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Automated Bottle Filling System

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Abstract - ***The field of automation has a notable impact in a wide range of industries beyond manufacturing. Automation plays an increasingly important role in the world economy. Filling is a task carried out by a machine that packages liquid products such as cold drinks or water. In past, humans were the main method for controlling a system. More recently, electricity has been used for control and electrical control is based on microcontrollers for various purposes like medicines, pharmaceutical plants, chemical plants etc. There microcontrollers control the complete working of the system. It is common to use microcontrollers to make simple logical control decision. The automation in bottle filling industry comes with increased electrical components. Essential requirements of each component in the system is important to be studied in ordered to understand how each part works in coordination with other parts in the system. This study mainly includes design, fabrication and control system for automated bottle filling system. The main part is control system which includes C programming in Arduino microcontroller to control various components in system. A conveyor system with sensors and electromagnetic valve is fabricated for this purpose. The entire sequence of operation is controlled by arduino microcontroller. 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 to design this system. This proposed system is meant for small industries. It aims to eliminate problem faced by small scale bottle filling system. With this system which operates automatically, every process can be smooth and the process of refilling can reduce worker cost and operation cost.

Key Words: *Arduino, PLC, Rotary pump , LED etc…*

1. INTRODUCTION

The current scenario in industries is to embrace new technologies to proceed towards automation. The same vision is exercised in bottle filling plants. To meet the customer demands and accelerate the filling of bottles, all operations are nearly automated. The automation of bottle filling involves use of PLC for control but it is costly. Despite of all such advance technologies small industries are still involved in manual filling of bottles. They might be discouraged to adapt to new technology due to high cost involved in automation. The study emphasize on reduction in cost using arduino microcontroller. The arduino microcontroller is relatively cheap and widely available. 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 work generally emphases on small industries. It aims to eliminate problem faced by small scale bottle filling system. . With this system that operates automatically, every process can be smooth and the process of refilling can reduce the man power cost and operation time.

In order to get an idea on the basic fundamentals in the present study an extensive literature review has been carried out. Rajesh G. Khatod, Chandrashekhar Sakhale[2] in their paper worked on touch screen operated liquid dispenser machine for chemical, pharmaceutical industries. The research paper emphasized on reducing complexity and cost involved in present liquid dispenser machine. The research paper aimed to improve metering quality of dispenser machine. The microcontroller used was AT89C52. The system is controlled by microcontroller programming. Also, the research paper gives information about working of system and measurement of process variables.

A.S.C.S. Sastry, K.N.H. Srinivas [3] in their research paper introduced a systematic approach to design and realize a temperature and volume based liquid mixing system using three low cost microcontrollers. The primary function of this system is to mix different liquids of required ratio and temperature. In this paper the electronic sub system is developed with the help of three AT89S51 microcontrollers for controlling. Two LM35 sensors are used for sensing temperature. The mechanical sub system consists of two geared DC motors to allow the liquids in required ratio for mixing.

T. kalaiselvi, R. Praveena[4] in their research paper aimed at filling and capping bottles simultaneously. The filling and capping operation takes place in a synchronized manner. It also includes user defined volume selection menu 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 capping operations are controlled using a programmable logic controller. This is because PLC'S are very flexible, space efficient and reduces complexity.

2. COMPONENTS OF BOTTLE FILLING SYSTEM

The automation in bottle filling industry comes with increased electrical components. Essential requirements of each component in the system is important to be studied in ordered to understand how each part works in coordination with other parts in the system.

2.1Layout

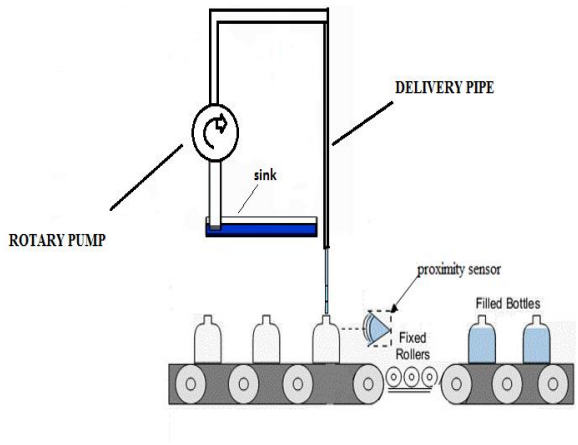

Fig- 1: Automated bottle filling system

Figure 1 shows the layout of automated bottle filling .The Automated Bottle Filling System will comprise of following components.

