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Design and Fabrication of Automatic Dispensing Machine

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Abstract-The purpose of the project is to design a system that can handle and dispense substances (food, chemicals etc.)without human intervention. The system being developed is in relation to the problems being faced by the labours in handling accurate quantity of substances in many retail shops/manufacturing industries. The conventional method used by the labours is through hand-handling the substances, which may be hazardous in case of chemicals. On successful completion of the project this problem is sure to get solved. The system is mainly divided into 3 layers: (1) User Layer (2) Decision Making Layer (3) Action Layer. User layer consists of touch pad for the human interaction, which takes the input from the users regarding substances and its subsequent weight. Decision making layer consist of micro-controller (Arduino UNO/ MEGA), as soon as the user enters the data, the data is processed by the system. Action layer comprises of Actuator (Motor, dispensing controller). After the authentication the Automatic Dispensing Machine dispenses the required amount on to a container. The system is designed using SOLIDWORKS software package. Later, Fabrication can also be done in detail as per required dimensions.

Keywords- Automatic Dispensing machine(ADS), Arduino Uno/Mega, screw-feeder, Solid works software, Flow Control Valve, Solid State Relay, HX 711 converter.

1. INTRODUCTION

Though the concept of complete automation has hit the Industry, there is still lack in the way how the new system is designed and integration of the same with the existing system to achieve automation partially or completely. On thorough study of the design requirements which can be feasible and affordable aswell for the real time application of dispensing machine, the machine is built also keeping in consideration of space constraints. This automatic dispensing machine processes and dispenses the substances on demand of the operator.

2. OBJECTIVES

- To eliminate problems encountered in processing and dispensing of accurate amount of substances required for respective processes.
- To expedite the process of weighing and dispensing
- This system when used in various chemical and tyre manufacturing industries eliminates the direct contact of humans with dangerous chemical, thus ensuring working safety of the labour-force.
- To increase the efficiency of the weighing and to reduce the error.

3. LITERATURE SURVEY

Sl. No.	Author and Year	Title	Name of the Journal	Comments
1	NourmaKhader, AleciaLashier and Sang Won Yoon. 2016	Pharmacy Robotic Dispensing and Planogram Analysis Using Association Rule Mining with Prescription Data.	Expert Systems With Applications.	Automation in pharmacies has achieved innovative levels of effectiveness and savings. In the present day, automated pharmacies are facing extremely large demands of prescription orders specifically at the central fill pharmacies that distribute drugs to retail pharmacies. As a result, improvements are necessary to the Robotic Prescription Dispensing System (RPDS) and RPDS planogram to increase the throughput of prescriptions. RPDS planogram defines where to allocate the dispensers inside the robotic unit and how to distribute them among the multiple robotic units.
2	Kin Man Lee,Umberto Ravaioli,ShrutiVaidya September 16th, 2015	Automated Dry food Dispenser		Purpose of this project was to develop a prototype for people who cook from scratch. Measuring precise quantities of dry food items needed and dispensing the same is achieved. Typical features: Interchangeable container for different culinary seeds, Android app to communicate with the system.
3	G. Satyashankaraiah and Siva Yellampalli. 2014	Android Based Fluid Dispensing and Blending System Automation.	Fluid dispensing and blending system.	This paper discusses the development of an android based smart automated fluid dispensing and blending system.The developed system confines to juice dispensing and blending application used in food processing. The system operation issliced into three layers of operations; user layer, decision making layer, and an action layer.
4	David F W Yap, S.P. Koh	Artificial Immune Algorithm based Gravimetric fluid Dispensing Machine		Manufacturers in coating industry encounter difficulties in co-regulated carton paintings as number of coatings can be as high as 30000 times. The solution is blending. The effective way in achieving material mixing is by using dispensing Machine.

