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AN AUTONOMOUS BOTTLE FILLING MACHINE ADDING TO THE ACCURACY AND PRECISION ALONG WITH REJECTION MECHANISM

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ABSTRACT

In current Manufacturing and packaging industries Filling is a task carried out by a machine that packs liquid products such as cold drink, water, Medicines Cosmetic Creams or Face wash. Traditional methods of bottle filling involved workers and it can be very tedious to handle this kind of stuff for the MNC companies. This method is time consuming which Adds to the expense. Our paper aims at filling of bottle and the rejection of incomplete filled bottle simultaneously. It also includes a user-defined volume selection through which the user can input the desired volume to be filled in the bottles .The entire system is more flexible and time saving. The filling and rejection Operations is controlled using microcontroller. This is because microcontroller is very user friendly and easy to program, cost effective, space efficient and reduces complexity. By programming the microcontroller we control the entire system. Hence the changing of data such as flow rate control, delay, counting of bottles, rejection criteria is easily modified. The process is fully automatic; during the process no worker is required so the designation of our project is "Autonomous bottle filling machine".

Keywords: Bottle Filling, Bottle Rejection, Micro Controller.

I. INTRODUCTION

Automation plays an increasingly important role in the world economy. One of the important applications of automation is in the soft drink and other beverage industries, where a particular liquid has to be filled continuously. For these kinds of applications, the trend is moving away from the individual device or machine toward continuous automation solutions. Totally Integrated Automation puts this continuity into consistent practice. Our project is also an application of automation wherein we have developed a bottle filling system .The various processes are controlled using a microcontroller. In the past, Human resources were the Pillar for controlling a system. In recent trends, electricity has been used for control in the filling plant and this electrical control was based on relays. These relays only allow power to be switched on and off without a mechanical switch. It is common to use relay to make simple logical control decisions. The advent of the microcontroller began to be the most common choice for manufacturing controls. Microcontroller has been gaining popularity on the factory floor and will probably remain predominant for some time to come. Mostly because of the advantages mentioned:

- Cost effective for controlling complex systems.
- Flexible and can be reapplied to control other systems quickly and easily.
- Computational abilities allow more sophisticated control.

- Trouble shooting aids make programming easier and reduce downtime.
- Reliable components make these likely to operate for years before failure.

Control systems are an integral part of modern society. There are many numerous applications that uses control system around us. A control system provides a desired output or response for a given input or stimulus. The reason that control system was built is for power amplification, remote control, convenience of input form; and compensation for disturbances. Today control system finds widespread application in the guidance, navigation, Control of missiles and space crafts, as well as it navigates planes and ships at sea. The applications is also expanded for the process control industry, regulating liquid level tanks, chemical concentrations in vats, as well as thickness of fabricated material.

II. OBJECTIVE

"To develop an automatic bottle filling system the major Aspects taken in to the considerations are deduction mechanism using sensors, Microcontroller for the incomplete filled bottle which is to be rejected automatically and this as a whole mechanisms are controlled by the microcontroller. The programming of ladder diagram and interfacing input and output module is most effective part of the system."

The advantages of "An automatic bottle filling system" are:

- Easily controlled through the Microcontroller.
- Precision and accuracy in the filling and rejection.
- Fewer workers are required.
- Time saving
- Low cost

Bottles are kept in position in a carton over a conveyor belt; the sensor senses the bottle to detect their presence. Depending on the output of the sensor, filling process will start by actuating the solenoid valve. The liquid filling is only depended on solenoid valve so there is no requirement of pump which again makes the entire system cost effective and simplified. If the particular bottle is not present then the valve will be deactivated thus it leads to "Zero" wastage of the liquid. As per the timing calculation the flow of liquid is based on the output area of the pipe, the valve remains "ON" during that duration which leads to the bottle filling as per pre desired requirement. No system in the world is perfect but this system nears us to the "ZERO" defects. Rather, Even though if any bottle is not filled as per desired requirement, than the bottle will be automatically rejected by rejection mechanism which is attached before the bottle is preceded to capping and packing.

III. PROCESS TECHNIQUES

3.1 Bottle Detection Using Sensor

Bottles are kept in position in their respective holders which are fixed to the conveyor at the input side. Photo electric sensors are used to detect the presence of bottles in the holder. Depending on the output of the sensors the filling operation takes place. A time delay is set in order to set the status of the bottles. If bottle is present the corresponding status bit in microcontroller which leads input to set at "1" else it is set to "0". Depending on this output the filling process of the bottles takes place. Thus for all the "n" bottles present in the input side then the sensor gives the corresponding output to the microcontroller which in turn switches ON the corresponding

Solenoid valve for filling operation to take place. If a particular bottle is not present the corresponding valves remain OFF.