2.1.1 Arduino 2560 Mega Micro Controller

Arduino board 2560 Mega is used to write programs & create interface circuits to read switches & other sensors. The power of the Arduino is not its ability to crunch code, but rather its ability to interact with the outside world through its input-output (I/O) pins. The Arduino has 14 digital I/O pins labeled 0 to 13 that can be used to turn motors and lights on and off and read the state of switches. Each digital pin can sink or source about 40 mA of current. This is more than adequate for interfacing to most devices, but does mean that interface circuits are needed to control devices other than simple LED's. In other words, you cannot run a motor directly using the current available from an Arduino pin, but rather must have the pin drive an interface circuit that in turn drives the motor. A later section of this document shows how to interface to a small motor. To interact with the outside world, the program sets digital pins to a high or low value using C code instructions, which corresponds to +5 V or 0 V at the pin. The pin is connected to external interface electronics and then to the device being switched on and off.

2.1.2 Infrared Sensor

An Infrared sensor as shown in figure 2 is a sensor which is able to detect the presence of nearby objects without any physical contact.

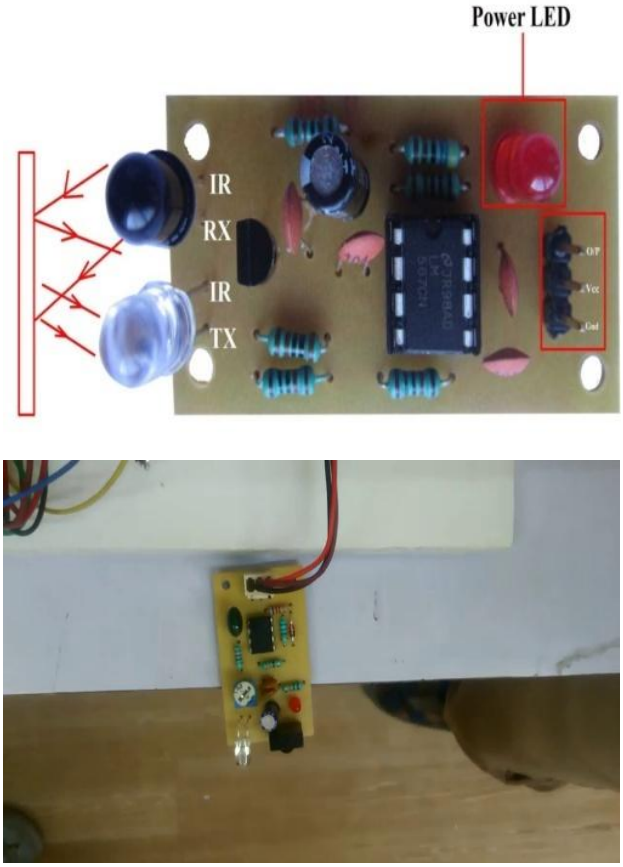

Fig- 2: Infrared sensor [5]

An Infrared sensor emits an infrared signal or a beam of electromagnetic radiation (infrared), and looks for changes in the field or return signal. The object being sensed is often referred to as the Infrared sensors target. Different Infrared sensor targets demand different sensors. For example, a capacitive or photoelectric sensor might be suitable for a plastic target; an inductive proximity sensor always requires a metal target. The maximum distance that this sensor can detect is defined "nominal range". Some sensors have adjustments

of the nominal range or means to report a graduated detection distance. Infrared sensors can have a high reliability and long functional life because of the absence of mechanical parts and lack of physical contact between sensor and the sensed object. Infrared sensors are commonly used on smartphones to detect (and skip) accidental touch screen taps when held to the ear during a call.

2.1.3 Display

The system uses 2-line, 16 character LCD display as shown in figure 3. It has 4 bit interface. It is relatively easy to use once you have it mapped into your processor's memory-mapped I/O. Then characters need to send to display, they show it up on the screen.

Fig- 3: LED Display

2.1.4 Keyboard

A keyboard is a set of buttons arranged in a block or "pad" which usually bear digits, symbols and usually a complete set of alphabetical letters. If it mostly contains numbers then it can also be called a numeric keypad. Keypads as shown in figure 4 are found on many alphanumeric keyboards and on other devices such as calculators, push-button telephones, combination locks, and digital door locks, which require mainly numeric input.