4. CONCEPT DESIGN

The system consists of mainly three layers:
1. User Interface layer
2. Decision making layer
3. Action layer

4.1 User interface layer:

The UI system consists of the physical part like screen, buttons and fingerprint which is used to take inputs. The entire UI is managed by managed processor. The instructions are displayed on the screen, where the user can use buttons to select the required option. Before selecting the option, the user is required to verify his identity by using RFID card or fingerprint. The system verifies the information with the database, if authentic provides him with other instruction like "required type and quantity of substance".

4.2 Decision making layer:

It is the brain of the system which takes the decisions about dispensing of the material. It mainly comprises of micro-controller (Arduino Uno/Mega). The data which are provided by the user is processed and decision is taken by the controller and gives the direction to the action layer to perform the required task.

4.3 Action Layer:

It the part of the system which executes the task obtained from the decision layer. It comprises of mechanical and electrical components to perform

the work. The main components of the machine are,

1. Single phase AC Motor
2. Screw Feeder
3. Solid-State Relay
4. Flow control valve
5. Servo-motor
6. HX 711 ADC convertor

4.3.1 Single Phase AC Motor:

A motor is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy.

The driving power of the loaded screw conveyor is given by:

$$\mathbf{P = P_H + P_N + P_{st}}$$

Where,

P_H = Power necessary for the progress of the material

P_N = Driving power of the screw conveyor at no load

P_{st} = Power requirement for the inclination of the conveyor

Power necessary for the progress of the material P_H:

For a length L of the screw conveyor (feeder), the power P_H in kilo watts is the product of the mass flow rate of the material by the length L and an artificial friction coefficient λ, also called the progress resistance coefficient.

$$\mathbf{P_H = I_m*L*\lambda*g / 3600 \ (kilowatt)}$$

$$\mathbf{= I_m*L*\lambda / 367 \ (kilowatt)}$$

Where,

I_m = Mass flow rate

λ = Progress resistance coefficient = 3

Each material has its own coefficient λ. It is generally of the order of 2 to 4. For materials like rock salt etc, the mean value of λ is 2.5. For gypsum, lumpy or dry fine clay, foundry sand, cement, ash, lime, large grain ordinary sand, the mean value of λ is 4.0.

In this connection it should be noted that the sliding of the material particles against each other gives rise to internal friction. Other resistance due to grading or shape of the output discharge pattern contributes to the resistance factor. That is why the parameter λ is always higher than that due to pure friction.

Drive power of the screw conveyor at no load, P_N:

This power requirement is very low and is proportional to the nominal diameter and length of the screw.

$$\mathbf{P_N = D_i*L / 20 \ (Kilowatt)}$$

Where,

D_i = Nominal diameter of screw in meter

L = Length of screw conveyor in meter

Power due to inclination: P_{st}

This power requirement will be the product of the mass flow rate by the height H and the acceleration due to gravity g.

$$\mathbf{P_{st} = I_m*H*g / 3600}$$

$$\mathbf{= I_m*H / 367}$$

H should be taken positive for ascending screws and will be negative for descending screws.

Total power requirement:

The total power requirement is the sum total of the above items

$$\mathbf{P = (I_m (\lambda.L + H) / 367) + (D_i.L /20) \ (Kilowatt)}$$

4.3.2 Screw-Feeder:

The screw-feeder is the important part of the mechanism, once the motor starts to rotate; it pushes the substances in between the space of the blades. Blades are designed using the empirical formulas,

$$\boldsymbol{P=0.75D_i}$$

P – Pitch of the screw
D_i – Inner Diameter of casing

$$\boldsymbol{SC = CFH*CF}$$

SC – Selection Capacity

CFH – Required Capacity in cubic feet per hour

CF – Capacity factor= 1.50 (for $P=0.75D_i$)

