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Design and Fabrication of IOT Enabled Automatic Beverage Bottle Filling and Capping Assembly Line

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Abstract: Our paper includes a novel method that aims to completely automate the bottle filling and capping process as well as keeping the production under the surveillance all day through Internet by making the use of IOT technology. This will result in lesser variability in the packaging process, reduction in time involved in the production and greater control and consistency of product quality.
Keywords: Bottle Holder, conveyor belt, microcontroller, relay, sensor, solenoid valve.

I. INTRODUCTION

In the traditional or conventional machining, the worker was required to observe and perform the operations on a machine manually to make particular product or job. These tasks become tedious for worker. For example, in small industries, bottle filling operation is done manually. The manual filling process has many shortcomings like spilling of water while filling it in bottle, equal quantity of water may not be filled, delay due to natural activities of human etc. This problem faced by small industries compels us to take up this project. Our project is meant for small industries as well as for those people who actually want to start their business in the field of beverages industry. It aims to eliminate problem faced by small scale bottle filling system as far as the initial cost and keeping surveillance over the production is concerned. To achieve our aim, we have used the concept of automation and use of cutting-edge technology like Internet of Things (IOT) in our project. Now a day's the automation becomes most important part in manufacturing industries.
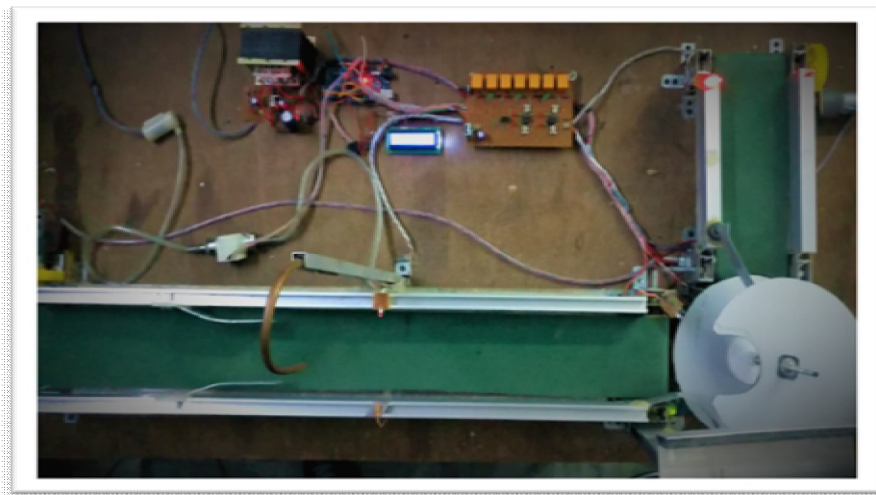
A. Working Principal

The project demonstrates the beverage filling and packing assembly line which is fully automatic and all the processes involved is controlled by the special micro controller MEGA. The entire assembly consists of a conveyor that pushes empty bottles towards the filling head. The filling head is responsible for filling of bottles with water. where the volume and flow of water is controlled by the solenoid valve which is in turn controlled by the microcontroller. Later, the assembly pushes the bottle in a circulating disc, which brings it to the capping station that places a cap on the bottle. The bottle that reaches the cap turning station which is a motorized arrangement responsible for spinning and tightening the cap on bottles. After this step, the assembly pushes the bottle over to the next point where it is rolled down the system as a finished product. The entire process on the assembly line is controlled by Arduino MEGA.

