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Design of Automatic Food Grain and Powder Packing Machine

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Abstract

This paper presents an automatic packing machine which packs both the food grains and powdered spice. This functionality of this packing machine includes weighing the product, cover wrapping, filling and date sealing. Many small-scale industries use manual packing since conventional machine is of high cost and it has some other issues. This packing machine would solve the heating issues and also cost effective.

Keywords – PLC, HMI, Weighing Hopper, Packing

I. INTRODUCTION

Packing machines are used throughout all the small-scale industries. This packing process includes weighing the product, overwrapping, filling, date sealing, combining. Packing machine can be designed for small packages or variable package size and some are adjustable to the package sizes. Manual packing process can be slow and production rate slows down but automation line increases the production volume and good quality of product. Generally Packaging machinery have some classifications which are

- Standard Type
- Custom Made
- Upgraded type

Standard type machinery is designed and developed by following certain procedures and criteria that suits for specific type of application. Custom Made is a user defined machinery where customer provides the requirement and then machine is customized according to their need and it is generally high-cost machine and needs high maintenance. Upgraded type is more efficient packaging machinery where standard type is used with some modifications in their design, features and functionality.

Some of the available machines use embedded systems for controlling purpose which may lead to high heating issues that results in failure of some components. In such a case, frequent maintenance is required and its cost also increases tremendously. The existing packing machines in the market will pack either solid particles or powdered particles. Conventional powder packing machine has ribbon blender and screw conveyor for stirring the powder and transferring the powder. There is a need for two separate machines for packing both type of products and its maintenance cost also increases. Small industries cannot afford two separate machines to pack different products.

Fig.1. Conventional Packing Machine

Fig.1. shows the conventional packing machine. Conventional packing machine has the standard procedure and methodology to pack the food grains and powder. In this paper, packing method of both the food grains and powdered spices are integrated together. Sealing of the cover roll has separate mechanism. Both for transparent cover and colored cover, it is able to seal the food grains with specified quantity and length of the packet.

Next is the cost of conventional machine is too high in the market. There are only less numbers of packing machine manufacturers which leads to high cost in the market. The cost for separate food grain and powered spices packing machine is high. But if the packing method is integrated to a single machine, the cost may be reduced to the half of its original cost.

II. RELATED WORK

Few other works have been done in the relevant field.

Liu Cheng and Li Xiao gang [1] explained the come up with effective packaging strategies for a range of industrial applications that may be executed utilizing quick, reasonably cost technology. When working with industrial vision applications, which have severe issue limitations, a systems approach has been explicitly chosen. As a result of this, there are two main components to the packing operation. In the first case, morphological image processing procedures are used to create a geometric packing approach. As part of an algorithmic packing method using prolog, this is employed. At the heuristic level, form ordering, and shape orientation are addressed, both of which must be done before the geometric packer is implemented. Problem limitations particular to a certain application are addressed via heuristic techniques.

Sadegh vosough and Amir vosough [2], It has been addressed about the importance of the idea of the PLC and its application in the beginning, PLCs were meant to replace relay-based logic. PLCs were programmed in "ladder logic," which closely resembled a diagram of relay logic, according to the report. Because PLCs are designed for extreme circumstances (such as dust, moisture, heat, cold, etc.), they offer a large number of input/output (I/O) options. The cost of a packaged PLC is inexpensive compared to the cost of a custom-built controller design since PLC applications are generally highly customized.

Umesha. B. C and N. S. Sriram [3], According to this paper, a better packaging method will be implemented, which will result in a smoother procedure and a better product. Many industries utilize screw conveyors to move and/or elevate particles at a regulated rate. A wide range of industries utilize them for a variety of bulk material applications. This paper will utilize PLC (Programmable Logic Controller) programming to make the system run step-by-step.

Yundan Lu et al. [4], Filling systems have become increasingly popular as a result of the growth of the beverage sector. As a result of its low automation and integration level, the relay control mechanism used in traditional filling machines cannot keep up with the fast growth of automatic production. In recent years, PLC control methods have increasingly replaced relay control methods due to their benefits in terms of easy programming, robust anti-interference, and high operating dependability PLC-controlled automated filling system hardware and software are created in this study, with specific attention paid to the injection section's servo control system, which uses a servo motor-driven dosing pump, and the filling precision is much enhanced.

Ganesh B.Shinde et al. [5] explains the initial stages in implementing a PLC-based auto-weighing control system for the automation sector. For example, many engineers are striving to create an automated system which operates extremely precisely, highly-effectively and within a short time period as a new development in contemporary globalization The development of auto weighing systems is becoming increasingly essential, especially due to the increasing demands for products and the shrinking supply of skilled personnel in industry. Industry has been weighing tasks in recent years and rejecting them manually if they are defective. As a result of automation (using load cells), defective tasks may now be rejected by PLC, while accurate jobs can continue on the conveyor belt. Because the demand for the product is greater,

the production pace should be higher in the industry. However, if we physically weigh the thing, it will take more time to do so, and the total speed of manufacturing will be slowed down. The goal of this paper is to build a PLC-based automation approach.

D.Kanimozhi et al. [6], As a part of the automation practices, this paper describes the use of a Programmable Logic Controller (PLC). Using PLC software, the paper aims to develop and build a compact, basic packaging system. The use of PLC technology is growing quickly, and it is proving to be a useful tool in automating processes. Control and automation of the packing system is carried out using PLC software. Consequently, the packing system was entirely automated. Apart from reducing product time and increasing production rate, this system is more efficient than manual systems. A Programmable Logic Controller (PLC) is used to automate a process in this study.