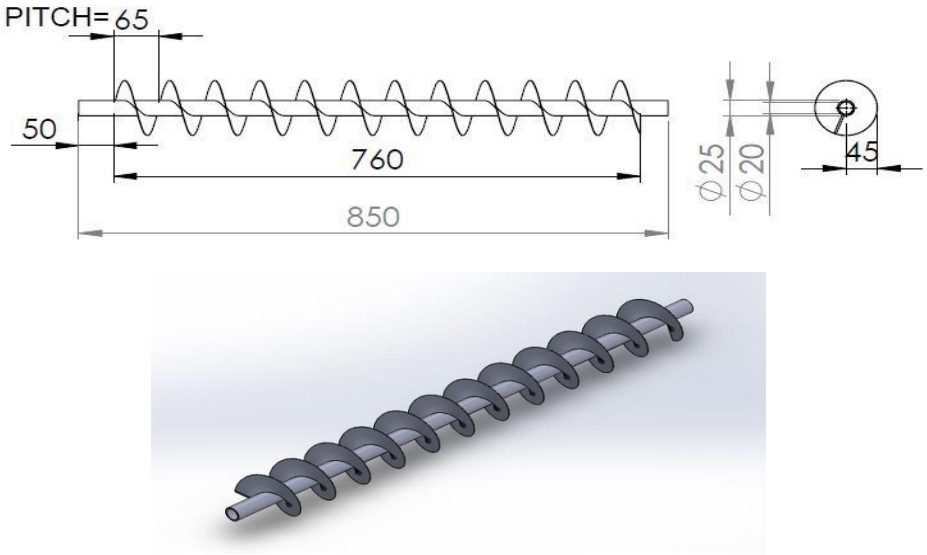

Figure 1

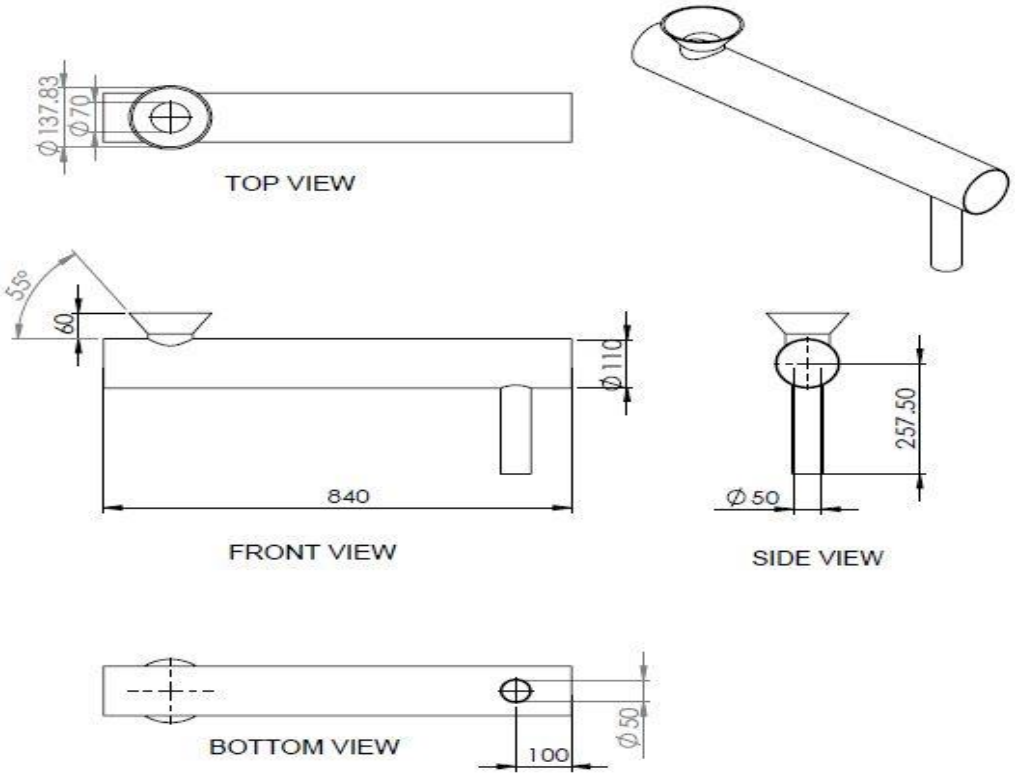

Figure 2

4.3.3 Solid State Relay:

Solid State Relays (SSR's) are normally-open semiconductor equivalents of the electromechanical relay that can be used to control electrical loads without the use of moving parts. SSR's provide complete electrical isolation between their input and output contacts with its output acting like a conventional electrical switch in that it has very high, almost infinite resistance when non-conducting (open), and a very low resistance when conducting (closed). The

controlling of SSR's are is done by the Micro-controller.

4.3.4 Flow Control Valve:

The flow of substances into the load cell needs to be precisely controlled. This can be achieved by the incorporation of control valve. The timing of opening and closing of the valve is controlled by the micro-controller, which obtains feedback from the load cell. The development of load from various iterations is as shown below.

Load cell development:

a. Butter-Fly Valve:
In this, a plate is incorporated inside the cylinder as shown in the fig. 4. The Valve is controlled by the servo motor which inturn controlled by micro-controller.

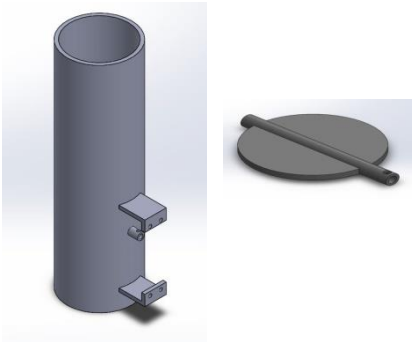

Figure 4

Limitation:

- The regulation of flow was very difficult to be achieved whenever there was a demand of smaller quantity i.e., the control of discharge of chemicals to the accurate amount was not possible to achieve.

