

Responses to Reviewers

Response to Reviewer 1 Comments

1. Summary

We sincerely thank the reviewer for the helpful comments and suggestions. Based on the feedback, we revised the final report to improve the clarity, completeness, and technical accuracy of the design documentation. The major revisions include adding subsystem-level electrical schematics, expanding the weekly project schedule with individual responsibilities, and rewriting the uncertainty analysis to focus on the HX711 load cell measurement system. Detailed point-by-point responses are provided below.

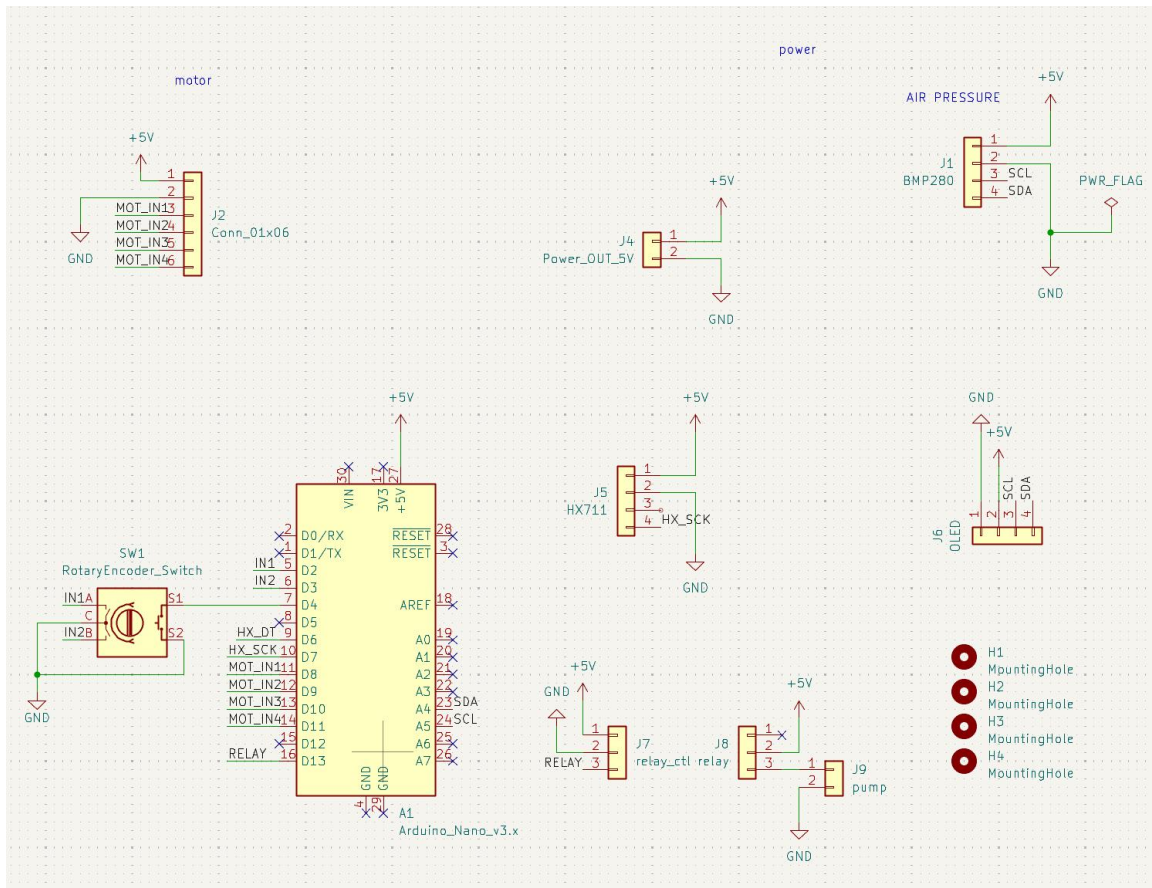
2. Point-by-point response to Comments and Suggestions for Authors

Comments 1:

The PCB layout is included, as well as CAD, but no electrical schematic is provided. Please produce circuit diagrams for the MOSFET motor driver, the relay control, the HX711 wiring, power distribution, or any subsystem-level schematic.

Response 1:

Thank you for pointing this out. We agree that the original report did not provide sufficient circuit-level information. Although the previous version included the system block diagram, PCB layout, and CAD structure, it did not clearly show how the electrical subsystems were connected and controlled. This made the electrical design difficult to reproduce and verify. Here is the electronic schematic:



Comments 2:

Please provide the weekly project schedule that the team used to complete this project, showing tasks that lead up to the final development of the prototype and which student(s) worked on each during each week.