3.2 Operating Solenoid Valve

When the sensor senses the bottle, the conveyor belt will be stopped after pre assigned seconds. So the bottle comes in the alignment of the output of the solenoid valve.

3.3 Filling Operation

Once the bottles are detected in the input side the conveyor motor switches ON and it starts moving in the forward direction. The bottles then reach the desired position for filling and the conveyor stops. The corresponding pumps in process tank switch ON and filling operation takes place. There are three tanks present in the filling side namely: process tank, concentrate tank (Tank 1) and tank to store liquid (Tank 2).Tank 1 and tank 2 have low level and high level sensors (LLS and HLS) respectively. Process tank has three level sensors (LLS, HLS and MLS). MLS is used to denote the middle level of the tank. When the liquid in the process tank reaches below low level (LLS) pumps in Tank 1 and Tank 2 switches ON and the process tanks get filled. When the level of liquid reaches high level (HLS) the pumps in Tank 1 and Tank 2 switch OFF.

3.4 Rejection

The rejection is based on the level of liquid in the bottle. The sensor (self-made sensor) detects the level of the liquid. If the level of liquid is not in the linear line / level of the positioning transmitter and receiver, the bottles will be rejected through the motor connected with the rejection Flap that is placed in the conveyor path.

3.5 Controlling

The all the task are controlled by the microcontroller. The programming is done in C language. The modification can easily be done in Set program as per the requirements and the programming module is attached with the computer. The ARDUINO software is used in the project to control the program.

IV. MECHANICAL DESIGN

4.1 Photoelectric Sensor

The photoelectric sensor is operated on 12V DC and the relay output is given to the PLC input terminal. The sensor we use here is the product of the AUTONICS Ltd.

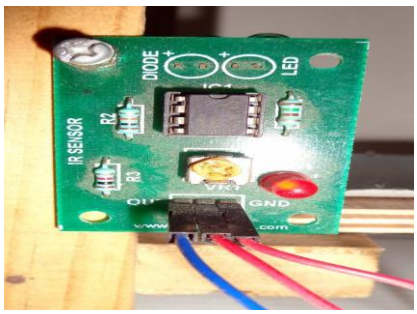

Fig 1 Photoelectric Sensor

4.2 Motors

10 RPM, 12V DC geared motor for robotics and multi applications. Very easy to use and also available in standard size. Nuts and threads required to mount on shaft are easily connected and internal threaded shaft for easily connecting it to the roller of the conveyor.

Fig 2 DC Motor

4.3 Features

- 10 RPM 12V DC motors with Gearbox.
- 6mm shaft diameter with internal hole.
- 125gm weight.
- Same size motor available in various RPM.
- 2kg-cm torque
- No-load current = 60 mA (Max), Load current = 300 mA (Max).
- The 10 RPM DC gear motor is used in the project to run the conveyor belt. And the 45 RPM DC motor is used to reject the incomplete bottle.

4.4 Solenoid Valve

The solenoid valve for liquid is used to allow the liquid to pass to the output. The liquid solenoid valve operates at 12V DC and we use it for ON-OFF condition. When the bottle is exactly under the valve, the microcontroller gives the signal to Open /ON Condition for the valve so the liquid is able to flow. When the bottle filling is completed, the valve gets Closed/OFF and the conveyor belt starts. The valve remains open for the pre assigned time so that bottle filling is done at the desired level.

Fig 3 Solenoid Valve

- Latch time of solenoid valve is calculated with the help of flow rate equation.
- Elevation of tank in our project is not very high so increase of velocity is negligible in pipe.
- So, velocity of water at inlet of pipe is simply expressed as:

  $$V = (2*g*h)^{1/2}$$

  And,

  $$Q = A*V$$

  Where,

A = Cross-Section of inlet of valve

V = Velocity of water

h = Height of tank

Now,

$V = (2*g*h)^{1/2}$

$V = (2*9.81*1)^{1/2}$

V = 4.42 m/s

While,

Q = A*V

$Q = 4.42*3.14*0.5*10^{-2}$

$Q = 6.93 \times 10^{-2}$ m/s

Q = 0.06 lit/s

Flow rate is in m^3/s and our bottle is of 200 ml so as per flow rate we decide time for latch of solenoid valve.

