
Responses to Reviewers

Response to Reviewer 1 Comments

1. Summary

We sincerely thank the reviewer for the helpful comments on our final report. The reviewer pointed out two main issues. First, the Design section needed clearer visual documentation of the physical prototype, including real photos, labeled components, and a brighter replacement for the original Figure 2. Second, the Requirements and Verification section needed quantitative experimental results rather than only a verification plan. In particular, the reviewer requested the overall material-identification accuracy and the number of repeated mechanical sorting trials used to verify smooth bin or servo movement.

2. Questions for General Evaluation

Reviewer's Evaluation

Introduction	4/5
Design	7/9
Cost and Schedule	2/2
Requirements and Verification	6/8
Conclusions	5/6
Total Score	24

Reviewer's Comments

Design: Add real photos and figures of the whole system. Label the components. Improve Figure 2 because it is too dark.

Requirements and Verification: Verification lacks quantitative experimental data. What is the overall accuracy of identifying the type of objects? How many repetitions did the team try to move the bin smoothly? Say 100 times or 500 times. Do some tests.

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

Comment 1: Add real photos and figures of the whole system. Label the components. Improve Figure 2 because it is too dark.

Response 1: We agree with the reviewer. The original Figure 2 was too dark and did not clearly show the physical layout of the prototype or the relationship among the main components. In the revised report, we improved the Mechanical Structure subsection by adding a clearer set of mechanical figures. The original dark figure was replaced and supplemented with three views: an assembled CAD rendering, an exploded mechanical structure view, and a labeled physical prototype photo. The assembled CAD rendering shows the overall geometry of the three-tier acrylic structure. The exploded view clarifies the layer-by-layer assembly, including the inlet, top layer, middle layer, bottom layer, slide, and support studs. The labeled prototype photo identifies the major components of the final system, including the object feeding tube, backboard, upper acrylic guide plate, support rods, auxiliary sensor module, camera, main routing platform, servo motor, secondary servo/gate actuator, Arduino UNO, and output bins. These revisions make the mechanical design easier to understand from the perspectives of assembled structure, structural decomposition, and physical implementation. The change can be found in Section 2.4.2, the Mechanical Structure figures.

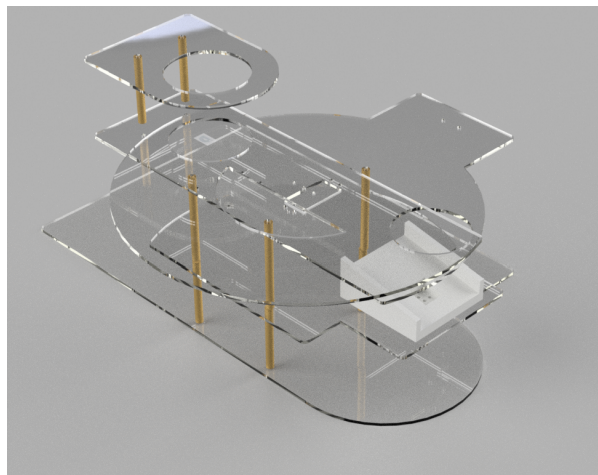


Figure 1: Assembled CAD rendering added in the revised Mechanical Structure subsection.

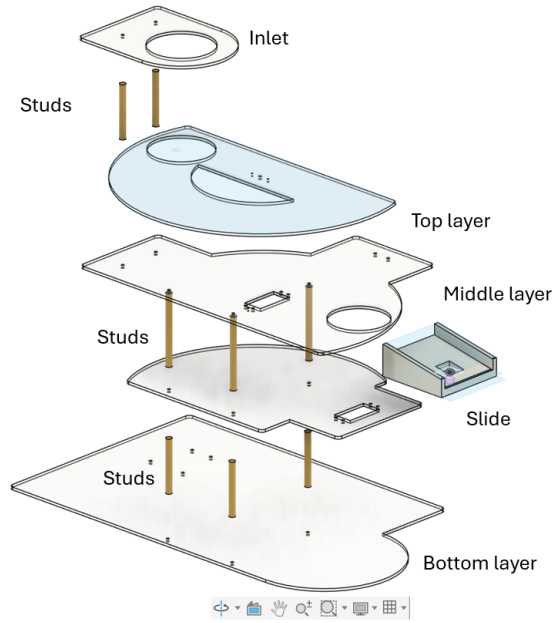


Figure 2: Exploded mechanical structure view added in the revised Mechanical Structure subsection.