Response 2:

Thank you for this suggestion. We agree that the original schedule was too general and did not fully describe the week-by-week development process. Although the original design document included a schedule table with major tasks and team members, it did not provide enough detail about how the prototype was developed over time .

We expanded the schedule section to include a more detailed weekly project timeline. The new schedule describes the major tasks completed each week, the development milestones, and the student(s) responsible for each task. The revised schedule now better reflects the actual development process from proposal refinement to final prototype testing.

March 15 - March 31	Revised proposal, confirmed system requirements, selected major components, created initial block diagram, began CAD structure planning	Everyone
March 15 - March 31	Component research for sensors, microcontroller, load cell, motor, pump, and display	Shining, Zixin
March 15 - March 31	Initial CAD modeling and mechanical	Yuyang, Gaoning

	housing design	
April 1 - April 7	Electrical subsystem planning, power distribution design, and schematic preparation	Shining
April 1 - April 7	Arduino testing for rotary encoder, OLED display, pressure sensor, and basic button input	Zixin
April 1 - April 7	Continued CAD refinement and container structure design	Yuyang
April 1 - April 7	Component ordering and mechanical feasibility checking	Gaoning
April 8 - April 12	Breadboard testing of motor control and relay control	Zixin, Shining
April 8 - April 12	HX711 load cell setup and preliminary calibration	Zixin
April 8 - April 12	Finalized 3D model and prepared parts for manufacturing/assembly	Yuyang, Gaoning
April 13 - April 22	Integrated motor, load cell, OLED, encoder, and vacuum pump into one control system	Zixin
April 13 - April 22	Debugged mechanical dispensing structure and reduced jamming problems	Gaoning, Yuyang
April 13 - April 22	Verified power delivery and relay switching under load	Shining
April 23 - April 28	Improved dispensing control logic, including tare-before-dispensing and no-rice detection	Zixin
April 23 - April 28	Completed prototype assembly and mechanical finishing	Yuyang, Gaoning
April 23 - April 28	Conducted mock demo and integration testing	Everyone
April 29 - May 7	Final system testing, load cell calibration, dispensing accuracy testing, and vacuum function testing	Everyone
April 29 - May 7	Prepared final presentation and demonstration script	Everyone
May 8 - May 25	Completed final report, revised design documentation, added schematics and uncertainty analysis	Everyone

Comments 3:

For the uncertainty analysis, add a discussion about the resolution and the accuracy of the load cell that you used to measure the mass of dispensed rice. What is the finest amount of

mass that your load cell can discern?

Response 3:

Thank you for this important comment. We agree that the original tolerance analysis did not focus on the most critical source of dispensing uncertainty: the load cell measurement system. Since the final dispensing accuracy depends directly on the measured rice mass, Here includes a specific uncertainty analysis for the HX711 load cell subsystem.

In the final prototype, the load cell is read through an HX711 amplifier module. The HX711 data pin is connected to Arduino D6, and the clock pin is connected to Arduino D7. Before each dispensing cycle, the system enters a tare state. During this state, the container is placed on the weighing platform and the system performs a tare operation to remove the container mass from the measurement. This allows the controller to measure only the dispensed rice mass during operation.

During dispensing, the software reads the HX711 multiple times and uses the averaged value to reduce noise. In the final code, each weight update is calculated using the average of five HX711 readings. This helps reduce short-term fluctuation caused by electrical noise, motor vibration, and small mechanical disturbances. The final code also prevents temporary measurement drops from affecting the accepted weight value. Because the amount of rice in the container should physically increase during dispensing, the software only updates the accepted weight if the new reading is greater than the previous accepted reading. This prevents issues such as the measured weight briefly dropping because of vibration or sensor noise.

Although the HX711 has a high theoretical ADC resolution, the practical resolution of the assembled prototype is lower because of real-world noise sources. These include motor vibration, contact instability between the container and weighing platform, electrical noise, and small movements of rice during dispensing. Therefore, the finest reliable mass change should be evaluated based on the assembled system rather than the theoretical ADC resolution alone.

In our final implementation, the smallest reliable weight change used by the software is approximately 1 g. The final code sets the weight-progress threshold to 1.0 g, meaning the system treats a mass increase of at least 1 g as a reliable indication that rice is still being dispensed. Smaller changes may be difficult to distinguish from normal measurement noise, so they are not used as reliable progress indicators.