Gana V V and Dr. C Mallikarjuna [7], An automated packing process prototype is shown in this study using a programmable logic controller (PLC). This has a direct influence on both the company's survival and economic advantages due to the rapid development of packaging technology that relies on current mechanization and automation. Small businesses can save money by using a low-cost automated packing equipment. The pneumatic, mechanical, and electrical systems of this low-cost automated machine are simple and easy to maintain. This paper presents a mechatronics system, which takes feedback from sensors and accordingly sends signals to the parts.

III. METHODOLOGY

Methodology of the paper provides sequential step to be followed and each step deals with necessary part of the packing machine. Fig.2. shows the flow chart of methodology.

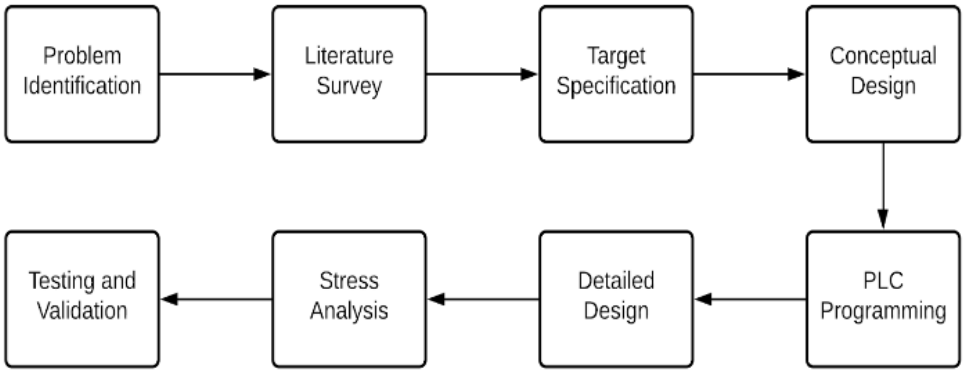

Fig.2.Flow Chart

A. Problem Identification

In the small-scale industries, packing machine has some problems faced by the operators. There is a no need for separate machines for powder and food grains packing. Frequent damage in heater used for sealing the package due to voltage fluctuations. Heating issue has been major problem which results in failure of some small components. As a result, frequent maintenance is needed to run the machine for long time.

B. Literature Survey

Many papers were studied to get clear working of packing machine. Methods used to pack the food grains were analyzed. Different approaches used in packing machine were studied. PLC Programming and logic used in packing machine were examined and studied.

C. Target Specification

Some target specifications were specified after identifying the customer needs. Then the list of metrics is created by considering problem statement and this metric is subjective.

D. Conceptual Design

After sorting out all the problems, various solutions have been framed and analyzed for the feasibility. Here the problems with the existing packaging machine are divided into sub problems and each sub problem is carefully taken into consideration and initially focused on critical sub problems which is the need of single packaging machine for food grains and powder. After gathering this information, concepts were generated and which end up in lots of ideas both feasible and some may unfeasible then eliminating the less promising ideas & unfeasible ideas and identified the independent approaches to the problem. Now Combining the idea/solutions of sub problems into single solution. And ensured that solution is focused too much attention on combining the machine for food grains & powder while ignoring the overall configuration and decided that this is the core of the problem and finalized to focus on this issue.

E. PLC Programming

Packing machine uses PLC as its main controller to operate the entire process. Certain sequence has to be followed in the packing process. Each step in the sequence is controlled by different actuators and other components. All the components are connected to the PLC. In order to maintain the sequential process, Program need to be fed to the PLC. This program is in form of ladder logic where the logic of packing process is specified. First of all, it is important to understand the logic and sequence of the process. PLC Programming determine the process time and number of outlet packets. More attention should be given to PLC Programming because it determines the efficiency of the machine.

F. Detailed Design

Considering design depend critically on design for commercial success and the design falls into any one of these

- Ergonomic need
- Aesthetic need

Our aim is to mainly focus on ergonomic need as one of our sub problems is facing difficulty while using HMI. Design of hopper and vibrator should meet as per the requirement of user. Considering the food grain capacity, individual parts of packing machine must be designed and developed.

G. Stress Analysis

Static stress analysis is one of the important procedures to perform while designing all the mechanical parts. Stress analysis gives us the better understanding of load acting on the mechanical part and deformation while applying maximum load. This analysis helps to reduce the testing cost and time. In case of more deformation of material, changes can be made in design before fabrication. Similarly, stress analysis on packing machine needs to be done to ensure that design is will not be subjected to any deformation under maximum load.

H. Testing

Once the design and stress analysis is completed, the packing machine is almost ready for next procedure. Results from the stress analysis gives us a lot of details about design. Stress analysis on the lower frame was made because it holds almost the entire machine. From the stress analysis result, entire design is safe.

IV. COMPONENT SELECTION

For the packing machine, there are many components used. Each component has its specific role in packing machine. Main part of packing machine is the Programmable Logic controller and human machine interface. Let's discuss only the important parts of the packing machine.

A. PROGRAMMABLE LOGIC CONTROLLER(PLC)

Programmable logic controller is a type of microcontroller which uses to implement the logic, timing, sequencing, counting and arithmetic operations to control the processes. It uses ladder logic to implement the process. Because of its speed, stability and reliability, Delta's DVP series programmable logic controllers are utilized in a broad range of industrial automation equipment. In the packing machine Delta DVP14SS2 PLC is used and it has 8 input ports and 6 output ports. It is a 32-bit PLC with programming capacity of 8K steps.Fig.3 shows the Delta PLC used in packing machine.

