Department of Electronics and Communication Engineering

Vasavi College of Engineering (Autonomous)

ACCREDITED BY NAAC WITH ‘A++’ GRADE

IBRAHIMBAGH, HYDERABAD-500031

CERTIFICATE

This is to certify that the Theme Based project titled “Grain Ratio-Rite Meter” submitted by:

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Students of the Electronics and Communication Engineering Department, Vasavi College of Engineering in partial fulfilment of the requirement of the award of the Degree of Bachelor of Engineering in Electronics and Communication Engineering is a record of the bonafide work carried out by them during the academic year 2023-2024.

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1. ABSTRACT

Ratio-Rite Grain mixer is a device that mixes two or more different types of grains in a specific ratio as defined by the user.

This takes n- types of grains in some fixed ratio r1: r2: r3: r4…. and mixes it in that particular ratio making sure that the total quantity doesn't exceed the necessary total weight.

This is primarily used in rice milling industries to mix different types of grains evenly in a certain ratio

For example, A traditional rice bag filled in a rice mill can have white rice, discolour, broken rice, and frk rice in the ratio 71:3:25:1 which means for every 100 kgs of rice we can have 71 kgs of pure rice, 25 kgs of broken rice, 3 kgs of discolour and 1 kg of FRK rice

2. PROBLEM ACKNOWLEDGEMENT

In current industries, machines use pneumatic systems to achieve a controlled dispensing of rice grains which consumes a lot of power and needs extra maintenance.

And also, buying a compressor and related equipment is an additional investment to the industry

So, we aim to eliminate this pneumatic system replacing it with a mechanical system that can be controlled by motors for controlled dispensing of rice grains.

3. PROBLEM STATEMENT

Develop a device that mixes n different types of grains at a given fixed ratio, ensuring that the total weight doesn't cross a preset weight limit.

4. LITERATURE REVIEW

As there was a piece of limited information about the ratio rite mixing of grains earlier, we decided to look over the mixing processes already being employed.

1. Grain Mixing Technologies

- **Twin-Screw Auger Mixers:** These mixers utilize two intermeshing screws that convey and fold the material within the mixing chamber. They offer good mixing uniformity and are suitable for various dry ingredients like grains
- **Ribbon Blenders:** These mixers have a horizontal, U-shaped trough with a rotating ribbon that moves the material back and forth, promoting gentle mixing. They are efficient for delicate grains and achieve good homogeneity

2. Dosing and Blending for Granular Materials

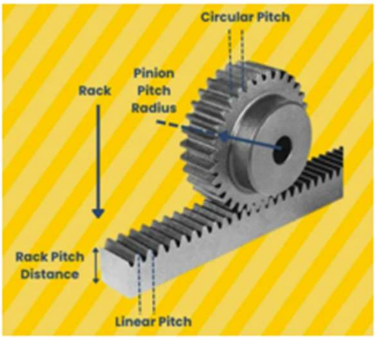
- Research in this area focuses on achieving precise and consistent ratios when blending granular materials like grains. This literature explores metering systems, hopper design, and flow control mechanisms to ensure accurate dosing of individual components.
- The dosing mechanisms available till now are using pneumatic systems to achieve controlled dispensing of the grains to the mixers.

3. Limitations of Existing Technologies

- While both twin-screw auger mixers and ribbon blenders offer good mixing, they might require adjustments or modifications to achieve precise and consistent ratios for different grain types and target ratios.
- The existing technologies don’t consider the factor of an increase in broken rice due to rice getting in contact with a hard metal which shouldn’t happen.
- Existing literature might not address the specific design elements or functionalities incorporated into the Ratio-Rite grain mixer.

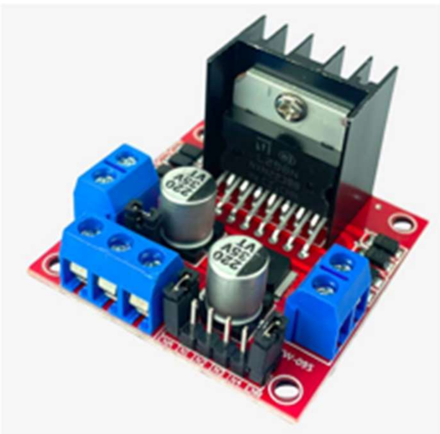
A device needs to be developed that takes care of supplying different types of grains in a particular ratio to the already available mixers in the market.

