitted ASCII/PWM command sequence:

```
[HW] TX 01/54
#{000P1500T1500!#001P2000T1500!#002P2000T1500!#003P0850T1500!#004P1500T1500!#005P1500T1500!}
[HW] TX 02/54 {#005P1445T1000!}
[HW] TX 03/54 {#000P1500T1500!#001P2000T1500!#002P2000T1500!#003P0850T1500!#004P1500T1500!}
[HW] TX 04/54 {#000P1572T0800!#001P1196T1500!#002P2203T1500!#003P1839T1500!#004P1500T0400!}
[HW] TX 05/54 {#000P1562T0400!#001P1090T0800!#002P2003T1500!#003P1762T0800!#004P1500T0400!}
[HW] TX 06/54 {#005P1730T1000!}
[HW] TX 07/54 {#001P2075T1800!#002P2075T1800!#003P0850T1800!#004P1500T1800!#005P1760T1800!}
[HW] TX 08/54 {#000P2211T2500!}
[HW] TX 09/54 {#000P2211T2000!#001P1389T2000!#002P2315T2000!#003P1743T2000!#004P1500T2000!}
[HW] TX 10/54 {#004P1426T0800!}
[HW] TX 11/54 {#000P2211T2000!#001P1236T2000!#002P2383T2000!#003P1997T2000!#004P1426T2000!}
[HW] TX 12/54 {#005P1525T1000!}
[HW] TX 13/54 {#001P2075T1500!#002P2075T1500!#003P0850T1500!#004P1500T1500!#005P1500T1500!}
[HW] TX 14/54 {#000P1500T1500!}
[HW] TX 15/54 {#005P1445T1000!}
[HW] TX 16/54 {#000P1500T1500!#001P2000T1500!#002P2000T1500!#003P0850T1500!#004P1500T1500!}
[HW] TX 17/54 {#000P1495T0400!#001P1215T1500!#002P2240T1500!#003P1856T1500!#004P1500T0400!}
[HW] TX 18/54 {#000P1493T0400!#001P1109T0800!#002P2045T1500!#003P1785T0800!#004P1500T0400!}
[HW] TX 19/54 {#005P1730T1000!}
[HW] TX 20/54 {#001P2075T1800!#002P2075T1800!#003P0850T1800!#004P1500T1800!#005P1760T1800!}
[HW] TX 21/54 {#000P2179T2500!}
[HW] TX 22/54 {#000P2179T2000!#001P1396T2000!#002P2325T2000!#003P1746T2000!#004P1500T2000!}
[HW] TX 23/54 {#004P1530T0800!}
[HW] TX 24/54 {#000P2179T2000!#001P1280T2000!#002P2387T2000!#003P1923T2000!#004P1530T2000!}
[HW] TX 25/54 {#005P1525T1000!}
[HW] TX 26/54 {#001P2075T1500!#002P2075T1500!#003P0850T1500!#004P1500T1500!#005P1500T1500!}
[HW] TX 27/54 {#000P1500T1500!}
[HW] TX 28/54 {#005P1445T1000!}
[HW] TX 29/54 {#000P1500T1500!#001P2000T1500!#002P2000T1500!#003P0850T1500!#004P1500T1500!}
[HW] TX 30/54 {#000P1525T0800!#001P1211T1500!#002P2230T1500!#003P1849T1500!#004P1500T0400!}
[HW] TX 31/54 {#000P1520T0400!#001P1105T0800!#002P2035T1500!#003P1780T0800!#004P1500T0400!}
[HW] TX 32/54 {#005P1730T1000!}
[HW] TX 33/54 {#001P2075T1800!#002P2075T1800!#003P0850T1800!#004P1500T1800!#005P1760T1800!}
[HW] TX 34/54 {#000P2064T2500!}
[HW] TX 35/54 {#000P2064T2000!#001P1385T2000!#002P2309T2000!#003P1742T2000!#004P1500T2000!}
[HW] TX 36/54 {#004P1574T0800!}
[HW] TX 37/54 {#000P2064T2000!#001P1272T2000!#002P2371T2000!#003P1915T2000!#004P1574T2000!}
[HW] TX 38/54 {#005P1525T1000!}
[HW] TX 39/54 {#001P2075T1500!#002P2075T1500!#003P0850T1500!#004P1500T1500!#005P1500T1500!}
[HW] TX 40/54 {#000P1500T1500!}
[HW] TX 41/54 {#005P1445T1000!}
[HW] TX 42/54 {#000P1500T1500!#001P2000T1500!#002P2000T1500!#003P0850T1500!#004P1500T1500!}
[HW] TX 43/54 {#000P1655T1500!#001P1138T1500!#002P2098T0800!#003P1803T1500!#004P1500T0400!}
[HW] TX 44/54 {#000P1637T0400!#001P1025T0800!#002P1861T1500!#003P1684T0800!#004P1500T0400!}
[HW] TX 45/54 {#005P1730T1000!}
[HW] TX 46/54 {#001P2075T1800!#002P2075T1800!#003P0850T1800!#004P1500T1800!#005P1760T1800!}
[HW] TX 47/54 {#000P2096T2500!}
[HW] TX 48/54 {#000P2096T2000!#001P1394T2000!#002P2321T2000!#003P1745T2000!#004P1500T2000!}
[HW] TX 49/54 {#004P1470T0800!}
```

```
[HW] TX 50/54 {#000P2096T2000!#001P1279T2000!#002P2384T2000!#003P1922T2000!#004P1470T2000!}  
[HW] TX 51/54 {#005P1525T1000!}  
[HW] TX 52/54 {#001P2075T1500!#002P2075T1500!#003P0850T1500!#004P1500T1500!#005P1500T1500!}  
[HW] TX 53/54 {#000P1500T1500!}  
[HW] TX 54/54  
{#000P1500T1500!#001P2000T1500!#002P2000T1500!#003P0850T1500!#004P1500T1500!#005P1500T1500!}
```

Sequence completed.

[LOOP] Run status: sent; report: /Users/xinruixiong/Desktop/ME470/Integrated

Algorithm/sim_output/detected_books_loop/20260521_110842/detected_books_loop_report.md