Fig.3. Delta PLC

B. HUMAN MACHINE INTERFACE(HMI)

An HMI is a platform for interacting with automation technology. Delta's HMI solutions offer a number of communication interfaces for rapid communication and control of a variety of equipment, systems, and facilities. The touch is resistant and may be operated with gloves to avoid direct contact. It enables quick system construction, reducing wiring and installation time, lowering operating expenses, and increasing system efficiency by removing necessity time-consuming modifications and extra maintenance costs. In the packing machine, Delta VS070HE-1 HMI is used which has a resolution of 800 x 480.It has 2 USB ports and RS232 COM port. Fig.4 shows the Delta HMI used in packing machine.

Fig.4. Delta HMI 7'' display

C. RELAY

Relay is mechanical device which is used to protect and switch the circuit and for supporting high power devices. All the circuits are equipped with relay in order to protect the circuit. The purpose of relay is to avoid the excessive current flowing to the circuit to prevent the elements of the circuit. Similarly in packing relay is used to prevent the damage of elements caused due to excessive current flow. Relay MY4N DC24 is used in packing machine. Rated current is 7A and it is operable in DC. Fig.5 shows the relay used in relay used in packing machine.

Fig.5. Relay

D. SOLID STATE RELAY

SSR is a compactly built contactless electronic switch device made up of an integrated circuit (IC) and discrete components. SSRs can turn on or off the state of the electronic circuit very quickly, similar to the function of traditional mechanical relays. Inside the SSR, there is no moveable mechanical part, and there is no mechanical action during the switching operation. As a result, the Solid-State Relay is also referred to as a "non-contact switch." The solid-state relay's amplification and drive function make it ideal for driving high-power actuators, and it's more reliable than electromagnetic relays (EMR). Solid state relay control switches utilize extremely little power, hence modest control currents can be employed to manage high load currents. Between the input and output terminals, the solid-state relay employs robust and dependable optoelectronic isolation technology. Fig.6 shows the SSR used in packing machine.

Fig.6. Solid state relay

E. MINIATURE CIRCUIT BREAKER

When the network is in an unstable state, such as an overload or defective condition, an MCB is an electrical switch that immediately shuts off an electrical circuit. When continuous current flows through MCB, the bi-metallic strip gets heated and releases. Due to this circuit becomes open and current flow stops to the circuit. In order to turn on the circuit, the MCB has to be turned on manually. In a short circuit, however, when the current is rapidly raised, the nozzle linked to solenoid is electromechanically moved. The latch mechanism is instantly released when the nozzle meets the trip lever, enabling the circuit breaker contacts to open. Fig.7 shows the Miniature circuit breaker used in packing machine.

Fig.7. Miniature Circuit Breaker

F. TEMPERATURE CONTROLLER TC 533

Selected TC533 Temperature controller is of dual display controller, it had Thermocouple and RTD input, it is available with both on/off and PID control action, Selected TC533 is a field selectable control output by relay or SSR. Fig 4.9 shows the temperature controller TC 533 for Heating element. Fig.8 shows the Temperature controller TC 533 used in heating element of sealing.

Fig.8. Temperature controller TC 533

G. LOAD CELL

There are a number of measuring devices available in electronics that may be used for various purposes based on their requirements. To measure weight, a single sensor called as a weight sensor or load cell is utilized. This sensor is most often used in weighing systems, where it is utilized to decide weight for a number of applications. Because weight sensors are known for their precision and consistency in giving precise weight data, they may be used in the design of weighing systems. The operation of a loadcell is dependent on converting a load into an electrical signal. Depending on the load and circuit used, the signal might be a change in voltage, current, or frequency. This sensor detects the physical changes, which includes force, weight, or pressure, and outputs a proportionate value. It converts a quantifiable and standardized electrical signal from a force like as tension, compression, pressure, or torque. Fig.9 shows the load cell which is used to weigh the food grains.

Fig.9. Load Cell

H. PROXIMITY SENSOR

A proximity sensor detects the existence of things in its near area without having to make direct touch with them. This can be done by utilizing an electromagnetic field or an electromagnetic radiation beam whose return signal varies in response to the presence of any item in the near area. Different types of proximity sensors include capacitive proximity sensors and inductive proximity sensors, magnetic proximity sensors which are required for different sorts of targets, such as plastic targets, metal targets, and so on. The normal range of a proximity sensor is the range within which it can detect an object. Because there are no mechanical parts and no physical contact between the sensor and the perceived object, proximity sensors can last a long time and have a high level of reliability. Fig.10 shows the proximity sensor used for industries

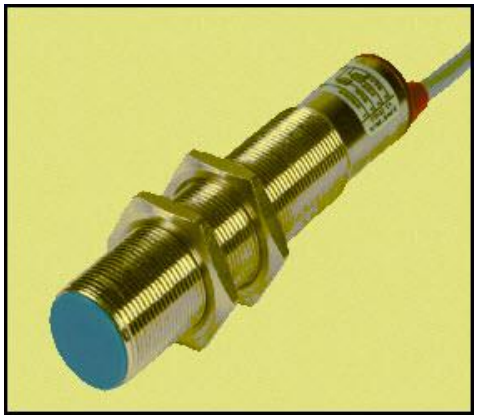

Fig.10. Proximity Sensor

I. VIBRATOR AND FEEDER

Using a vibration-based feeder and a scale controlled by an automatic switch, food grains can be packed in the same quantity every time, faster and safer. Vibration aids in the distribution of commodities within packaging and other units, lowering packaging and transportation costs. Vibrators can also aid with efficiency. As a result, industrial vibrator-based packaging solutions are adaptable to both major businesses and small independent producers in terms of capacity and cost. Fig.11 shows the vibrator used for weighing the food grains.

