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Review on Smart Bottle Dispenser And Filling Plant Using Industrial IoT

Vijay Murge[1], Amol Jadhav[2], Sanket More[3], Sandesh Shinde[4], Akshay Magar[5], Dr. D. R. Shende[6]

[1, 2, 3, 4, 5, 6]*(Department of Instrumentation Engineering, AISSMS IOIT, Pune, India)*
Corresponding Author: amoljadhav31998@gmail.com

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Abstract: *Up to yet, there are so many industries are working on manual process. But due to an increase in technology and automation, most of the industries are now becomes worker less i.e. fully automated. There is the requirement of the laborers which makes the industries full of errors and decreases work rate to improve it and reduce errors automation are used. Most of which is performed by pneumatic actuators with electrical and automation control. there are lots of difference between a traditional factory and fully automated industry 4.0 based factory In the current industry environment, providing high-end quality service or product with the least cost is the key to success and industrial factories are trying to achieve as much performance as possible to increase their profit as well as their reputation in current industries there is the utilization of data, finding errors in the system, analysis of system performance are done very efficiently but there is lots of contrast between the traditional industry and industry 4.0 based industry is that in the industry not only data analysis can be done but also in addition to condition monitoring and fault diagnosis, components and systems able to get self-based awareness, this will provide management system with insights for the status of the factory. Hence it will provide the best performance with better management and controlling processes with better time management.*
This paper describes the automation process of dispensing and filling the bottles of different sizes using Industrial IoT. This process can be used for industrial purposes.

Keywords*: Bottle Dispenser, Filling Plant, Industrial IoT*

I. Introduction

In a bottling plant before filling the bottle we need the proper size of the bottle to be fetched from the inventory and brought to the filling station on time. In some plants, the bottles are directly manufactured at the place before filling. In the single plant, if we use the bottle fetching and filling mechanism, the process becomes simpler but simultaneously it loses flexibility. So to make it flexible we decentralize the process and separate the dispenser from filling plant which makes the future changes in process simpler and it becomes more flexible. This process of decentralization and interoperation of plants was proposed in "Industry 4.0- (use of Cyber-Physical Systems)" which is explained as follows.

There have been three industrial revolutions up to this point in time and the fourth is in progress. The first revolution started in the late 18th century and was brought about by the advent of the steam engine and focused on mechanization. The second industrial revolution began around the late 19th century and focused on mass production with the introduction of manufacturing lines. This enabled industry to scale up manufacturing with better coordination between labor and machines. The third revolution began around the end of the 20th century with the introduction of the microcomputer. This allowed for the automation of several manufacturing processes using machines that could repeat a series of tasks with high precision with minimal supervision under strictly defined conditions.

There are six design principles in Industry 4.0. These principles support companies for identification and implementation process in Industry 4.0 scenarios.

- Interoperability: the ability of cyber-physical systems(i.e. work piece carriers, assembly stations, and products), humans, and Smart Factories to connect and communicate with each other via the Internet of Things and the Internet ofServices.
- Virtualization: a virtual copy of the Smart Factory which is created by linking sensor data (from monitoring physical processes) with virtual plant models and simulation models.
- Decentralization: the ability of cyber-physical systems withinSmartFactoriestomakedecisionsontheirown.
- Real-Time Capability: the capability of collecting and analyzingdatato providethederivedinsights.
- Service Orientation: An offering of services (of cyber-physical systems, humans, or Smart Factories) via the Internet ofServices.
- Modularity: flexible adaptation of Smart Factories for changing requirements by replacing individualmodules.

This project is part of the Smart Factory which is designed to follow all the above principles of the Cyber-physical system. Smart bottle filling plant gives us flexibility while filling the different sized bottles with different liquids according to the manufacturing demand. This also helps in manufacturing customproducts.

II. Literature Survey

Cyber physical systems

It provides a next-generation computational framework for dynamic, data-driven optimization of production. In keeping with the principles of Industry 4.0, our architecture is easy to reconfigure and connect to various hardware/software devices allowing for quick reconfiguration of factories. It has a live representation of the real world enabling managers and other users to keep track of activities in the factory. It also provides users with statistics and other abstraction tools to augment decision-making capabilities and can automatically allocate resources thereby allowing for nearly autonomousoperationofthefactory.[1]

A. Water Pump ControllingSystem

We can control the water pump by connecting it with an output pin of microcontroller via a motor driver circuit. When the microcontroller sends a positive signal (+5v) or a ground signal (0v) to the motor driver circuit, then the water pump becomes on or off respectively. We also would like to use a manual switch on the motor driver circuitwhich is supposed to use for controlling it manually. It makes this system more user friendly.[2]