5. COMPONENTS USED



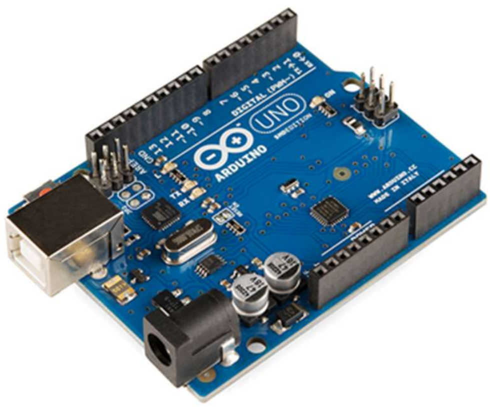
Rack and pinion

Geared Dc motor 60 RPM



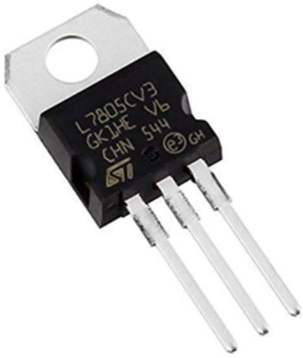
L298N

20x4 LCD with I2C



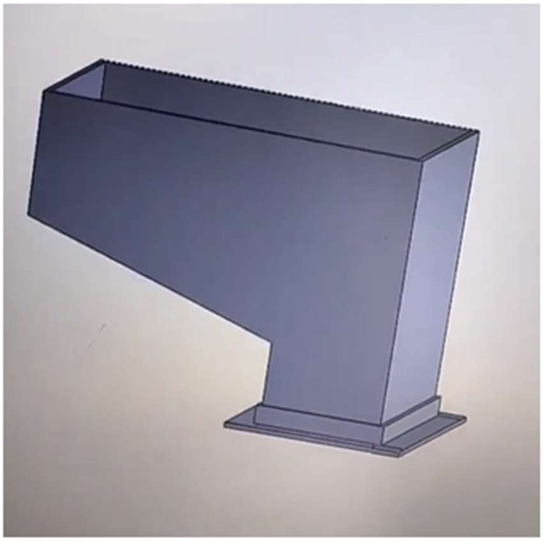
Arduino Uno

Push Buttons

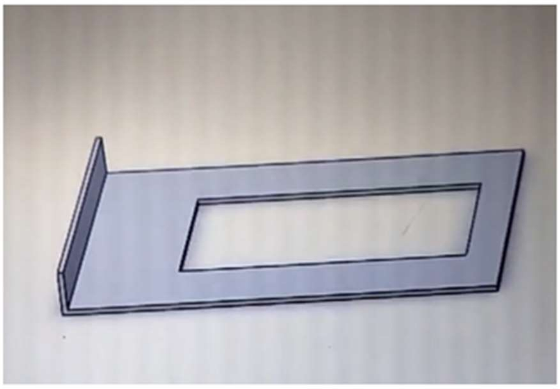


LM7805

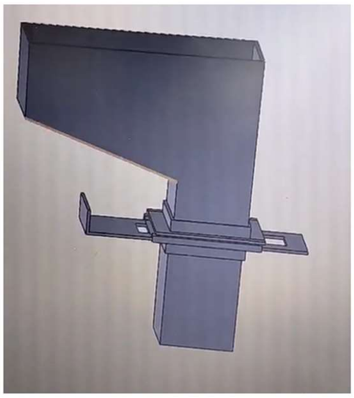
12V 5A DC ADAPTOR



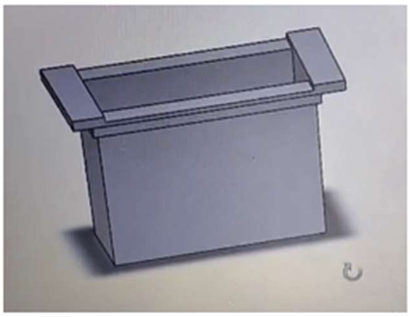
Hopper



Control gate



Assembled version



Transition bin

6. FLOW OF SOLUTION

To achieve the desired functionality of all the devices we have followed a few steps for a complete solution and they are:

- **Make a BOM (bill of materials):** Based on our requirements we made a list containing all the hardware components that would be required for our project.

- **Calibrate the load cells:** Once all the hardware components were procured, we started calibrating the load cells with standard weights.

- **Test individual components:** After procuring all the components, all components were tested for their functionality to ensure there weren't any defective components.

- **Design linear actuator:** To design a linear actuator that helps us in the controlled dispensing of grains, we have adopted a rack and pinion mechanism integrated with each chamber's gate.