It consists of number of various proximity sensors that detect the presence of bottle on the assembly line and sends the signal to the controller accordingly. The system is also equipped with Wireless Transceiver Module which makes it IOT enabled. The volume and flow of water to be filled can be changed according to the demand and capacity of bottle through an online platform just by entering the desired quantity of beverage. The server will receive the data entered and sends the instruction to the microcontroller to change the allowable quantity to be filled. With the help of this IOT technology the manufacturer can keep 24x7 surveillance over the entire production and can monitor the total number bottle filled, total quantity of beverages filled per day, total duration for which the assembly line is in working mode, etc.
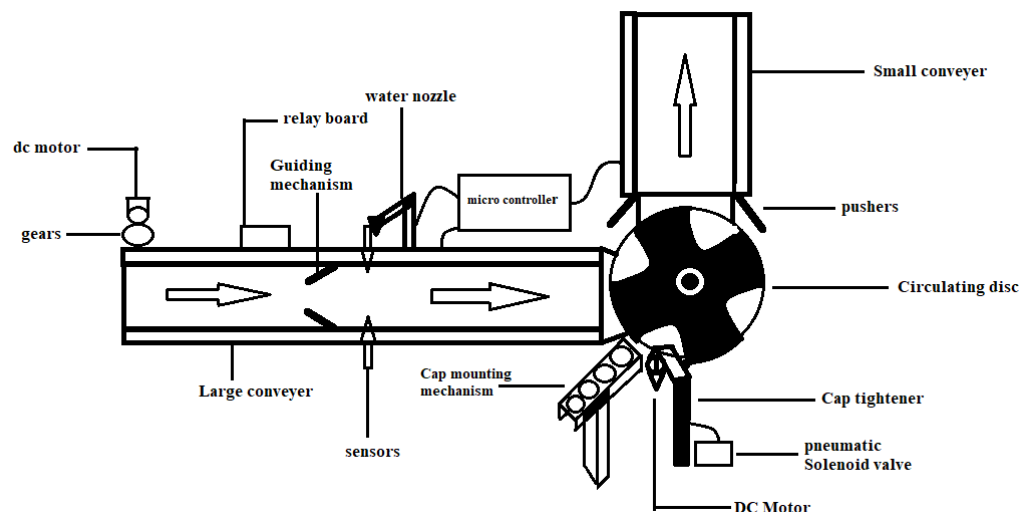
II. COMPONENTS USED

1) *Conveyer:* A Conveyor Belt is the carrying medium of automatic bottle filling machine. It is used to carry the bottle from one part of the assembly to the other part. The material used in the conveyer is PVC.


2) *DC Motor:* The dc motor is used to rotate the conveyor belt at a desired speed which is fully controlled by Microcontroller. The specification of the motor includes 12 Volt having 30 RPM.

3) *Solenoid Valve:* A solenoid valve is an electromechanically operated valve. It is used to control the flow of liquid and is controlled by microcontroller. It runs on 12V DC 500mA current.
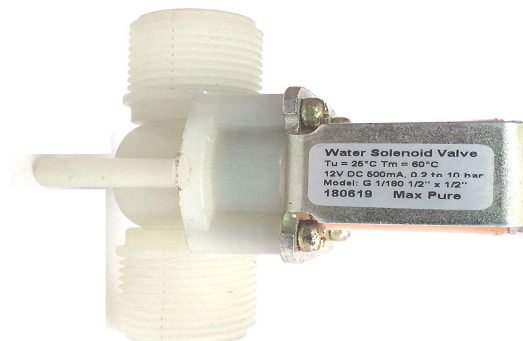

4) *Pump:* A pump is used to supply the liquid to the bottle via nozzle. This pump runs on 12V DC and is of self-priming diaphragm type. This is capable of filling the bottle at the rate 25ml per second.

5) *Arduino MEGA microcontroller:* Arduino MEGA is used as a micro controller. It is the small computer on a single integral circuit containing a Processor Core, memory and Programmable input/output Peripherals.


6) *Rack and Pinion gears:* Rack and pinion gear system is used in the capping mechanism in order to control the vertical motion of cap tightener.
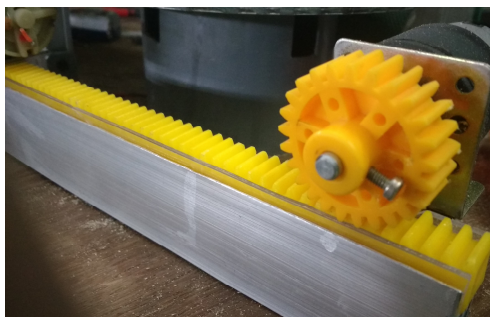
7) *Transformer:* A centre-tapped stepdown transformer is used in order to lower down the voltage from 220V to 12V. Alon with it, two bridge rectifiers are used in the circuit. It runs on 12V/5amp current.


