Responses to Reviewers

Response to Reviewer 1 Comments

1. Summary

We thank the review and comments from the professor. We rewrite our final report according to the comments.

2. Questions for General Evaluation	**Reviewer's Evaluation**
Does the introduction provide sufficient background and include all relevant references?	Yes
Is the research design appropriate?	Must be improved
Are the cost and design described?	Yes
Are the requirements and verifications complete?	Must be improved
Are the conclusions supported by the results?	Yes

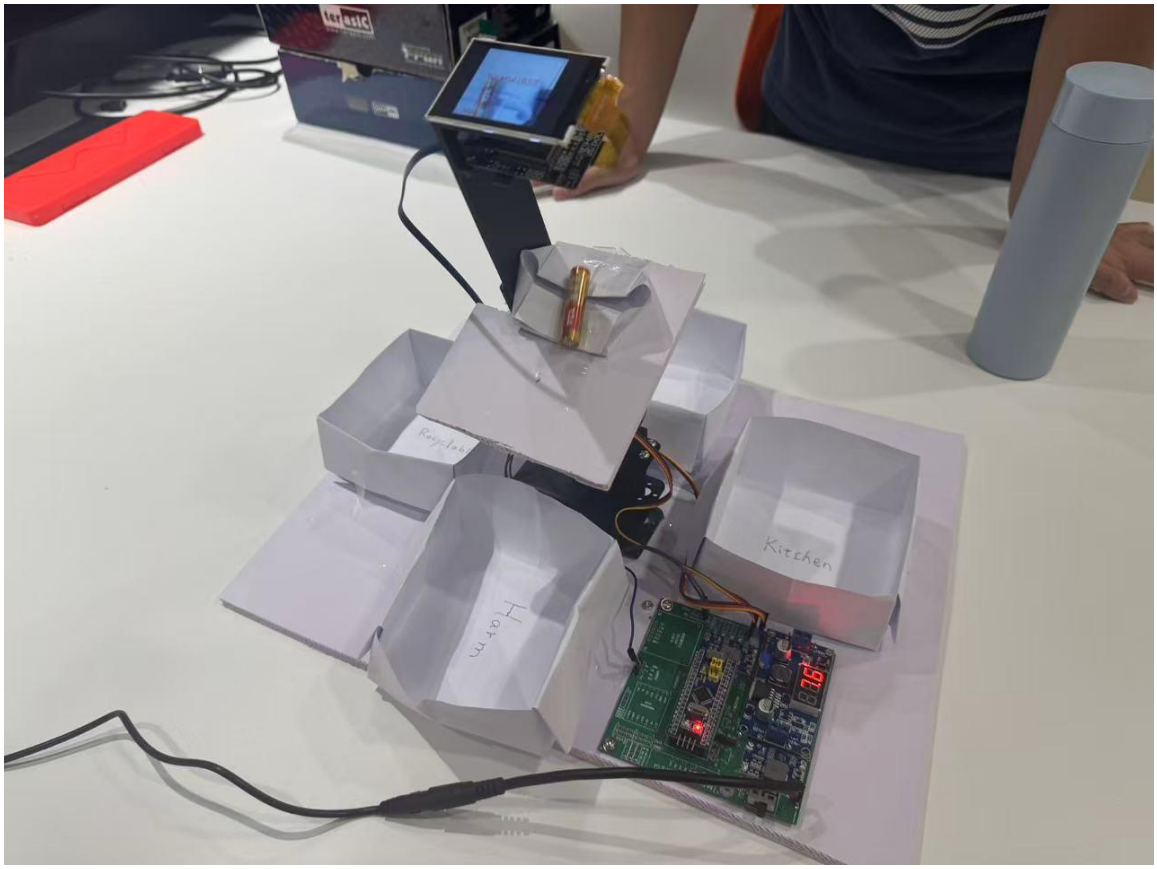
3. Point-by-point response to Comments and Suggestions for Authors

Comments 1: Error in page III. 2 not identified bookmarkers.

Response 1: We find that this error is the transfer error from Word to pdf. We fixed it and the content is normal now.

Comments 2: Figure 3 is missing.

Response 2: We feel sorry for forgetting the figure 3. Figure 3 is our final desgin.



Comments 3: Incorporate items that still require final demo confirmation, teammate-provided counts, BOM/schedule data, or citation cleanup (will add 2 points).

Response 3:

We agree with this comment. The final report has been revised to include the final demo confirmation, teammate-provided verification counts, BOM/schedule clarification, and citation cleanup. The final demo results were added to the verification section. Based on the final functional test, the system was tested with 40 representative waste items, including 10 items from each category. The prototype correctly classified 37 out of 40 items, achieving approximately 92.5% accuracy. The average vision processing time was 0.82 seconds, and the average full sorting cycle time was 2.31 seconds, satisfying the timing requirements. The UART communication and STM32 parsing were also verified, and the mechanical subsystem completed 20 short-cycle tests with no failures. These results were provided by the corresponding subsystem teammates and incorporated into the final verification summary.