Fig.11.Vibrator and feeder

J. MOTOR

Electric motors are used to fill the packets with food grain and to pull the laminates off the rolls for packaging. To enhance the manufacturing pace, it was determined to draw the laminates for 160 mm in 0.1 sec. To fill the appropriate quantity of food grain in the packets, a motor with a capacity of 0.5 HP is required to operate the food grain at 1400 rpm. It was determined that a motor with a capacity of 0.5 HP and a speed of 955 rpm is necessary to pull the laminates at the desired speed. A three-gear ratio was used to boost the speed of the available motor. Fig.12 shows the motor used in packing machine.

Fig.12.Motor

K. MOTOR DRIVE

Motor Drive is the essential component of packing machine. This component controls the input power to the motor. The Motor and Motor drive together forms a Drive System. The motor drive is capable of controlling the speed of the motor by changing the frequency of the motor. Actually, there are separate drives for AC motor, DC motor and Servo Motor. Here the AC drive is used for this application. The specification of this drive is chosen based on the requirement for application. Fig.13 shows the motor drive used for controlling the motor in packing machine.

Fig.13.Motor Drive

L. SWITCHED MODE POWER SUPPLY

In an electronic power supply system, a switching regulator is utilized to correctly transfer electrical power. It is a type of power supply unit that is often seen in computers and is used to regulate the voltage to the specs of the computer. To change output voltage and current across different electrical topologies, SMPS adjusts the foundations of typically lossless storage, such as capacitors and inductors. Switching regulators in SMPS devices turn on and off the load current in order to maintain and regulate the voltage output. SMPS's, unlike linear power supplies, alternate between low energy loss, full-on and full-off phases and spend far less time in high dissipation cycles, resulting in lower depletion strength. Fig.14 shows the SMPS used in packing machine.

Fig.14.SMPS

M. PNEUMATIC CYLINDER

Pneumatic cylinders are the type of actuators which are used for low power applications. There are various types of pneumatic cylinders depending on the operating pressure and some other parameters. For packing machine miniature and compact cylinders are used for sealing the cover and weighing hopper opening and closing. Date printing and Packet separations are also done with the help of these cylinders. Miniature A51, A52 cylinder is used in the packing machine.Fig.15,16 shows the pneumatic cylinder used for packing machine.

Fig.15.Miniature Pneumatic cylinder

Fig.16. Compact Pneumatic cylinder

V. DETAILED DESIGN

The design of packing machine has been done using the software Solidworks 2021. The dimension of the machine has been formulated based on the requirement of clients. Each component in the packing machine has been designed with the help of estimated dimensions. The parts of packing machine includes hopper, vibrator, weighing hopper, vertical sealer and horizontal sealer. Each part has to be designed based

on the estimated dimension. Along with all these parts external frame and some additional components has to be added to achieve the complete structure of the packing machine.

A. HOPPER

The purpose of hopper is to load the food grains or powdered spices which is further fed to vibrator and weighing hopper. The hopper is in shape of frustum. More quantity of food grains can be loaded to hopper at once. Fig17. Shows the hopper for loading the food grains.

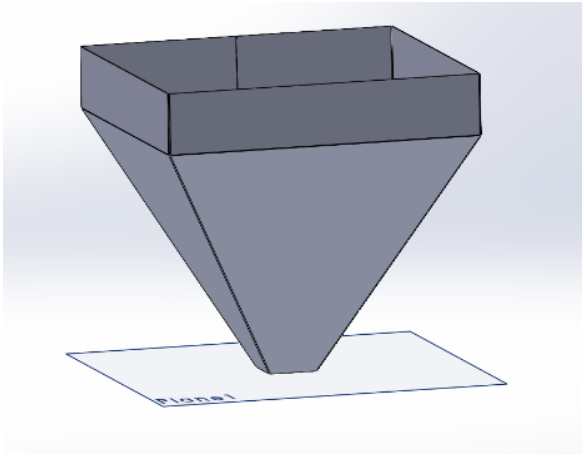

Fig.17.Hopper

B. VIBRATOR PLATE

The food grain from the hopper gets into vibrator Plate. An Electromagnet is attached to the bottom of vibrator plate from which food grains enter into weighing hopper. Along with electromagnet Spring is also attached to the bottom of vibrator plate. The purpose of vibrator is to pass the food grain to the weighing hopper slowly to measure and pack the small quantities. Fig.18 shows the vibrator plate used for loading food grain to weighing hopper.

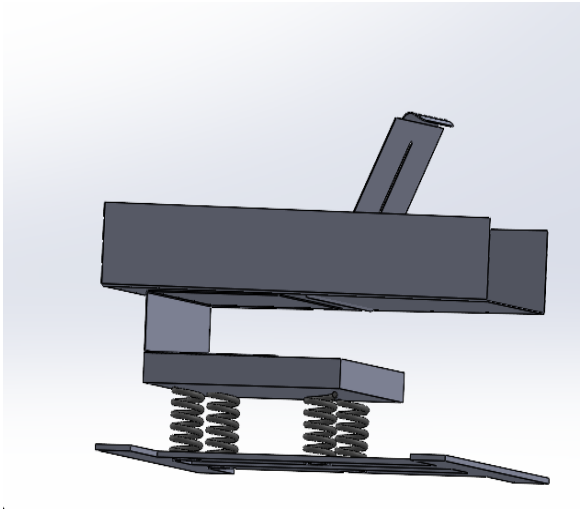

Fig.18.Vibrator Plate with spring at base

C. WEIGHING HOPPER

This is the most important part of packing machine where the food grains are weighed and packed accordingly. The load cell is attached above to the weighing hopper. The required weight to be packed is fed through HMI panel. Based on the weight given, load cell weighs the food grain and sends to the cover. This weighing hopper design is based on the Four Bar linkage. Slight modification has been done in the four-bar linkage where the frame length is varying. This mechanism is actually a Double rocker mechanism where the crank and rocker oscillate to certain extent. A Pneumatic actuator is fitted to the Connecting rod of weighing hopper which controls the opening and closing of the hopper. Fig.19 shows the weighing hopper used to weigh the food grain using load cell.