8) *Wireless Transceiver Module:* A Wi Fi Transceiver Module is used to connect the whole system with internet. This is attached to the input/output pin of the microcontroller and helps in controlling the data through internet.
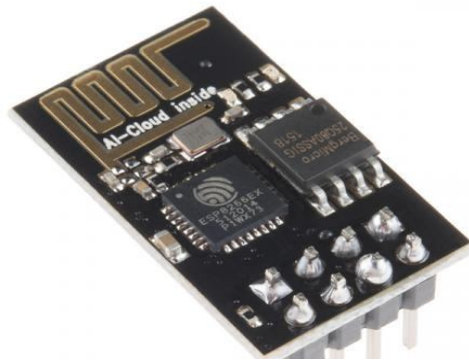
9) *Infrared sensor:* Infrared sensors are used to detect the presence of bottle at various places in the assembly line. Depending on the presence of bottle, it sends the signal to the micro controller informing about its presence and hence performs the action accordingly. Its specification includes the range (10-15cm) at 5V DC|2.
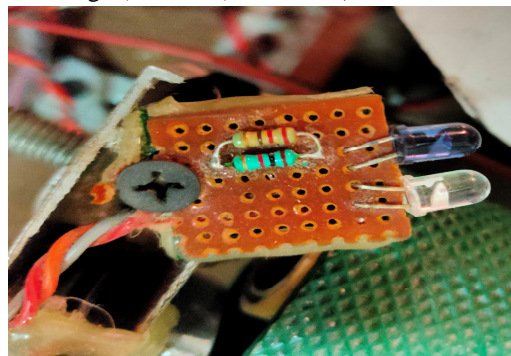
10) *Relays:* A relay is an electromagnetic switch operated by a relatively small electric current that can turn on or off a much larger electric current. The heart of a relay is an electromagnet (a coil of wire that becomes a temporary magnet when electricity flows through it). It is used to switch ON/OFF the various motors and other equipment and is controlled through micro controller.
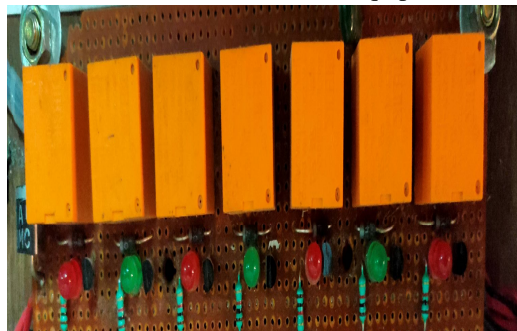
III. PROPOSED METHODOLOGY

The entire project performs five major functions which are as follows:
1) Transferring the empty bottle to the Filling station.
2) Filling the empty bottles after detecting its presence.
3) Transferring the filled bottle to the Capping station.
4) Capping the filled bottle at the Capping station.
5) Recording various data (amount of water and number of bottles filled, operation time, etc.) and upload it to the server.

The development of the entire project has been divided into several stages which are as follows:
1) Design & development of conveyers for transferring of bottles using belt and roller arrangements.
2) Design and development of Capping mechanism based on Rack and Pinion arrangement.
3) Design and development of Flow system using pump, nozzle and solenoid valve arrangement
4) Design and development of Electronic circuits and installation of electronic components (flow sensors, solenoid valve, detectors, micro controllers, dc motors, relays, etc.)
5) Installation of IOT.

Following are the procedure that will be followed during the development of the project:
1) Finding definition of project.
2) Literature reviews
3) Concept of bottle filling
4) Selection of concept
5) Collect information regarding the hardware used in project.
6) Division of project into several modules.
7) Collection of hardware
8) Assembly
9) Testing and observation in running mode

IV. MATERIAL SELECTION

S. No.	Title	Material Used/Value
1	Frame of assembly line	Aluminum composites
2	Conveyer belt	PVC
3	Rotating Disk	Aluminum Composite (ACP)
4	Rollers	Nylon (3D Printed)
5	Rotating drum diameter	0.21m
6	Conveyer belt width	0.105m
7	Conveyer Length	0.85m
8	Conveyer height	0.10m
9	Filling time	25ml/sec

V. CONCLUSIONS

The automatic bottle filling and capping machine uses an Arduino based MEGA microcontroller that controls the filling and capping process. Depending upon the output of the micro controller, the corresponding solenoid valve or dc motors will be energized and filling, capping and transferring of bottle operation takes place. The presence of bottle is detected by the infrared sensors installed in assembly line. If the particular bottle is not present then the solenoid valve will not activate and doesn't allow the dispensing of water in the filling station thereby avoiding wastage of the liquid. The present system will provide a great deal of applications in the field of automation and ensures human safety and makes the process faster thereby maintaining adequate supply of the products in the market in order to meet the ever-increasing demand. Further, it also promotes beverage related business start-ups as less capital is required for its installation.

VI. ACKNOWLEDGMENT

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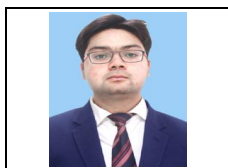
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