Net time required to fill bottle = 0.20/0.06

= 3.5 Sec

V. ELECTRONICS EQUIPMENT

5.1 Amplifier Circuit with Intensity Regulator

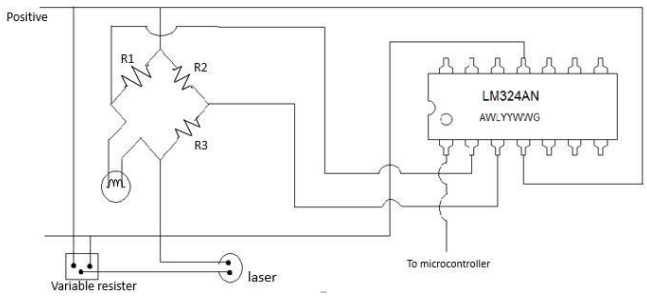

Fig 4 Amplifier Circuit with Intensity

5.2 Microcontroller

Microcontroller will work as a command centre of whole filling, sensing and other processes. We are going to use programming development board of AT mega 328P microcontroller with which several input and output will be connected listed below.

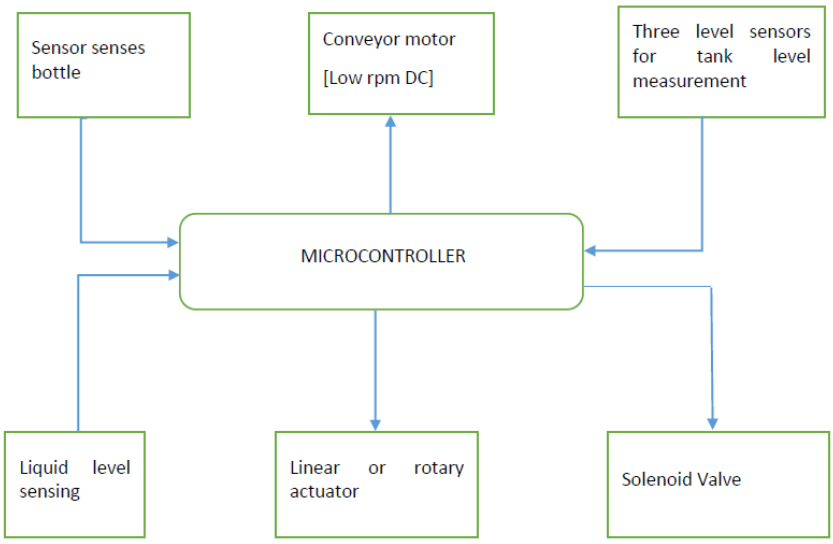

Fig 5 Flow Chart of Micro Controller Control

5.3 Interfacing Devices

There will be several devices as input and output which we will connect to microcontroller listed below

- Solenoid valve
- Proximity sensors
- Rejection motors
- Conveyor motor
- Green switch
- Red switch

5.4 Development Board

We will use development board which consists of AT mega 328P microcontroller with serial transmission programming cable inbuilt with port for external power supply. Since our sensor is a passive type we choose development board with extra 5V power supply and a set of DPDT switches for future scope of wireless development. There is a ON-OFF switch and Reset key provided by manufacturer for start Program from first line as well as some expandable function are also provided by them. Since these extra features will not apply for particular this application we will not gone through it deeply.

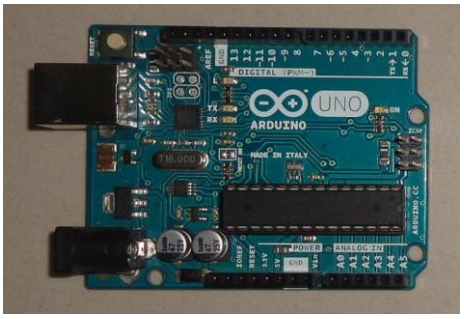

Fig 5 Development Board

5.5 328P Data Sheet

As we can see in the figure, there are four sets of terminal P0 to P3 are there among them we will use P0 port for all operations.

- 5V power lines will be connected to VCC.
- GND will be connected to ground.
- XTAL1 and XTAL2 will be connected to crystal and across that one capacitor will be there.
- Sensor will be connected to P0.1
- Green switch will be connected to P0.1
- Red switch will be connected to P0.2
- Solenoid valve will be connected to P0.3
- Conveyor motor and rejection motor will be connected to motor driver circuit and as a input of that motor driver circuit P0.4 and P0.5 will be use.