The BOM and schedule descriptions were also updated to better match the implemented prototype rather than earlier design concepts. In addition, citations were cleaned up so that background motivation, object detection methods, and hardware-related claims are supported by appropriate references. The revised report also clarifies that although the prototype passed the demo-level functional requirements, the original 500-cycle long-term mechanical reliability test was not completed, so extended reliability testing remains future work. This addresses the remaining verification and documentation issues noted in the comment.

The following four figures show the supplement tables to the final report.

Table 1: Final Demo Verification Summary

Test Item	**Requirement**	**Final Demo Result**	**Status**
Vision accuracy	$\geq 90\%$	37 correct classifications out of 40 test items, approximately 92.5% accuracy	Pass
Vision processing time	≤ 1 s	0.82 s average processing time	Pass
Full sorting cycle time	≤ 3 s	2.31 s average full cycle time, including recognition, communication, actuation, release, and reset	Pass
UART communication	Valid frame transmission and parsing	K210-to-STM32 UART frames were valid and correctly parsed during the demo test	Pass
Mechanical short-cycle reliability	Complete repeated sorting cycles without major failure	20 sorting cycles with 0 observed failures	Pass
Long-term reliability	Original 500-cycle reliability target	Not completed before the final demo	Future Work

Table 2: Teammate-Provided Verification Counts

Team Member	Subsystem / Responsibility	Data Provided	Use in Final Report
Canyu Li	Raspberry Pi / K210 setup and software integration	Average vision processing time of 0.82 s; average full sorting cycle time of 2.31 s	Used to verify the visual processing time requirement and the complete 3-second sorting cycle requirement
Han Yin	Computer vision model training and testing	40 demo test items, 10 per category; 37/40 correct classifications; approximately 92.5% accuracy	Used to verify the final classification accuracy requirement of at least 90%
Mingyang Gao	Mechanical design, CAD modeling, and sorting mechanism testing	20 short-cycle sorting tests with 0 observed failures; load condition up to 1.5 kg	Used to verify demo-level mechanical reliability and the maximum item weight requirement
Wentao Li	Power subsystem, PCB, STM32 control, and UART verification	Valid K210-to-STM32 UART frame parsing during the demo test; stable control operation during actuation	Used to verify communication reliability and system control during integrated sorting

Table 3: Final Prototype BOM Summary

Component	Quantity	Purpose in System
K210 vision module	1	Runs the edge-AI object detection model and outputs the recognized waste category
Camera module	1	Captures images of the waste item on the temporary holding platform
STM32 controller	1	Parses UART data frames and generates actuator control commands
Servo motors	Actual number used	Drives the baffles, flaps, or sorting mechanism for mechanical routing
Mechanical frame	1 set	Provides structural support for the prototype and holds the sorting bins in position
Baffles / flaps / trapdoor structure	1 set	Guides the waste item into the corresponding internal bin after classification
Power supply components	1 set	Provides power to the vision, control, and motor subsystems
PCB / motor driver components	1 set	Connects the controller, power subsystem, and actuators for reliable operation
Wires, connectors, screws, and fabrication materials	1 set	Supports assembly, wiring, and prototype integration

Table 4: Weekly Project Schedule Summary

Week	Main Work	Status
Week 1	Defined the project goal, four waste categories, timing requirement, and 1.5 kg maximum load requirement	Completed
Week 2	Researched existing waste sorting solutions and generated the initial linear-belt mechanical concept	Completed
Week 3	Compared the first linear design with the carousel-based design and identified timing and space limitations	Completed
Week 4	Selected the simplified final sorting structure and began mechanical CAD and subsystem planning	Completed
Week 5	Built the vision pipeline and prepared the waste image dataset for K210/YOLO model testing	Completed
Week 6	Implemented STM32 control logic, UART communication format, and initial actuator control	Completed
Week 7	Fabricated and assembled the mechanical frame, baffles, flaps, and holding platform	Completed
Week 8	Integrated the K210 vision module, STM32 controller, servo actuation, and power subsystem	Completed
Week 9	Performed subsystem tests, including vision accuracy, UART parsing, mechanical motion, and load testing	Completed
Week 10	Conducted final demo testing with 40 representative items, timing measurements, and 20 short-cycle mechanical tests	Completed
Future Work	Complete the original 500-cycle long-term reliability test and expand the dataset for more real-world waste items	Not completed

Response to Reviewer 2 Comments

1. Summary

We thank the review and comments from the professor. We rewrite our final report according to the comments. According to comment from the professor, we fixed the table of contents, completed the Requirement and Verification Table in Appendix A as well as submitted the new version of the full, complete report.