- **Testing the linear actuator***:* The linear actuator was tested to ensure there is no component obstructing its way and its motion is completely in our control.

- **Integrate the flow control mechanism:** The designed linear actuator after its integration with the gate, is further integrated with the load cell to achieve controlled dispensing of grains by taking feedback from the load cells.

- **Performing the required calculations:** To achieve precise movement of the gate of the chambers we need to do some calculations and obtain a relation between the runtime of the motor and the distance moved by the gate.

  - **Pinion Teeth Count (N)**: The number of teeth on the pinion gear.
  - **Circumference of Pinion (C)**: The total distance the pinion travels in one complete rotation, calculated as $C = \pi \times D$ where D is the diameter of the pinion.
  - **Linear Displacement per Tooth (L)**: The distance the rack moves for each tooth of the pinion, $L = \frac{C}{N}$.
  - **Motor Run Time for One Tooth (T)**: The time the motor needs to run to move one tooth, derived from the total rotation time of the pinion divided by the number of teeth.

- **Programming the microcontroller:** Arduino uno was programmed to read the status of load cells and further decide upon the opening length of each of the 3 gates and make sure that grains are getting dispensed at a required ratio.

- **Assembly:** Once individual components assembly and testing are done, we have procured PVC pipes to build a frame for all the 3 chambers and they all were assembled as a single functional unit.

- **Testing all together:** Once all the components have been assembled the functional testing is done to ensure everything is working properly.

7. WORKING

The Arduino Uno plays a central role in automating the process of mixing grains in precise proportions. Initially, it receives input regarding the desired ratio at which different grains need to be mixed, as well as the total weight of the final packet. Based on this input, the Arduino calculates the exact weight of grains to be dispensed from each chamber to achieve the specified ratio.

Once the target weight for each chamber is determined, the dispensing process begins. Each chamber is equipped with a gate controlled by a linear actuator, which opens to allow the grains to flow out. As the gates open, load cells attached to each chamber continuously measure the weight of the grains being dispensed. These load cells send real-time weight data back to the Arduino.

The Arduino continuously monitors the weight data from the load cells and calculates the difference between the current weight and the target weight for each chamber. Based on this difference, the Arduino adjusts the opening length of each gate. If the current weight is significantly less than the target weight, the gate opens wider to allow more grains to flow out. Conversely, if the current weight is approaching the target, the gate opens more narrowly to fine-tune the dispensing process and prevent overshooting the target weight.

This feedback loop ensures that each chamber dispenses the correct amount of grain with high precision. As soon as the current weight in a chamber matches the target weight, the Arduino signals the gate to close, stopping the flow of grains. This process is repeated for all chambers until the required amount of each type of grain is collected in their respective buffers.

After the grains are dispensed into the buffers, they are ready for the next stage of mixing. The collected grains from each chamber are then directed to one of the mixers. Depending on the application and desired consistency of the mix, the grains are sent either to a Twin-Screw mixer or a ribbon blender. These mixers ensure thorough and even blending of the grains, resulting in a homogenous final product.

The Twin-Screw mixer uses two intermeshing screws that rotate to move the grains along and mix them thoroughly. This type of mixer is particularly effective for achieving a high degree of mixing uniformity and is often used for more complex or viscous mixtures.

On the other hand, the ribbon blender employs a horizontal trough containing a central shaft with helical ribbons attached. As the shaft rotates, the ribbons move the grains in opposite directions, promoting a thorough and even mix. Ribbon blenders are typically used for mixing dry powders and granules.

By leveraging the Arduino Uno's precise control and real-time feedback capabilities, the entire process from dispensing to mixing is highly automated and efficient, ensuring that the final mixture meets the specified ratio and weight requirements accurately. This automation reduces human error, increases production speed, and ensures consistent product quality.

8. OBSERVATIONS

The setup of our project incorporates simulated load cells for each chamber. These simulated load cells are crucial for mimicking the weight measurement process, which allows us to test and demonstrate the system's functionality without using actual grains. Each load cell simulation is controlled via pushbuttons located near the respective chamber. By pressing these pushbuttons, users can manually simulate an increase or decrease in the measured weight of the load cell.

When a user simulates an increase in the load cell value by pressing the corresponding pushbutton, the system responds by decreasing the outlet length of that particular chamber. This means the gate of the chamber will open less, allowing fewer grains to be dispensed. Conversely, if the user simulates a decrease in weight by pressing the appropriate pushbutton, the system will increase the outlet length of the chamber's gate. This results in the gate opening wider, thus permitting more grains to flow out.