B. Water LevelSensor

To make a special water level sensor we would like to introduce some convenient materials such as iron rod, nozzles, resistance, rubber, etc. A connecting rod made by iron andsteel which should be connected with ground and we need at least four nozzles which should be connected with +5v via a 1kΩ resistance. We need to bind them together and put a rubber at their joint point which will act as an insulator for everynozzle. When the sensor touches water, nozzles and connecting rod getan electricconnectionusingwaterconductivity.[2]

C. VolumeCorrection

The objective of this experiment is to verify that the amount of insecticide solution dispensed by the machine into the bottle is within the specified tolerance — 200 ml to 240ml. The experiment starts by loading empty 250ml bottles on the conveyor. The machine is then turned on. Wait until allbottlesare filled and Measure the actual volume dispensed into the bottles using a beaker and record. By this method correction in volume is achieved and the cost of manufacturer and customer isreducedbyreducingthe lossoffilledliquid.[2]

Bottle Filling Process

The bottles go to the filling section and the sensor 1 detects the bottle and activates the cylinder C now the piston moves forward clamps the bottle and activates the cylinder D and the piston pushes the filler into the bottle and then the cylinder v activates to open the nozzle and fills the required quantity. When the height of the liquid is

sensed by the sensor 2 then cylinder v closes the nozzle, the piston of the cylinderD goes back and the filler is moved up and the bottle getsunclamped andmovestowardscappingsection.[3]

Automation in bottling Industries

The designed low-cost industrial automation process is programmable. The automation process has preciseness and accuracy in its operations, which is controlled through its controllers. The sequence of operations is such as automatic clamping, de-clamping, injecting the molten material, filling, and capping process of the bottles are essential in industries to increase their production rate. Therefore, the required ladder program is designed in the programmable logic controller to itsoperatingprocess. This is achieved through the use of simple devices like limit switches, relays, sensors, pneumatic actuators, and electrical controls. The small scale industries use conventional methods for manufacturing the bottles, filling and capping the bottles. These bottles are filled manually and in unhygienic conditions which contaminate the productsfilled.

A large amount oflabor is required to perform these operations. The conventional process is converted into the automation process, by this method the production rate increases at a low investment. This is achieved through low-cost industrial automation. [3]

III. Related Work

This paper deals with the automation of the bottle filling process of Coca-Cola bottles. Normally in the Coca-Cola factory, the scenario is that the liquid level is maintained manually by human sight. When the bottle passes through the conveyor belt. The project shows how it can be done automatically. In this system, a webcam is used for the detection of the bottle. The next component used is multiple input-output cables and is connected between the camera and monitor to capture the image of the bottle. Then sensors are used to sense the bottle. The operation is done on a PLC where RGB format is changed into HSV format which means Hue, Saturation, and the value component that needs to be extracted. The final control element is a control valve that fills the bottle according to the filling ratio set by the PLC by using a variable speed drive that adjusts the speed of filling.[5]

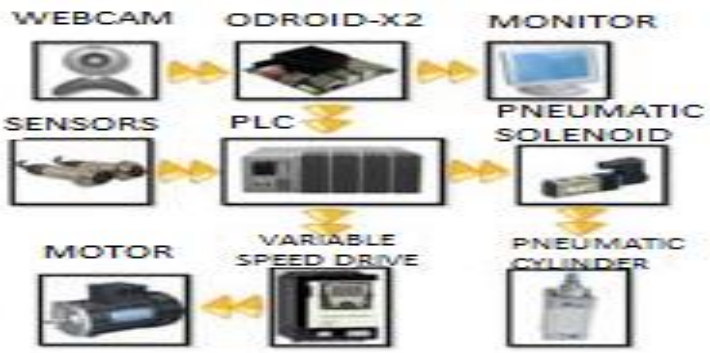

Fig (1)Block diagram of liquid level control

This paper proposes a system in which multiple liquids can be filled in the bottle using a single system. The whole process is operated by a PLC. The two inputs given to the PLC are two proximity sensors 1 and 2 which detect the color of the bottle. PLC has two outputs i.e. Solenoid valves that operate two taps containing two liquids. A switch-mode power supply is used to trigger the PLC at 24V DC. Based on the sensing of the sensor 1 and 2, the desired liquid is filled in the appropriate bottle a motor is used for the conveyor which is controlled by the relay and this both are operated by PLC. The PLC used the decision based on the sensors detecting the color of the bottle.[6]