b. Double Plate with roller Guide ways:
In this 2 plates were installed at some angle and rollers inside the walls. The rollers support the plate while movement also acts as the load carrying agent.

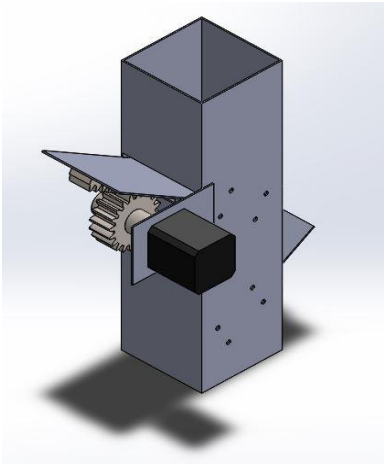

Figure 5

Limitation:

- The rollers could not sustain heavy loads.
- As the plates with chain went in chamber, grease in touch poisoned the chemicals at the outlet.

c. Double Plate with the guide ways inside the chamber:
This is same design with Guide ways instead Rollers. The guide ways support for the entire length of the plate.
The advantage of this type of mechanism is that when there is flow of particular chemicals from the Screwfeeder the upper plate is opened there by making the flow pass through the vertical column.

When the upper plate is opened for a while and the lower plate is already closed, there is a finite volume of the chemicals stored in the space in between the plates. This acts as reserve quantity and also eliminates the drawback that used to cause by butterfly valve mechanism. Actuating the lower plate slowly with the help of stepper/Servo motor, fixed quantity of chemicals can be made to be discharged at the outlet.

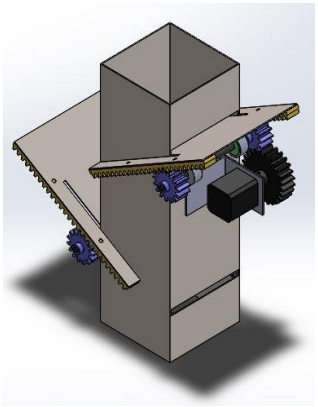

Figure 6

4.3.5 Servo motor:

A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors.