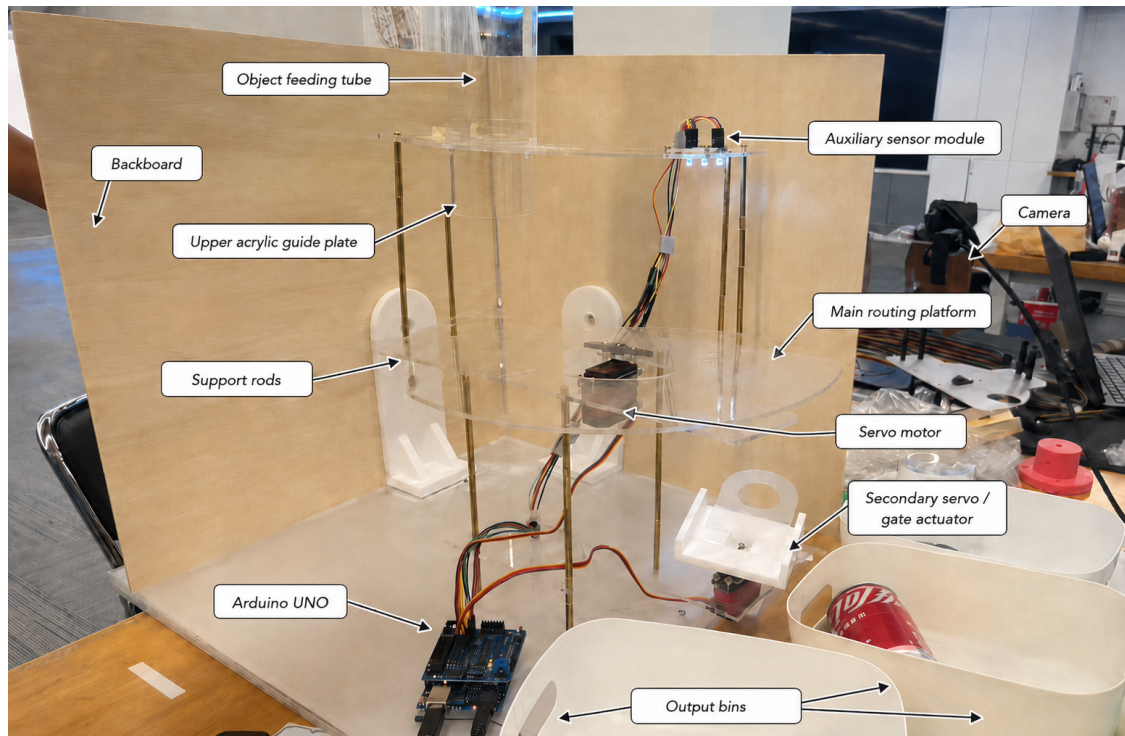


Figure 3: Labeled physical prototype photo added in the revised Mechanical Structure subsection.

[To improve the readability of the mechanical design, the Mechanical Structure subsection was revised with three complementary figures. The revised figures include an assembled CAD rendering of the three-tier mechanical structure, an exploded view showing the inlet, top layer, middle layer, bottom layer, slide, and support studs, and a labeled physical prototype photo. The physical prototype photo identifies the object feeding tube, backboard, upper acrylic guide plate, support rods, auxiliary sensor module, camera, main routing platform, servo motor, secondary servo/gate actuator, Arduino UNO, and output bins. Together, these figures more clearly show the overall mechanical layout, layer-by-layer assembly, and final fabricated implementation of the sorting system.]

Comment 2: Verification lacks quantitative experimental data. What is the overall accuracy of identifying the type of objects? How many repetitions did the team try to move the bin smoothly? Say 100 times or 500 times. Do some tests.

Response 2: We agree with the reviewer. The original Requirements and Verification section mainly described the verification plan, but it did not include enough measured quantitative results. In the revised report, we updated this section by adding experimental results for the vision classification subsystem, the Arduino/servo command-response test, and the full-system sorting test.

For the vision subsystem, we evaluated the Random Forest classifier on a stratified held-out test set rather than on the full physical sorting process. The held-out test set consisted of approximately 30% of the collected images and was separated from the training set before model training. The classifier correctly predicted 806 out of 820 held-out test images, resulting in a test-set material-classification accuracy of 98.3%.

For the control and actuation subsystem, we tested the Arduino communication and servo response using 100 repeated command cycles. The Arduino correctly decoded all commands, the servo reached the expected calibrated positions in all trials, and the mechanism returned to the neutral position after each sorting action.

For the complete physical sorting process, we performed 200 full-system trials. A trial was counted as successful only if the object was detected, classified, transmitted to the Arduino as a class code, and guided into the intended output bin. Among the 200 trials, 185 were successful, corresponding to a full-system sorting success rate of 92.5%.

The change can be found in Section 3, the Requirements and Verification results.

Table 1: Summary of added quantitative verification results.