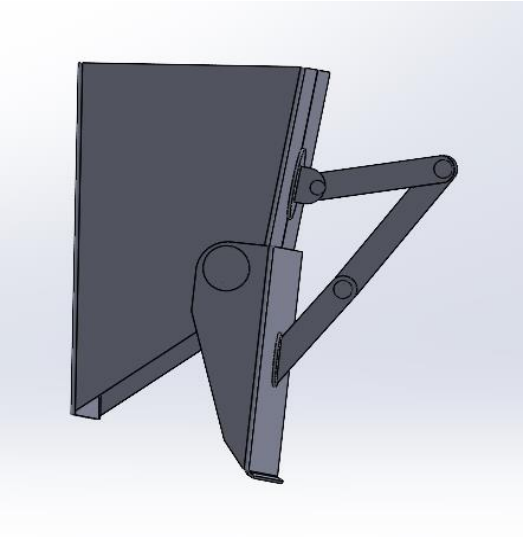

Fig.19.Weighing Hopper

D. VERTICAL SEALING

Vertical Sealing is the initial step to done for plastic covers before putting the grains. Pneumatic actuator is attached to this part which seals the cover vertically but it makes open in top and bottom. Also heating element is attached to this part which heats the cover partially to seal the cover. There comes the Horizontal sealing which completely seals all the sides and gives out the final packed food grains. Pneumatic actuator is actuated based on the ladder logic given in PLC. Once the Vertical sealing and Bottom of the cover sealing is done the weighed food grains will be put inside the cover. Fig.20 shows the vertical sealer used for sealing the cover

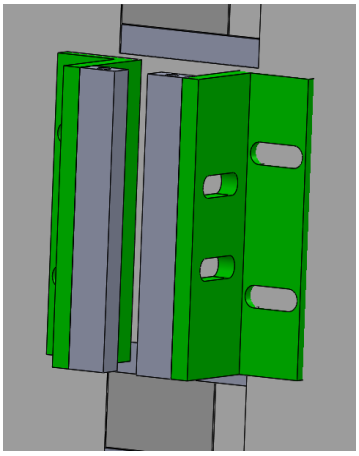

Fig.20.Vertical Sealer

E. HORIZONTAL SEALING

Once the Vertical sealing of cover is done, it is much more important to do horizontal sealing to get fully packed food grains. Heating element is provided to seal the cover both upside and downside openings. Similar to vertical sealing, horizontal sealing is also actuated by pneumatic actuators. Horizontal sealing is done before putting the weighed food grains in the cover. After putting all the weighed food grains in the cover, again horizontal sealing is to be done to seal the top opening and to get a complete packets of food grain of particular weight. Along with horizontal sealer, a puller is attached just above to it. Puller drags the cover from the cover frame roll and vertical sealing is done initially. Puller is also more important component in sealing part. Fig.21 shows the horizontal sealer for sealing the top and bottom of the cover.

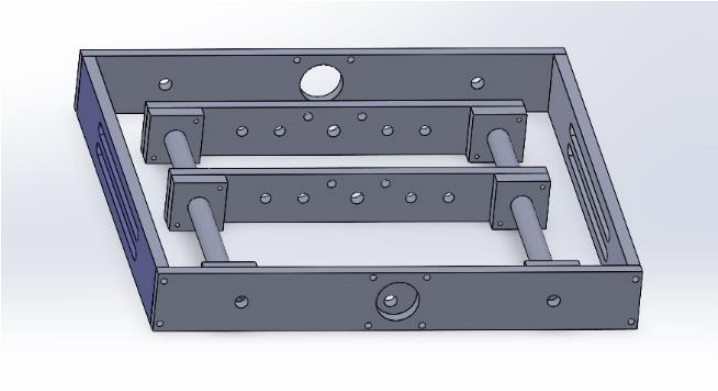

Fig.21.Horizontal Sealer

F. HMI SCREEN

Human Machine Interface is an important component of this packing machine. Omron 7-inch Touch screen panel is used. All the inputs to the machine are fed through this Touch screen HMI. Along with HMI screen, Emergency stop button is also provided to turn it off in case of any emergency. Key lock is given to avoid the unnecessary interruptions during the process which locks the settings and inputs given to it. Fig.22 shows the HMI screen used for packing machine.

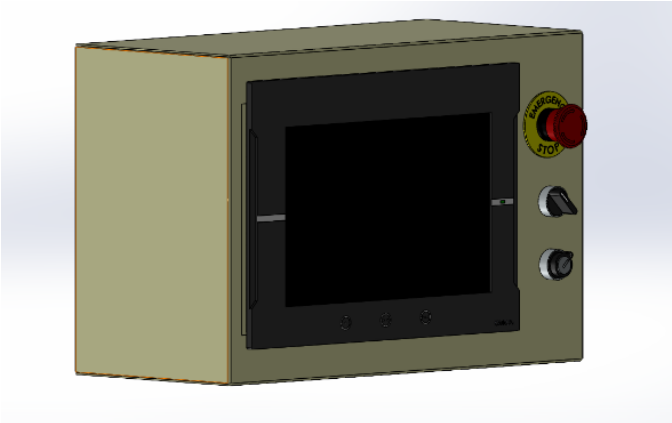

Fig.22.HMI screen

G. SUPPORTING FRAME

Two Frames are provided to support the components of the machine. One is upper frame and another is the lower frame. Upper frame supports the hopper, vibrator and weighing hopper. Upper frame bears more weight because the food grains are loaded into the hopper and food grains stays in hopper for long time until the process starts. Lower frame supports the horizontal and vertical sealing components, Air compressors for pneumatic actuators and HMI panel box. Also, Lower frame bears some weight which is

almost equal to Upper frame. But these weights are permanent and it can never be reduced. Fig.23,24 shows the frame supporting the packing machine.