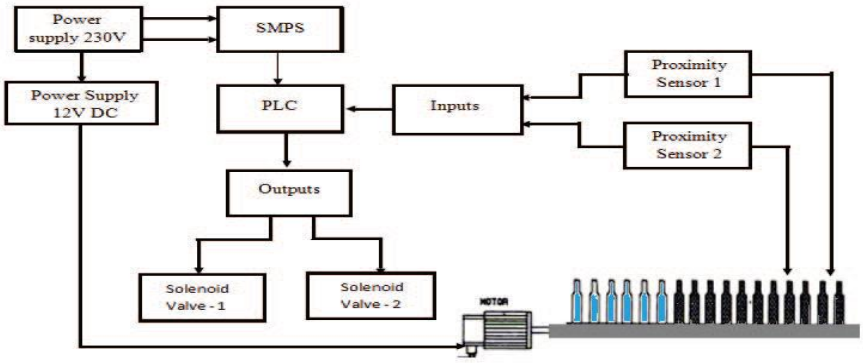

Fig (2): Proposed Automated Multiple Liquid Bottle Filling (MLBF) System

In this paper, RFID is used to track the wine bottles which are dispatched after production. RFID tags are fitted on every bottle as labels so they can be tracked from anywhere in the world. It is used to keep a track of the record of the bottles which are transported. Radiofrequency identification is used to get the exact location of the bottles by detecting the unique code on the label. Then the code is transmitted from the location of the bottle to the receiver antenna near to the factory and that unique code can be traced by computer. An RFID reader is used to read the code on the label. The reader detects six wine bottles at a time but sometimes due to some multiple tags the code cannot be traced. As the bottle moves further in any direction the receiver antenna also moves one degree ahead in that direction. [7]

In this paper, PLC is used to fill the liquid in the bottle up to a certain height. For that fillers are used according to viscosity and the flow of the liquid. Overflow filler is the suitable filler used because it is used for less viscous fluids and it fills the bottle according to the direction given by the PLC. Also, a meter is fitted above the control valve which shows us the amount of liquid filled in the bottle. Depending upon the thickness of the fluid there are different types of fillers used according to our requirement. Sensors are used to sense the bottles while passing on the conveyor. The project is just all about the exact height upto which the bottle is to be filled.[8]

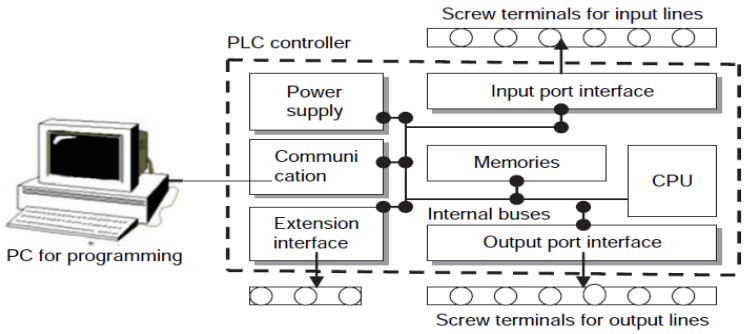

Fig (3): Basic elements of PLC controller

In this paper logo is printed on the bottle decides what type of liquid is to be filled in it. It consists of a webcam or camera to take the image of the logo. Then image processing is done on it in MATLAB. Here Arduino and PLC interface together. Two IR sensors are used to detect two different types of logos and depending on that two valves fill liquids in the bottle appropriately. If a bottle is detected by IR sensor 1 then valve 1 fills the liquid in it and the same is for IR sensor 2. The PLC contains the code for starting and stopping the motor which runs the conveyer belt. So a logo is used to fill multiple liquids simultaneously. [9]

IV. Proposed System Data

To fill the bottle properly it must be held at the center of the conveyor that is just below the poring nozzle of filling plant, to make it possible the bottle is held by a specially designed module which can hold any size of the bottle (in specific higher and lower range and resolution.) at the center of the conveyor and just below the filling nozzle.At first, the module is placed on the conveyor and it traverses to the holding station and stopped and held by SM1 where the module is sensedby Infrared proximity sensor S1 and the data is written on the NFC tag (Near Field Communication) by NFC trans-receiver RC-522, it can read from as well as write the data on NFC tags NT which are passive data storage media. It works as the communication media between the product and the machine. The production target is received from the web app via the Internet. This target is processed by the controller and it sequences the filling and fetching process of bottles to reduce the total time of filling the whole batch of the bottles. It sends the data of the size of the bottle, type, and quantity of the liquid to be filled in the bottle to the RC522. RC522 writes the same data in the NFC tag on the module. Same time the controller communicates with filling plant controller for the availability of that specific liquid, and with inventory management for loading the bottles into the silo. It also checks the number of available bottles and plans the process accordingly in coordination with the inventory. Once the data is written on the module it is again read back to check the sound and consistent transfer of data which ensures the readability of data at the filling station. After getting the successful data transmission flag from the controller module is sent silo holding the corresponding bottle to be filled, by opening the servo SM1.Then the bottle is stopped and held by the corresponding servo (i.e. if bottle size to be filled is in Silo 1 then module is stopped by SM2 which holds module just below the Silo 1 so that the bottle will fit into the module) after holding the module in proper place silo will drop one bottle into the module. Then the module will be dispatched for further process of filling and dispatch by opening the path blocked by servo, simultaneously controller will communicate it with the fillingplant.