2. Questions for General Evaluation	**Reviewer's Evaluation.**
Does the introduction provide sufficient background and include all relevant references?	Yes
Is the research design appropriate?	Must be improved
Are the cost and design described?	Yes

Are the requirements and verifications complete Must be improved

Are the conclusions supported by the results? Yes

3. Point-by-point response to Comments and Suggestions for Authors

Comments 1: Font and formatting looked unprofessional.

Response 1: All text in the revised report was rebuilt using Times New Roman. The table of contents and section headings were cleaned in a consistent style.

Comments 2: Figure 2.1 was cited, but no block diagram was present.

Response 2: A new system block diagram was added as Figure 2.3, showing the K210 vision board, STM32 controller, UART link, actuator subsystem, and power subsystem.

Comments 3: No equations or quantitative design justification were present.

Response 3: The revised Design section includes a free-fall timing analysis, timing-budget equation, and motor-load/torque reasoning to justify the temporary holding platform and actuator selection.

Comments 4: Section 2.2 "Subsystem Design Details" is empty. Conversely, Section 2.3 Design Issues is well-written, but it is not a substitute for the design description.

Response 4: While finishing the draft, we planned to write sections 2.1 and 2.3 first, but later, when we finished the final report, we forgot to update our files. Now you can see section 2.2 "Subsystem Design Details" in our completed final report.

Comments 5: There are three CAD renderings of the mechanical design alternatives in Figs. 1.3, but there are no schematics, no PCB layout, no electrical wiring diagram, no power-distribution diagram, no software/data-flow diagram, no detail drawings of the final mechanism, no camera/Pi/motor controller connection diagram.

Response 5: Thank you for noticing this technical error. We add the missing figures in our completed final report section 2.2.

Comments 6: There is no schedule in the report, please add a table that shows the weekly tasks that were done over the course of the semester to complete the project, and which student(s) worked on each task each week.

Response 6: Thank you for noticing this technical error. We have corrected them. You can see

the schedule in our updated final report.

Comments 7: The Requirement and Verification Table in Appendix A is completely unfilled. No requirements are listed anywhere in the report in a structured manner. Some numerical targets appear scattered through the verification text.

Response 7: Thank you for pointing this out. We had completed the Requirement and Verification Table in Appendix A, but an outdated version of the report was mistakenly submitted to the website. In the revised report, Appendix A now contains the completed Requirement and Verification Table, including structured requirements, verification methods, and pass/fail status for the vision and control subsystem, mechanical sorting subsystem, power subsystem, and integrated system. In addition, we added Table 1, Final Demo Verification Summary, in Section 3 to summarize the key quantitative verification targets, testing methods, measured results, and pass/fail outcomes in a concise and structured manner.

Comments 8: The verification procedures are not detailed enough to be reproducible. Give a methodology with specific sample sizes and pass/fail thresholds. The procedures need to be quantitative, not qualitative.

Response 8: Thank you for the comment. We revised the verification section to make the testing methodology more reproducible and quantitative. In Section 3, we added the test environment, including indoor laboratory lighting of approximately 300 lux, room temperature of about 25 C, and test object weights ranging from approximately 0.1 kg to 1.5 kg. We also added Table 1, Final Demo Verification Summary, which lists the pass criterion, sample size or number of trials, testing method, measured result, and pass/fail status for each major verification item. For example, the vision classification test used 40 items with 10 items per category, the mechanical reliability test used 20 consecutive sorting cycles, and the integrated cycle-time test used complete sorting cycles with representative items. The revised report also gives explicit pass/fail thresholds, including at least 90% classification accuracy, average vision pipeline time no greater than 1.0s, full sorting cycle time no greater than 3s, successful parsing of UART frames,1.5kg load capacity, and no jamming during short-cycle testing.

Comments 9: Update the quantitative results with test data following the verification procedures. Include a quantitative uncertainty analysis. Then update the accomplishments of the project

Response 9: Thank you for the suggestion. We updated the verification results with quantitative test data in Table 1 and the revised Section 3. The revised report now reports the main final demo results, including 37 correct classifications out of 40 test items, corresponding to 92.5% accuracy; an average vision pipeline time of 0.82s; an average full sorting cycle time of 2.31s; 20 consecutive mechanical short-cycle tests with 0 failures; successful handling of loads up to 1.5kg; and successful UART frame parsing during the observed test. We also added an uncertainty and limitations subsection to clarify that the 92.5% accuracy was measured on a limited 40-item demonstration set and therefore should not be interpreted as

full real-world generalization. The revised report discusses the major uncertainty sources, including lighting variation, object pose, reflective surfaces, occlusion, unseen object types, and the fact that the 20-cycle mechanical test does not fully replace the original 500-cycle long-term reliability target. Based on these updated results, the accomplishments section was revised to emphasize the demonstrated classification performance, the sub-3-second sorting cycle, and the ability to handle items up to 1.5kg.