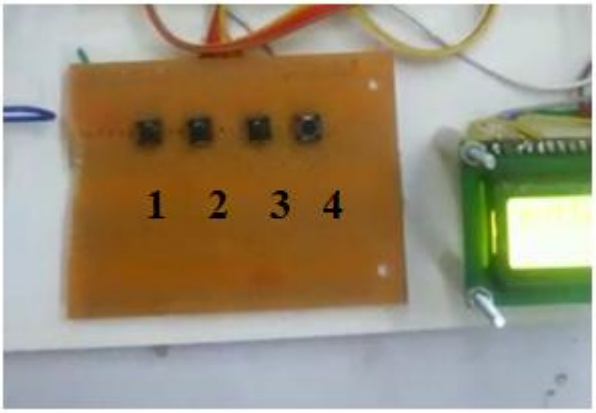

Fig- 4: Keyboard(1. ENTER 2. INCREASE VALUE 3. DECREASE VALUE 4. RESET)

2.1.5 Rotary pump

A Rotary operated pump arrangement as shown in figure 5 uses a rotary pump arrangement to provide a fixed volume of liquid to flow into the bottle according to time based on user input.

Fig- 5: Rotary pump

According to user input the time is calculated to fill varying volumes of bottles.

2.1.6 Relay

A relay as shown in figure 6 is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid state relays. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits) The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

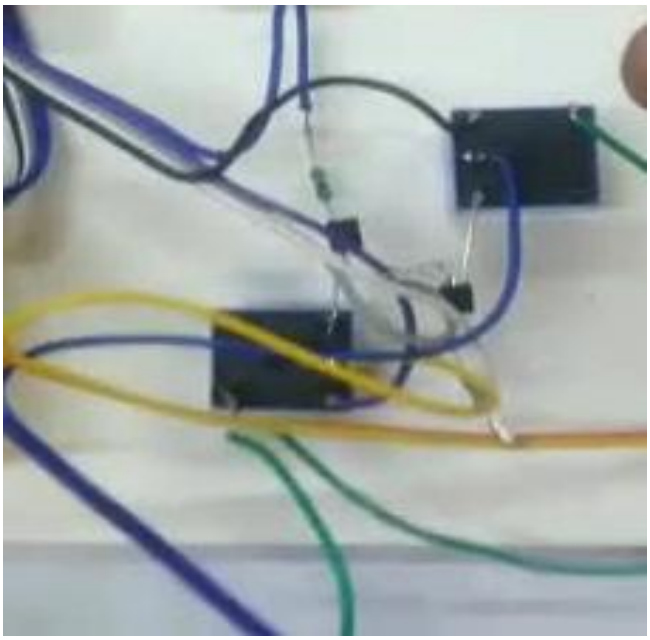

Fig- 6: Relay [5]

2.1.7 Flat Belt Conveyor

Fig- 7: Flat belt conveyor

A Flat Belt Conveyor as shown in figure 7 is used to support the bottles on their location & carry them forward sequentially to fill with water. A Flat Belt is passed over three rollers to performed rolling action.
The system involves four motors. Two motors are used to run conveyor belt and secondary motor is used to transfer filled bottles from one production line to another production line. The primary motor is controlled by arduino microcontroller and secondary motor run continuously for smooth operation.

2.1.8 DC motor

A DC motor is an essential part in the conveyor system. A motor is a rotary mover that allows for precise control of angular position, velocity and acceleration. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with motors. DC motors are a specific class of motor although the term motor is often used to refer to a motor suitable for use in a closed-loop control system. Dc motors are used in applications such as robotics, CNC machinery or automated manufacturing operations.

3. DESIGN AND WORKING OF AUTOMATED BOTTLE FILLING SYSTEM

3.1 Design

The construction of the system is as shown in figure 1.It involves assembly of all the components listed above. A simple conveyor belt will be stretched between two rollers, one roller which pushes it and other roller which pulls belts as the belt moves. The conveyor belt and rollers are accommodated on table frame. The Infrared sensor is fixed at certain position on table frame in such way that it is able detect the bottle. All electrical components are situated on the ply at the bottom of table frame.