For user verification and real-time monitoring, the setup is equipped with a 20x4 LCD display. This LCD screen is an essential component as it provides immediate feedback by displaying the exact amount of weight dispensed by each chamber. Users can easily verify the system's operation and the accuracy of the simulated dispensing process through the information shown on the LCD.

At the beginning of each operation cycle, when the setup is initialized, a crucial system check is performed. The outlets of each chamber automatically open and close completely. This initialization step ensures that there are no obstructions in the flow path of the grains and that the gates of each chamber are functioning smoothly. By performing this check, the system ensures that the dispensing process will proceed without any blockages or mechanical issues that could affect the accuracy and efficiency of grain dispensing.

This observation highlights the interactive and automated aspects of our project, emphasizing the role of the simulated load cells, the manual control via pushbuttons, and the importance of the LCD display for user interaction. The initial system check further underscores the attention to detail in ensuring the reliability and smooth operation of the grain dispensing mechanism.

9. CHALLENGES ENCOUNTERED

While working on this project, we encountered several significant challenges, each of which required careful consideration and problem-solving to overcome. Here are some of the key difficulties we faced:

Impact Force for Load Sensor

One of the primary challenges was dealing with the impact force on the load sensors. The cardboard platform we initially used for testing proved to be unsuitable. The impact force of the grains caused the cardboard to dent, which in turn compromised the accuracy of the force measurements. This issue highlighted the need for a sturdier testing platform. Ideally, a metal platform would be necessary to properly capture the impact force without deformation, ensuring the load sensors could provide accurate and reliable measurements.

Right Positioning of Motors

Another critical challenge was ensuring the correct positioning of the motors in our rack and pinion mechanism. For the pinion to remain continuously engaged with the rack, the motor driving the pinion needed to be positioned with high precision. Any misalignment could result in the pinion slipping out of contact with the rack, disrupting the movement and accuracy of the grain dispensing mechanism. Ensuring the motor was properly aligned and maintained constant engagement with the rack was essential for the smooth operation of the system.

Vibration Transmission and Frame Instability

We also faced issues related to vibration transmission and frame instability. The frame designed to house all three modules in our project experienced significant vibrations. These vibrations, generated by one module, were transmitted throughout the entire frame, leading to overall instability. This not only affected the performance of the individual modules but also posed a risk to the structural integrity of the entire setup. Mitigating these vibrations and stabilizing the frame were crucial to maintaining the functionality and reliability of the system.

Data Acquisition Challenges

Capturing precise weight measurements posed another challenge due to the limitations of our current microcontroller’s clock speed. The microcontroller's limited processing capacity made it difficult to capture minute variations in weight from the load sensors accurately. This limitation hindered our ability to obtain the high-resolution data needed for precise control of the grain dispensing process. Addressing this required optimizing the data acquisition process and considering potential upgrades to more capable microcontrollers.

Despite these challenges, we took a systematic approach to address and mitigate each issue as we progressed with the project. In the following section, we will provide a detailed approach to how we tackled these difficulties and the solutions we implemented to ensure the successful completion of our project.

10. SOLUTIONS PROVIDED

After encountering several challenges that impeded our progress, we decided to brainstorm and develop solutions to overcome these obstacles. Our approach yielded positive results, demonstrating the effectiveness of our strategies. Here is an expanded explanation of our approach to these challenges:

Impact Force for Load Sensor

To address the issue of the impact force on the load sensor, which was causing inaccuracies due to the denting of the cardboard platform, we implemented a workaround suitable for our prototype stage. Instead of relying on actual load sensors, we used pushbuttons for each chamber. These pushbuttons can simulate an "increase in dispensed weight" or "decrease in dispensed weight" signal to the microcontroller (MCU). This approach allows us to analyse the behaviour of the system as if we were using real load sensors, without being affected by the platform's limitations. This simulation enabled us to continue testing and refining the system's logic and functionality.

Right Positioning of Motors

Ensuring the right positioning of motors in our rack and pinion mechanism was critical for maintaining continuous engagement. To achieve this, we employed small clamps, similar to zip ties, to apply gentle pressure on the motor. This method ensured that the pinion remained consistently engaged with the rack, preventing any slippage and ensuring smooth and precise movement. The clamps provided a simple yet effective solution to maintain the necessary contact between the motor and the rack, enhancing the reliability of the grain dispensing mechanism.