Verification Item	Number of Trials	Successful / Correct Trials	Result
Vision classification on held-out test set	820	806	98.3%
Arduino command decoding	100	100	100.0%
Servo movement to target angle	100	100	100.0%
Return-to-neutral motion	100	100	100.0%
Full-system physical sorting	200	185	92.5%

[The computer vision subsystem was evaluated using a stratified held-out test set rather than the full physical sorting process. The held-out test set consisted of approximately 30% of the collected images and was separated from the training set before model training. The test set included 820 images in total, including 21 background images, 288 paper images, 244 aluminum-can images, and 267 plastic-bottle images. For each test image, the predicted label was compared with the ground-truth label. The classifier correctly predicted 806 out of 820 held-out test images, resulting in a test-set material-classification accuracy of 98.3%. This result evaluates the material-recognition performance of the vision model only. The complete physical sorting performance, which also includes serial communication, servo motion, object sliding, and bin entry, was evaluated separately in the full-system integration test.]

[The Arduino communication and servo mechanism were tested through repeated command cycles. Codes 0 to 3 were sent from the vision computer to the Arduino, and the corresponding servo response was observed. A total of 100 command cycles were tested. The Arduino correctly decoded all commands, the servo reached the expected calibrated positions in all trials, and the mechanism returned to the neutral position after each sorting action. The command-response success rate was 100.0% for all three tested items.]

[The full sorting process was tested using representative paper, aluminum-can, and plastic-bottle samples. A trial was counted as successful only if the object was detected, classified, the Arduino received the correct command, and the object entered the intended output bin. The full-system test included 200 physical trials in total, and 185 trials were successful. The resulting full-system sorting success rate was 92.5%.]

Response to Reviewer 2 Comments

1. Summary

We sincerely thank the reviewer for the helpful comments on our final report. The reviewer requested a clearer explanation of the vision training dataset size. The original report described ROI cropping, feature extraction, and Random Forest classification, but it did not clearly state how many images were collected, how the images were distributed across classes, or how the dataset was split for training and testing. In response to this comment, we revised the Design section to include the dataset size, class distribution, data collection condition, and stratified train-test split.

2. Questions for General Evaluation

Reviewer's Evaluation

Introduction	4/5
Design	7/9
Cost and Schedule	2/2
Requirements and Verification	5/8
Conclusions	6/6
Total Score	24

Reviewer's Request

Add explanation of vision training data size.

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

Comment 1: Request: Add explanation of vision training data size.

Response 1: We agree with the reviewer. The original report explained the vision pipeline, including ROI cropping, feature extraction, and Random Forest classification, but it did not provide enough information about the size and composition of the training dataset. In the revised report, we added a dedicated paragraph and a dataset summary table in the Vision Perception Module subsection. The revised section now reports the total number of labeled images, the number of images in each class, and the collection condition of the dataset. We also clarified that the images were collected under the final prototype camera and lighting setup and that the dataset was divided using a stratified train-test split before training the Random Forest classifier. The change can be found in Section 2.3.2, the Vision

Perception Module subsection.

Table 2: Summary of added vision dataset information.

Data Source	Background	Paper	Aluminum	Plastic	Total
All collected images	70	961	813	891	2735

[The vision dataset was collected using the same camera position and lighting condition as the final prototype. Four image classes were used in the training process: background, paper-based waste, aluminum beverage cans, and plastic bottles. The dataset contained 2735 labeled images in total, including 70 background images, 961 paper images, 813 aluminum-can images, and 891 plastic-bottle images.]

[The images were collected with small variations in object position, rotation, distance from the camera, and surface orientation to improve the robustness of the classifier. For each image, the predefined region of interest was cropped and converted into a numerical feature vector using color, brightness, edge, contour, highlight, dark-area, and normalized color-ratio features. The dataset was divided into training and testing subsets using a stratified split so that each material class was represented in both sets. The held-out test-set performance of the trained Random Forest classifier is reported in the Requirements and Verification section.]

Summary of Major Revisions

[The revised report addresses the reviewers' main concerns by improving the mechanical figures, adding component labels, explaining the vision training dataset size, and supplementing the verification section with quantitative experimental results. In the Design section, the original dark mechanical figure was replaced and supplemented with three clearer views: an assembled CAD rendering, an exploded mechanical structure view, and a labeled physical prototype photo. The labeled prototype photo identifies the major hardware components, including the object feeding tube, upper acrylic guide plate, auxiliary sensor module, camera, main routing platform, servo motor, secondary servo/gate actuator, Arduino UNO, support rods, backboard, and output bins.

The revised report also adds the size and class distribution of the vision dataset. The dataset contains 2735 labeled images in total, including 70 background images, 961 paper images, 813 aluminum-can images, and 891 plastic-bottle images. In the Requirements and Verification section, the report now includes quantitative results for the vision classifier, Arduino/servo command response, and full-system sorting process. The vision

classifier achieved 98.3% accuracy on a stratified held-out test set. The Arduino/servo command-response test achieved 100.0% success over 100 command cycles. The full-system physical sorting test achieved 92.5% success over 200 trials. These revisions make the final report clearer, more reproducible, and better supported by measured system performance.]

We sincerely appreciate the reviewers' comments, which helped us improve the clarity, reproducibility, and technical completeness of the final report.