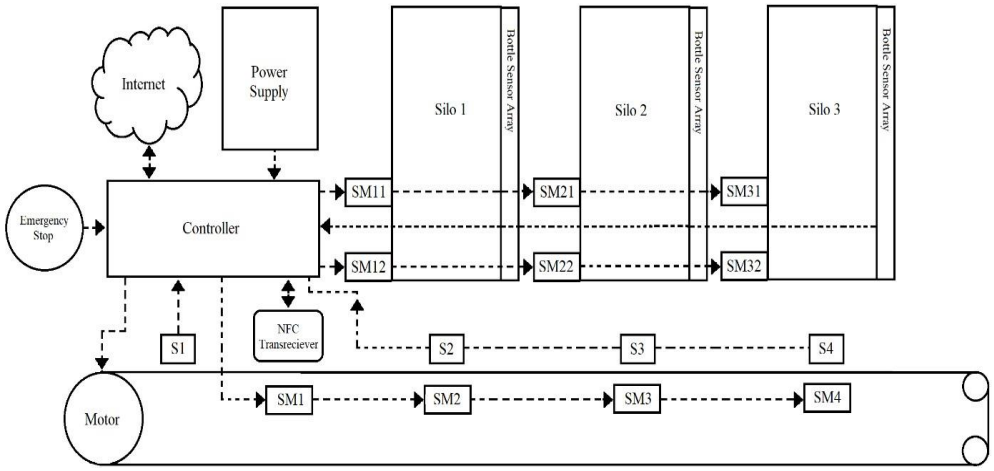

Fig.(4). Fig. ofbottle dispenser plant of proposed data system

The plant is designed to fill various sizes of bottles(in specific range) with a number of liquids (at a time storage facility for 3). Provided the liquids are in a specific range of temperature, viscosity, chemical reactivity, etc. The bottle enters the conveyor from the previous plant, and it is sensed by sensor S1. Sensor S1 is an IR proximity sensor. This gives the signal of the presence of the bottle on the conveyor.Then the bottle is stopped by a servo SM1. It holds the bottle till the data of process over the bottle is read and the filling process of the previous bottle is complete if any. The data of processes to be done on the bottle such that amount i.e. in milliliters and type of the liquid is stored it the NFC (Near Field Communication) sticker which is a passive radio information storage media. The data read is fed to the Raspberry Pi. It processes the data and sends the signal to the conveyor, servos, pumps, and solenoids accordingly.

The bottle now comes under the nozzle and stopped by the servo SM2 until it is filled. The signal is sent to the corresponding pump to pump the liquid into the measuring system it sends the liquid to the nozzle in batches. This reduces the need for level measurement of liquid in the bottle the bottle isfilled with the quantity stored in by the NFC. If one bottle is under filling progress and another bottle comes on the conveyor then itisheldbySM1tillthe firstbottleiscompletelyfilled.

After the bottle is completely filled SM2 opens the path and the bottle is sent to the dispatch. Also, the quantity and the bottle data is updated in the web app to give the live process report. Every sensor data is reflected to show the process status.

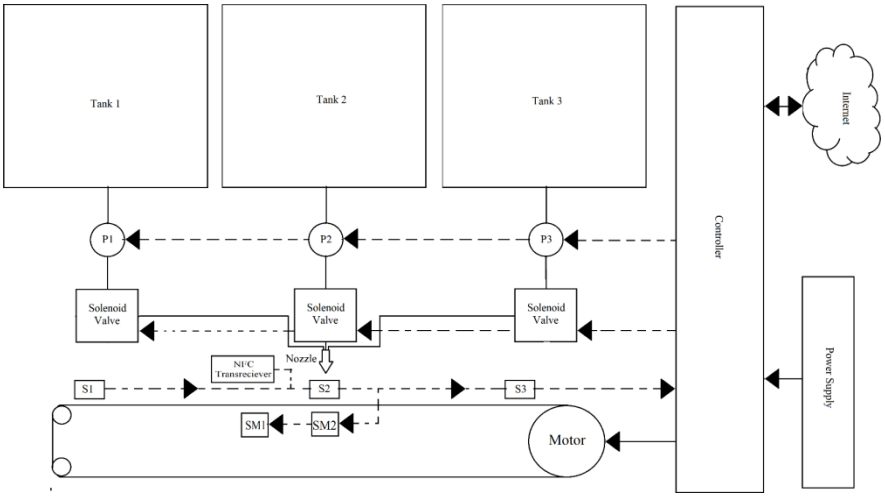

Fig.(5). Fig. of bottle filling plant of proposed data system

V. Conclusion

This paper presents an automatic bottle filling using IIOT. This system comprises of filling bottles of different sizes with liquids of different colours using Raspberry pi. This system is fully automated. Our system is user friendly and is designed by taking into consideration the customer requirement.

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