Vibration Transmission and Frame Instability

To tackle the challenge of vibration transmission and frame instability, we redesigned the system's structural layout. We implemented separate frames for each module, effectively isolating the sources of vibration. By doing so, we minimized the transmission of vibrations from one module to another, thereby promoting exceptional stability throughout the system. This strategic design adjustment not only stabilized the individual modules but also enhanced the overall structural integrity of the entire setup, ensuring that vibrations did not interfere with the system's performance.

Data Acquisition Challenges

The challenge of capturing precise weight measurements due to the limited clock speed of our current microcontroller was a significant obstacle. To overcome this, we considered upgrading to microcontrollers with higher clock speeds. A faster MCU would be capable of capturing minute variations in weight more accurately, providing higher resolution data necessary for precise control of the grain dispensing process. This upgrade would enhance the system's ability to process and respond to weight measurements in real-time, improving overall performance and accuracy.

By implementing these solutions, we were able to mitigate the issues that were hindering our project's progress. Each approach was carefully considered and tailored to address specific challenges effectively. The use of pushbuttons for simulating load sensor signals allowed us to continue development despite platform limitations. Small clamps ensured proper motor alignment and engagement in the rack and pinion mechanism. Isolating modules with separate frames addressed vibration issues, and upgrading to a higher-speed MCU improved data acquisition capabilities. These strategies collectively enabled us to advance our project successfully.

11. RESULTS

Design of Linear Actuator Using Rack and Pinion Mechanism

Implementation:

A linear actuator has been meticulously designed and implemented using a rack and pinion mechanism. This design choice allows for precise linear movement, which is crucial for the controlled dispensing of grains.

Advantages:

The rack and pinion mechanism provides a robust and reliable method for converting rotational motion into linear motion, ensuring consistent and accurate actuator performance.

Microcontroller Programming for Weight Ratio Maintenance

Programming:

The microcontroller has been expertly programmed to ensure a seamless connection between the dispensed weight and the ratio to be maintained. This involves complex algorithms that continuously monitor and adjust the dispensing process.

Precision:

The programming allows for real-time adjustments based on feedback from the system, ensuring that the desired weight ratios are consistently achieved.

Controlled Dispensing Based on Target Weights

Accuracy:

Controlled dispensing of grains has been successfully achieved by calibrating the system to dispense precise amounts based on the target weights for each respective module.

Consistency:

This control mechanism ensures that each module receives the correct amount of grains, thereby maintaining uniformity and meeting the specified requirements.

Feedback-Based Grain Ratio Maintenance

Feedback System:

The system incorporates a sophisticated feedback loop that continuously compares the dispensed weight with the target weight and adjusts the dispensing mechanism accordingly.

Ratio Maintenance:

By utilizing this feedback-based approach, the system effectively maintains the grain ratio during dispensing. This ensures that the mixture of grains remains consistent and within the desired specifications.

Summary and Impact

These results demonstrate the successful integration of mechanical design, microcontroller programming, and feedback control to achieve precise and reliable grain dispensing. The combination of these elements ensures that the system can consistently meet target weights and maintain the desired grain ratios, which is crucial for applications requiring high accuracy and consistency. Overall, the results highlight the effectiveness of the designed system in achieving its intended goals.

12. APPLICATIONS

There are several applications for ratio-rite grain mixer and few of them include

- Flour making industry:
  - These days many of the flour making industries are coming up with new ideas like, multigrain Ata, seven grain flour, millet flour blend.
  - All of these new ideas include mixing of grains in a proper ratio which can be achieved through our project.
- Rice milling industry
  - Rice milling industry requires to maintain a certain set ratio between broken rice, frk rice, and normal rice to meet the set standards of FCI, our ratio rite grain mixer will serve this purpose for them.
- Bakery products
  - They use multigrain flour blends to make cakes, cookies, muffins etc. To mix the multigrain flour with other flours in a proper ratio, our project helps do that.

- Seed blending
    - Seed blending is intentional mixing of 2 or more seeds to achieve diverse crops, to set an exact ratio between the diverse seeds our grain mixer can be used.
- Beer and whiskey production
    - Beer and whiskey production uses combines different grains such as barley wheat and rye in precise ratios, to achieve this by consuming low power our ratio rite grain mixer can be used
- Nutritional supplements
    - Many people now a days are using mixed grain powder as a nutritional supplement in their daily life, our project can help make these nutritional supplements ensuring all the grains to be mixed are in a set precise ratio.

13. COMMERCIAL SCOPE

1. Food and Beverage Industry

Bakeries and Cereal Manufacturers:

Market Need: Consistent quality and nutritional value in multigrain products.