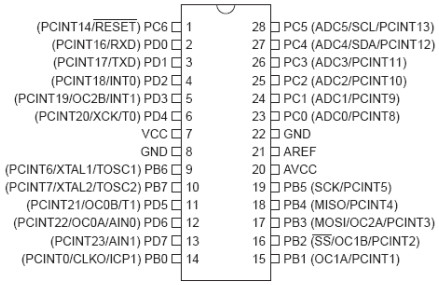

Fig 6 Pin Diagram

VI. EXPERIMENTAL SETUP

The Line diagram of the entire Bottle Filling Plant has been represented herewith below, as well as main aspects and main parts used are Proximity Sensor, Conveyor belt, Solenoid Valve, Level Sensor, Mechanical Arm, Motor, Roller

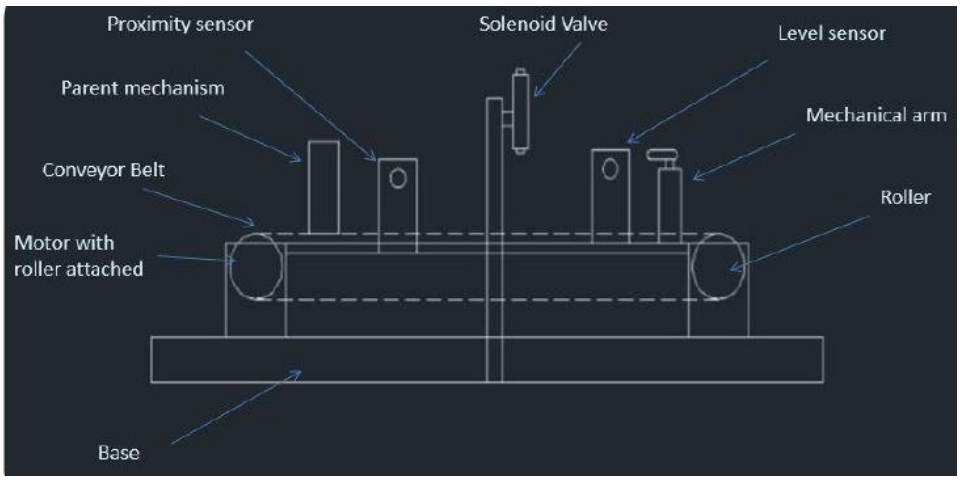

Fig 7 Line Diagram of the Bottle Filling System

The entire plant can be run in the following series as the Bottle to be filled is supposed to be kept on the conveyor belt as with the help of motor and roller the bottle moves in the linear positive direction and proximity

sensor senses the bottle after which the bottle moves ahead as pre defined time and stops exactly under the solenoid valve, through which the bottle gets filled, after this process the bottle again moves in linear direction, now level sensor checks the level of liquid if the level is found to be below the Lower Limit than the mechanical arm will reject the bottle and if the level is found to be within the limit of approval than the bottle is preceded for the capping and packaging.

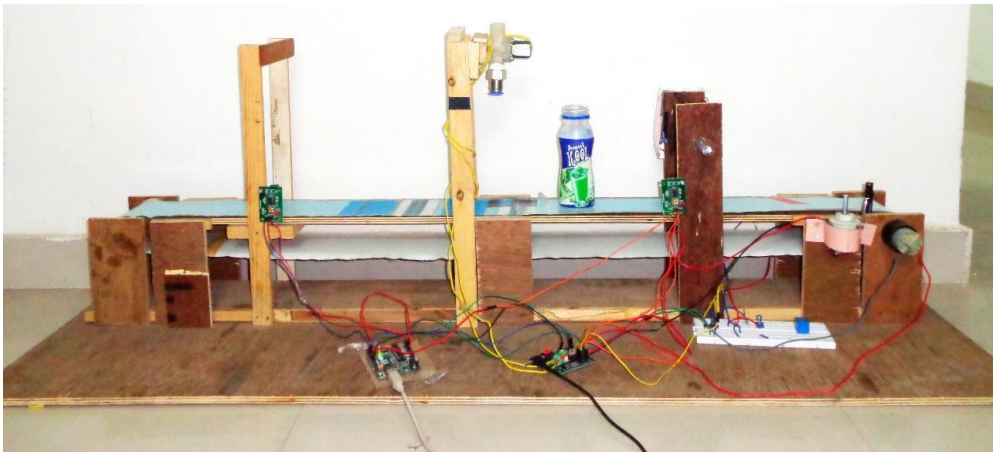

Fig 8 Actual Prototype of Bottle Filling Plant

VII. CONCLUSION

This project lead us to an effective conclusions, mostly for mass production which is the case in today's industries and MNC's, it is cost effective with high rate of Accuracy and precision which can be run by minimum labor and still the high rate production can be achieved. Secondly it is also time effective and due to reject mechanism the customer satisfaction for the guaranteed amount of goods can be achieved, with future scope point of view, easy operating so that unskilled labor can also operate very easily.

VIII. FUTURE SCOPE

Further the operational chain can be expanded for the capping and foil sealing of the product with continuation in the cycle of this Bottle filling Plant. The use of different type of Sensor can add to the Accuracy and precision of the product. The Calculation design can be generated to speed up the process while reducing the wastage at Zero level.

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