The bottles to be filled are arranged on conveyor belt. A tank or sink is placed using support. A rotary pump is controlled by the arduino which dispense metered quantity of water in bottle. The four motors are clamped on the table frames which are driven by 12V dc supply and 30rpm. The electrical circuit and display and keyboard are clamped on the table top along with the battery

A gravity operated filling system has a big difficulty in measuring the correct volume of liquid to be filled. A separate arrangement of a timer operated valve or a secondary tank arrangement requires an extra sensor and valves which adds up unnecessary cost to the system. A rotary pump arrangement as shown in figure uses a rotary pump arrangement to provide a varying volume of liquid to flow into the bottles.

On the input provided by the user for volume, the program calculates the time for which the motor must be kept on and a delay time is provided. The pump gets ON for given period of time to fill required amount of liquid into bottles.

Fig- 8: Rotary motor and pump mechanism

3.2 Working of bottle filling system

In Automated bottle filling system, the whole process of filling must be completed without human interference. This is achieved by following flow chart in figure 9.In this system, when start button is pushed, the motor starts running which gives translational motion to the conveyor belt.

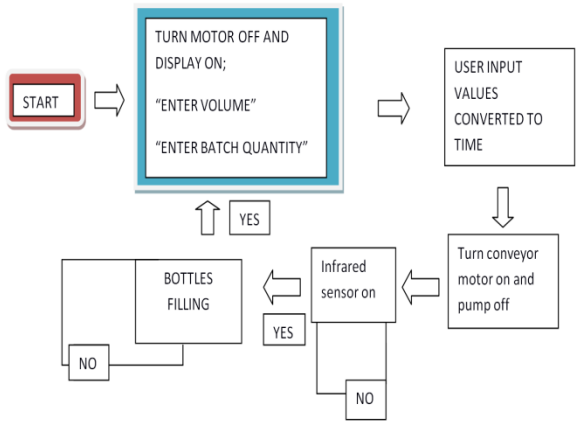

Fig- 9: Bottle filling flow chart

When the start button is pushed the display shows the messages of "ENTER VOLUME TO BE FILLED" and "ENTER BATCH QUANTITY". Once the user enters the values, the values are fed into the system and the volume is converted to the time delay of the pump. As soon as the user enters the values ,the conveyor is turned on and the bottles move on the conveyor. Once the bottle reaches the infrared sensor , it senses the bottles and gives feedback to arduino. The pump gets turned on and the bottles are filled. The process is then repeated for particular batch.

4. EXPERIMENTAL RESULTS AND DISCUSSIONS

The experimental results are obtained by observations taken for different volume inputs and outputs of volumes filled in bottles. Two graphs are obtained for the values of 100ml and 200 ml as input.

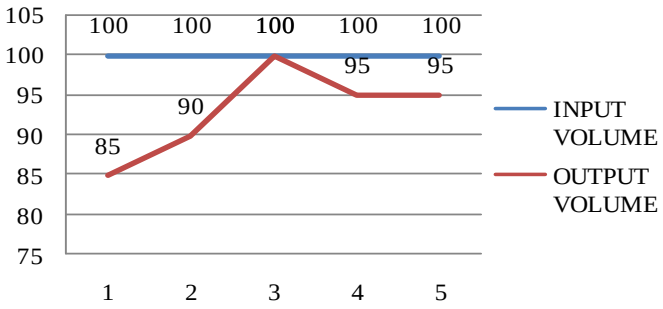

Fig- 10: Graph of observation number vs volume for filling 100 ml bottle

The graph of observation number vs volume filled for 200 ml of liquid bottle is given below:

Fig- 11: Graph of observation number vs volume for filling 200 ml bottle

From the above graph, it can be seen that there are possible deviations of the observed values from the input volume due to bubbles in delivery pipe and back flow of water due to gravity.

5. CONCLUSION

The automated bottle filling system using pump filling concept was successfully implemented and studied.

Various observations were taken which closely resembled the actual volume to be filled. The reason for deviations of the readings are studied accordingly. The automated bottle filling system was beneficial in reducing work, time and cost of filling. The fabricated model of Automated bottle filling system can be used where high precision is not necessary and time limits not bound. Hence it must be used application specific and must not be used in places where faster and more accurate methods of filling are available.

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