This practical resolution is sufficient for the project's dispensing accuracy requirement. The high-level requirement states that the dispenser should dispense the selected rice mass with an error no greater than $\pm 5\%$. For the minimum target mass of 100 g, $\pm 5\%$ corresponds to ± 5 g. Since the practical load cell resolution is approximately 1 g, the measurement resolution is smaller than the allowed error range. Therefore, the load cell subsystem provides adequate resolution for meeting the dispensing accuracy requirement.

The revised uncertainty analysis also discusses the main sources of measurement error:

1. **Tare offset error:** Reduced by performing tare before every dispensing cycle.
2. **Electrical noise:** Reduced by averaging multiple HX711 readings.
3. **Motor vibration:** Reduced in software by filtering and by accepting only non-decreasing weight values during dispensing.

4. **Mechanical instability:** Reduced by requiring the container to remain still during tare and by using a stable weighing platform.
5. **Rice flow delay:** Addressed by using real-time feedback and stopping the motor when the measured mass reaches the target.

In addition, the software includes a no-rice or blockage detection mechanism. Instead of stopping simply after a fixed dispensing time, the controller monitors weight progress. If the measured weight does not increase by at least 1 g within the timeout window, the system assumes that rice is not flowing or that the mechanism is blocked, then stops the motor and displays an error message. This logic makes the system more robust than a purely time-based dispensing approach.

Response to Reviewer 2 Comments

1. Summary

We sincerely thank the reviewer for the detailed evaluation of our final report. We appreciate the clear feedback on the missing or incomplete sections. Based on these comments, we revised and supplemented the report materials by improving the block diagram description, adding equation numbers, providing an itemized cost list and weekly work schedule, and expanding the conclusion with uncertainty analysis and future work.

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

Comments 1:

Introduction: Block diagram too simplistic, missing what is flowing to what.

Response 1:

Thank you for pointing this out. We agree that the original block diagram was too high-level and did not clearly show what type of information, power, or material flowed between subsystems. To address this issue, we added a more detailed explanation of the system-level block diagram.

In the revised description, the flows are separated into three categories: power flow, signal/data flow, and material/mechanical flow. The external power supply provides power to the Arduino Nano and the higher-current components such as the DC gear motor and vacuum pump. The Arduino receives data from the HX711 load cell module, BMP280 pressure sensor, and rotary encoder. It then sends control signals to the motor driver circuit, relay module, and OLED display. The material flow begins with rice stored in the container, which is moved by the dispensing mechanism into the weighing container. The load cell measures the dispensed rice mass and sends feedback to the controller so that the motor can stop when the target mass is reached.

Added / Revised Material

We added a more detailed block diagram explanation to clarify the following flows:

Power flow: external power supply → Arduino / motor circuit / pump circuit

Data flow: sensors and user input → Arduino

Control flow: Arduino → motor driver, relay, OLED display

Material flow: rice container → dispensing mechanism → weighing container

Feedback flow: load cell → HX711 → Arduino → motor stop decision

This makes the overall system operation clearer and addresses the concern that the original block diagram was too simplistic.

Comments 2:

Design: Missing equation numbers.

Response 2:

Thank you for pointing out this formatting issue. We agree that equations in the design section should be numbered so they can be clearly referenced in the text.

In the revised material, we added equation numbers to the equations related to dispensing mass measurement and dispensing error. Since the final prototype uses real-time load cell feedback, the most important equations are the measured dispensed mass and the percent error relative to the user-selected target mass.

The dispensed rice mass is calculated as:

$$m_{dispensed} = m_{measured} - m_{tare} \quad (1)$$

where $m_{measured}$ is the load cell reading after rice is dispensed and m_{tare} is the container mass removed during the tare operation.

The dispensing error is calculated as:

$$Error(\%) = \frac{|m_{dispensed} - m_{target}|}{m_{target}} \times 100\% \quad (2)$$

where m_{target} is the target mass selected by the user.

These equations are directly related to the project requirement that the dispenser should achieve a final mass error no greater than $\pm 5\%$.

Comments 3:

Cost and Schedule: Missing itemized list of costs.

Response 3:

Thank you for the comment. We would like to clarify that the original report did include an itemized Bill of Materials in Section 3.1, labeled as “Table 7: Itemized list of components and costs.” The table listed purchased components, quantities, and total costs.

However, we understand that the table formatting may not have made the cost information sufficiently clear. Some of the columns were difficult to read in the submitted version, and the final parts cost and labor cost were not visually separated in a clear summary table.