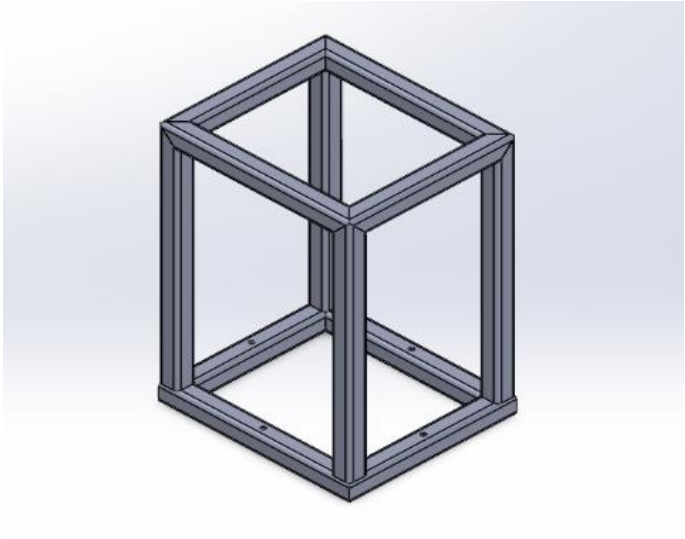

Fig.23.Upper frame

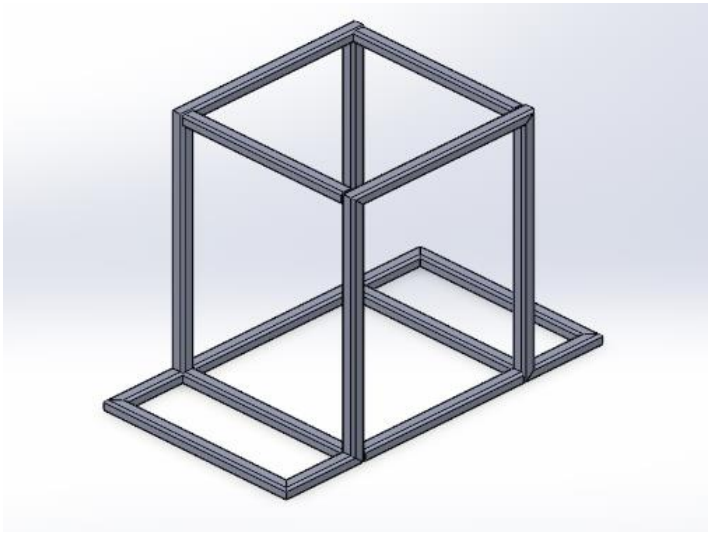

Fig.24.Lower frame

H. COVER ROLL FRAME

The plain cover is used for packing the food grains. This plain cover roll has to be fixed in some frame and sealed to pack the food grains. Cover roll frame is freely rotatable where the plain cover can be dragged for packing process. Initially, cover is vertically sealed and then bottom sealing is done. Now the cover is ready to get the weighed food grains and after putting it top sealing is done. Finally, a packed food grain is received. Cover roll frame provides a support to this entire process. Fig.25 shows the cover roll frame used for packing frame.

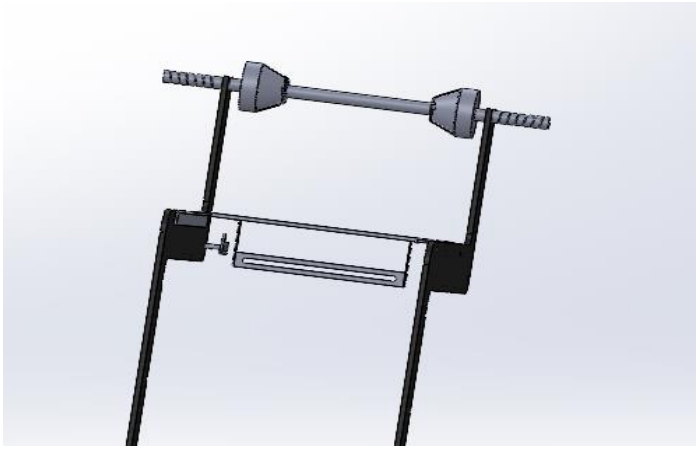

Fig.25.Cover Roll Frame

I. BAG FORMING RAIL

The purpose of bag forming rail is to fold the cover inwards and make it look like a packet. Before vertical sealing, the cover should be folded properly to seal and load the weighed food grains. Wrong folding may lead to spillage of food grains during transportation. So, this bag forming rail is the most important part which folds the cover and prepares for sealing. Fig.26 shows the bag forming rail used for sealing the cover.