Potential: Large bakeries and cereal producers could benefit from our precise grain mixing technology to produce a variety of multigrain breads, cereals, and snacks.

Snack Food Producers:

Market Need: Healthier snack options with balanced grain compositions.

Potential: Companies producing granola bars, crackers, and other grain-based snacks can use our mixer to maintain consistent product quality.

2. Health and Wellness Sector

Nutritional Supplement Companies:

Market Need: Accurate blending of grains for dietary supplements.

Potential: Health supplement companies can use our mixer to create precisely formulated products, enhancing their appeal to health-conscious consumers.

Fitness and Weight Management Products:

Market Need: Consistent and balanced nutritional profiles.

Potential: Businesses focusing on fitness and diet products can use our mixer to develop reliable meal replacements and health shakes.

3. Animal Feed Industry

Livestock Feed Manufacturers:

Market Need: Balanced and nutritionally complete feed mixes.

Potential: Large-scale animal feed producers can use our technology to ensure the nutritional needs of livestock are met with precise grain ratios.

Pet Food Manufacturers:

Market Need: High-quality and nutritious pet food blends.

Potential: Pet food companies can use the mixer to create consistent and balanced grain-based products.

4. Agricultural Sector

Seed Blending:

Market Need: Even distribution and optimized growth conditions for crops.

Potential: Seed companies can use our mixer to create precise seed blends, improving crop yields and quality.

5. Brewing and Distilling Industry

Breweries and Distilleries:

Market Need: Consistent grain mixtures for unique flavour profiles.

Potential*:* Craft breweries and distilleries can use our mixer to ensure consistency in their grain blends, enhancing the quality of their products.

6. Research and Development

Product Development Labs:

Market Need: Precise and reproducible mixing for R&D.

Potential: Research institutions and food development labs can utilize our technology for developing new grain-based products and conducting nutritional studies.

14. FUTURE SCOPE

1.Integration of a Packing Module:

Automated Packing:

Plan and develop an additional module that automates the packing of rice bags once the mixed rice is dispensed. This will streamline the process, reduce manual labour, and increase efficiency.

Benefits:

Improved Efficiency: Automating the packing process will save time and reduce the risk of human error.

Scalability: Allows for easy scaling of operations to handle larger volumes without significant increases in labour costs.

2.Output Tracking and Reporting:

Daily Output Tracking:

Implement a system to track and report the quantity of rice packed each day. This data can be displayed on a user-friendly interface for easy monitoring.

Benefits:

Operational Insights: Provides users with valuable insights into their production levels, helping them manage inventory and optimize production schedules.

Performance Monitoring: Enables users to track productivity and identify any inefficiencies in the process.

3.Mobile Application for Ratio Control:

User Access via Mobile App:

Develop a mobile application that allows users to control and adjust the grain mixing ratios remotely. This app could also provide real-time updates and notifications.

Benefits:

Convenience: Users can easily adjust settings and monitor the system from anywhere, enhancing flexibility and control.

User Engagement: An intuitive app interface can improve user engagement and satisfaction by making the system more accessible and user-friendly.

4.Enhanced Dispensing Control with Linear Actuator:

Precise Dispensing:

Gain more precise control over the dispensing mechanism through the implementation of advanced linear actuators. This will allow for finer adjustments and more accurate dispensing of grains.

Benefits:

Accuracy: Increases the precision of grain mixtures, ensuring consistent quality and meeting specific product requirements.

Reliability: Enhances the overall reliability of the system, reducing the likelihood of errors and improving product consistency.

15. CONCLUSION

The Ratio Rite Grain Mixer project addresses the critical need for precise and consistent grain mixing across various industries. By integrating advanced feedback systems, optical sensors, and microcontroller programming, our system ensures accurate weight control and consistent grain ratios, which are essential for maintaining high-quality standards in food production, animal feed, and other applications.

The implementation of a rack and pinion mechanism for the linear actuator has provided robust and reliable performance, while the feedback-based dispensing system has demonstrated significant improvements in accuracy and efficiency. Our observations indicate that these features collectively reduce errors, enhance operational efficiency, and ensure uniformity in the final product.

In summary, the Ratio Rite Grain Mixer stands as a versatile and innovative solution, poised to meet the evolving demands of various sectors. Its ability to deliver consistent, high-quality grain mixtures positions it as a valuable asset for businesses aiming to optimize their production processes and enhance product quality. We are confident in its potential to achieve significant commercial success and make a meaningful impact in the market.