4.3.6 HX 711:

HX711 is a precision 24-bit analog to-digital converter (ADC) designed for weigh scales and industrial control applications to interface directly with a bridge sensor. It is designed for high-precision electronic scale and design, with two analog input channels

5. MECHANISM

The system is supported on a stand made of mild steel. There are two slots on the screw-feeder channel for the entry and exit. The feeder is controlled with help of single phase AC motor. Gear box is clubbed with the motor prior to the feeder channel. The purpose of gear box is to reduce the speed of the motor to optimum value (30-50rpm). The exit of screw-feeder is further connected to the last chamber which has got a customized valve (to control the flow of the material), incorporated in it and it is regulated by servo/stepper motor. The requisite chemicals on operators demand gets into the screw-feeder channel from the hopper, further by the motion of screw-feeder the materials are being pushed along the length of screw-feeder and let into the last chamber. The last chamber consists of flow control valve. The material which is being pushed by the screw feeder is controlled by avalve. This valve is controlled by the servomotor which in-turn is controlled by the micro-controller.

6. MATERIAL

While developing the system it is very important that the system not only supports the design requirements but also keeps the chemical in safe condition i.e. the material selected for the fabrication should not be reacting with the chemicals being used. Out of various material available stainless steel has been selected for the dispensing machine and the structure needed for the support is been built with mild-steel.

Stainless steel used in food equipment shall be of a type in the AISI 200 series, AISI 300 series, or AISI 400 series. When used in food zone, stainless steel shall have a minimum chromium content of 16%. Stainless with a chromium content of less than 16% can also be used, provided alloy has been hardened or tempered by an appropriate post-weld heat treatment process.

Composition: C 0.08%, Cr 18-20%, Fe 64-76%, Ni 6.8-7%

For the support of the dispensing machine Mild steel is used. Mild steel is very strong due to the

low amount of carbon it contains. It has high tensile and impact strength. Higher carbon steels usually shatter or crack under stress, while mild steel bends or deforms. Mild steel is especially desirable for construction due to its weldability and machinability. Because of its high strength and malleability, it is quite soft. This means that it can be easily machined compared to harder steels. It is also easy to weld, both to itself and to other types of steel. It takes on a nice finish and is polishable.

Sl. No.	Properties	Industrial Standards (Stainless Steel)	Prototype (Mild Steel)
1	Density	8 g/cc	7.87 g/cc
2	Hardness, Brinell	123	126
3	Hardness, Rockwell B	70	71
4	Hardness, Vickers	129	131
5	Tensile Strength, Ultimate	505 MPa	440 MPa
6	Tensile Strength, Yield	215 MPa	370 MPa
7	Modulus of Elasticity	193 - 200 GPa	205 GPa
8	Shear Modulus	86 GPa	80.0 GPa
9	Poisson's Ratio	0.29	0.29
10	Cost	High	Low (compared to stainless steel)

7. POSSIBLE OUTCOMES

- The Automatic Dispensing Machine can be implanted in various industries like chemical industries, tyre manufacturing industries etc. where humans are exposed to hazardous environment.
- It can be implemented in various food processing industries.
- The machine can be installed in Fair price shops (Ration Shop) and can be automated such that human interference can be reduced and illegal activities can be curbed, losses for the government can be reduced.

REFERENCES

[1] Pharmacy Robotic Dispensing and Planogram Analysis UsingAssociation Rule Mining with Prescription Data, NourmaKhader, AleciaLashier and Sang Won Yoon.2016
[2] Automated Dry food Dispenser, Kin Man Lee, Umberto Ravaioli, ShrutiVaidya, September 16th, 2015
[3] Android Based Fluid Dispensing and Blending, System Automation.G. Satyashankaraiah and Siva Yellampalli, 2014
[4] Artificial Immune Algorithm based Gravimetric fluid Dispensing Machine, David F W Yap, S.P. Koh