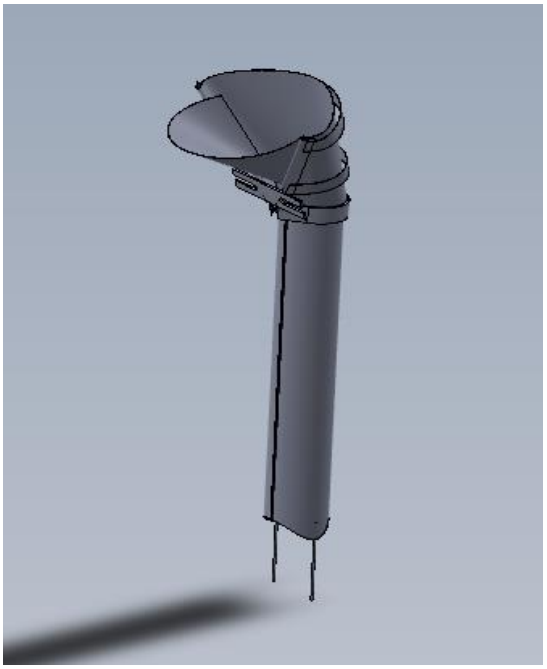

Fig.26.Bag forming rail

J. FINAL DESIGN AND ASSEMBLY

The given above parts are the important parts of packing machine. After designing all the parts based on the estimated dimensions, these parts have to be assembled to get a complete packing machine. Before assembling all these parts, analysis on these frames have to be done and it will be explained in upcoming chapters. This analysis will be very useful to study on stress and strain on the frame. All the designed parts need to be mated based on the rough sketch. Motion constraints has to be done carefully for the necessary parts. Also, there is a need for some freely movable parts which need to be specified during assembly. All the motion constraints and fixed parts has to be specified in the assembly section. Thus, all the parts have

been assembled and final design is achieved as per the problem requirement. Fig.27 shows the final design and assembly.

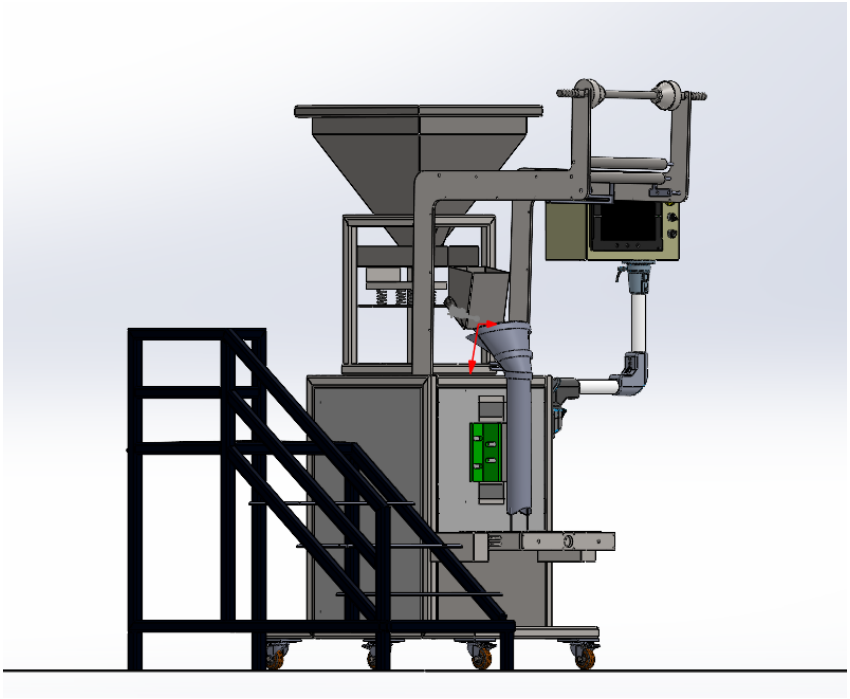

Fig.27.Final Design of Packing machine

VI. STRESS ANALYSIS

Stress analysis is the visualization of load acting on the mechanical part. Deformation of mechanical part at some of point of load can be calculated. A stress analysis can help to choose the best design alternatives for a component or assembly. Autodesk fusion 360 helps to a great extend to the stress and strain analysis and gives out lots of parameters. For the packing machine entire parts need not be analyzed. Only part which is subjected to maximum load need to be analyzed and checked for safety parameters. Here the lower frame holds the entire part of the packing machine and it is subjected to huge load. Components on the lower frame alone weighs around 80 kg and material to be added in hopper weighs around 20 -25 kg of food grains. Considering the maximum weight, total weight acting on the lower frame is 105 kg. Using this weight, force acting on frame is calculated by formula F = m x g where g is gravitational constant. After calculation, 1029 N force will be acting on the frame. Before analyzing the stress on the frame, the material and measuring unit has to be specified. Then motion constraints have to be specified because not all links of frame is subjected to load. Bottom face of the frame has no motion constraints. After applying the uniformly distributed load of 1029 N on the upper face of frame, result will be displayed. Maximum stress that frame can withstand is 10.53 MPa and it will deform in case if load is applied more than allowable maximum load. Fig.28 shows the maximum allowable stress on the frame.

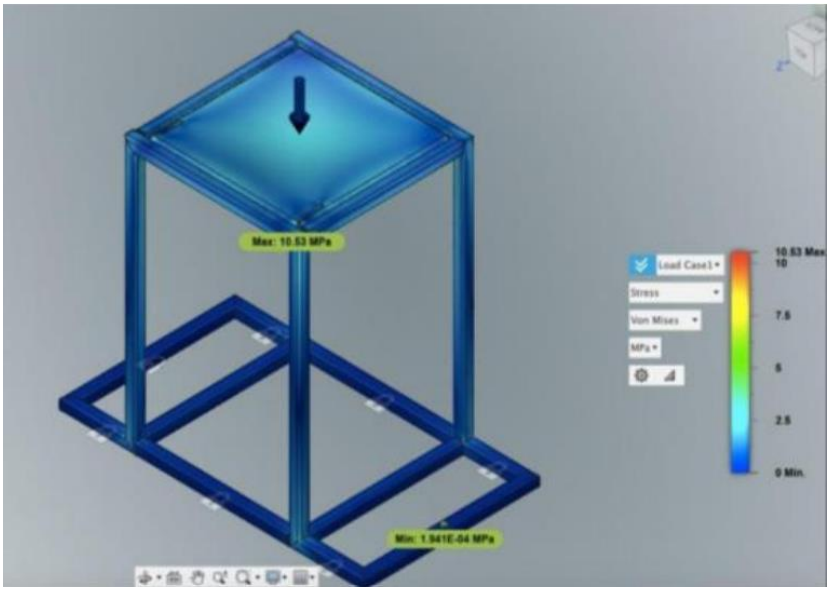

Fig.28. Maximum allowable stress

Deformation of frame when maximum load is applied is also visualized. Maximum displacement is 0.05194 mm. Actually, yield stress for mild stress is 415 to 600 MPa. But for frame design analysis comes around 10 MPa which is far less than the yield stress. Fig.29 shows the Displacement caused due to stress.