Therefore, we clarified and reformatted the itemized cost list in the rebuttal.

Item	Numbers	Price/RMB
3D Printed Parts	1546g	51
Square Silicone Ring	1	15
Round Silicone Ring	1	15
Silicone Gasket	4	0.44
Silicone Through-Hole Plug	1	0.53
Silicone Plug	1	4.87
Linear Rod Bearing	1	5.07
Air Tube	1	5.5
M8 Screw	12	11.6

M8 Nut	12	8.9
HX711 Electronic Scale Frame Load Sensor	1	22.5
PCB	5	200
220V Transformer	1	25.74
Electronic Switch Control Board	1	6.1
JGB37-520 DC Geared Motor	1	20.76
5V 2A Power Adapter	1	10.69
28BYJ48 5-Wire 4-Phase Stepper Motor with ULN2003 Driver	1	3.9
EC11 Rotary Encoder Digital Potentiometer	1	3.22
HX711 Module	1	3.38
Single / Double Row Pin Header	1	4.67
DC 5.5 × 2.1 mm Splitter Connector	1	4.02
12V Female to 5V Male DC Cable	2	11.44
Dupont 1-to-2 Cable	2	5.5
Arduino Nano 328P Development Board	1	17
220V Transformer	1	18.81
40P Dupont Cable	1	7.08
Atmospheric Pressure Sensor	1	6.5
Micro Solenoid Valve	1	4.31
High-Flow 555 Air Pump	1	22
BMP280 High-Precision Atmospheric Pressure Sensor	1	9.79
Relay Module	2	13.07
Arduino Nano 328 Development Board	1	12.92
Through-Hole LED	1	0.49
DC Power Plug and Socket	2	0.3
4-Phase 5-Wire Stepper Motor	1	4.8
Through-Hole LED Bead	1	0.99
1-Channel 5V Relay Module	3	10.38
UMW ULN2003A SOP	2	0.72
LM2596S DC-DC Buck Converter	1	3.96
EC11 Metal Shaft Rotary Encoder	1	2.09
DHT22 / AM2302 Digital Temperature and Humidity Sensor	1	5.28
2-Channel 5V Relay Module	1	6.13
OLED Display Module	1	10.89
Total		597.34

Comments 4:

Cost and Schedule: Missing work schedule.

Response 4:

Thank you for this comment. We would like to clarify that the original report did include a

work schedule in Section 3.2, labeled as “Table 8: Schedule for Final Project.” The schedule listed weekly tasks from March 15 to May 15 and included responsible team members for major tasks such as proposal revision, component selection, PCB design, Arduino code development, CAD modeling, system debugging, final testing, and documentation .

However, we understand that the original schedule may have been too condensed and may not have clearly shown the full week-by-week development process leading to the final prototype. To address this issue, we have clarified and expanded the schedule, you can find it in the response 2 of the previous response.

Comments 5:

Conclusion: Missing uncertainties and future work.

Response 5:

Thank you for this suggestion. We agree that the original conclusion did not sufficiently discuss uncertainties and future improvements. We expanded the conclusion to include both the main sources of uncertainty in the final prototype and possible future work.

The main uncertainty in the system comes from the load cell measurement subsystem. Although the HX711 has a high theoretical ADC resolution, the practical resolution of the assembled prototype is limited by motor vibration, electrical noise, mechanical contact between the container and the load cell platform, and rice movement during dispensing. In the final implementation, the smallest reliable weight change used by the software is approximately 1 g. The software performs a tare operation before each dispensing cycle, averages multiple HX711 readings, and only updates the accepted weight when the measured value increases. These steps reduce the effects of short-term noise and vibration.

There are also uncertainties related to mechanical dispensing. Rice grains do not always flow uniformly, and temporary jamming or slow flow can affect dispensing speed. To address this, the software does not stop based only on elapsed time. Instead, it checks whether the measured weight continues to increase. If the weight does not increase by the required threshold for a long period, the system identifies a no-rice or blockage condition and stops the motor.

The vacuum function also has possible uncertainty because the final pressure depends on the sealing quality of the container, pump performance, and small leaks in the structure. Future improvements should include a better-sealed container, more precise pressure testing, and longer-term storage experiments.

Future work includes:

Improving the mechanical dispensing structure to reduce jamming and make rice flow smoother.

Using a more robust motor driver circuit for better DC motor control.

Improving the enclosure sealing to make the vacuum function more stable.

Testing the system with different rice types and different