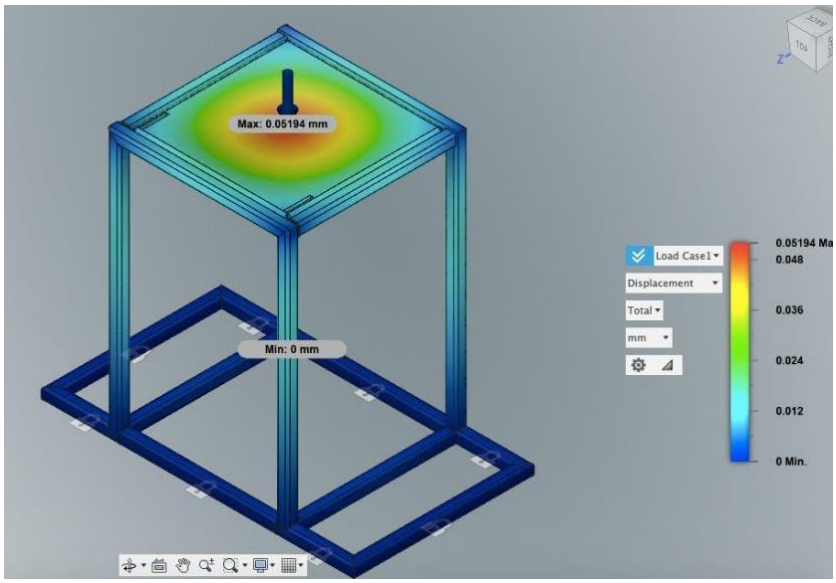

Fig.29. Displacement due to stress

Analysis results shows the safety factor is 15. A factor of safety of 5 to 8 is considered to be a safe to operate. Since all the links are fixed in the frame, it has no degree of freedom. To conclude, the design is safe to operate.

VII. PLC PROGRAMMING

The step by step working of the machine is controlled by PLC controller and the programming are done using the ladder logics. Delta DVP14SS2 is used as the controller. It is common in every machine that all the actions have to be frozen, the actions should be performed only if the emergency stop is disabled. As pneumatics forms the major part of the actuations, the air pressure has to be monitored and maintained at constant level to obtain the required functionalities Two sensors are used to monitor the status of the

hopper level, one for low level and another for high level. If the materials are present above the low level and upto the high level then only the indicator has to show that hopper is full, otherwise the operator has to check whether material is present or not.ow level is detected in the hopper, the LLS_ON will send a request to fill the hopper, Hopper_Fill_Request. Next step is to weigh the material for the set level and send it to the packing portion. If the Function Block generates the output as weigh_pan_empty this will trigger the output Ready_to_Weigh, this indicates that the pan box along with load cell is now ready for the operation.The output of previous step triggers the output, Feed_gate_open, this in turn opens the gate between the hopper and weighing hopper so that the material can flow towards the weighing portion.This latest output is used to activate the output of Bulk_Feed_Active which will make the vibrator to transfer material at a faster rate.Once the materials reach the weighing section, the load cell will be working under the BULK_FEED FB, three outputs will be generated from the load cell outputs, overweight, underweight and target weight. This is for the bulk weight, that is if the target weight is 2 kg, the bulk target will be 1.9 kg and the rest 100 g will be fed as fine feed in order to get more accuracy of packing and to avoid the excess material going into a packet. If it is underweight, the bulk feed will be again activated to get the required bulk target. If it is overweight the quantity will be adjusted in the fine feed part.Same as for Bulk feed, the weight will be checked for fine feed also in the FINE_FEED function block and the output will be used for the further control of input feed to get the target fine feed.If the eye sensor at the top detects that the film roll is not there, then both the cover release motor and the cover puller motor will be activated at the same time so that the cover can reach the sealing section.The eye mark sensor is not detected means, the film has reached the sealing section and it is time to actuate the horizontal sealers and vertical sealer so that the packet will be made before the material reaches the bag.Once the sealing is done, the materials will be dispatched from the weighing hopper by actuating the cylinder present at the weighing hopper, so that the material can reach the formed bag through the bag forming tube.

VIII. CONCLUSION

In this paper, the design of an automatic packing machine for small scale industries have been done. Both the food grains and powdered spices can be packed using this machine. Many problems were encountered in the packing process. Manual packing process requires a lot of time and energy to do it perfectly. To solve this problem, many solutions were provided and came up with one final concept. Compared to other commercial machines in the market, the designed product seems to be less cost and more efficient. All the target specifications were added to the machine which meets the requirement of customer. Final model of the machine was developed and all the motion constraints were specified. Static stress analysis of the lower frame were done to ensure the safety of design and studied the strain on that frame. PLC ladder logic were developed using ISP Soft software. All the design and analysis were completely analyzed and studied.

IX. FUTURE SCOPE

Future work will be focusing on complete fabrication and testing on this packing machine. Field trails will be done on various test cases. Improving the packing efficiency and fast production rate will be intense work to be focused and developed in the future. Minimizing cost will be the essential work need to be done and make it available for all the small-scale industry and even in grocery store in small size.

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