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AUTOMATIC LIQUID FILLING MACHINE

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ABSTRACT

A conveyer system is a common piece of mechanical handling equipment that moves materials from one location to another. Our project uses this technology for filling any desired liquid into a container one after another continuously with the help of Arduino nano.

This equipment will be useful in industries for large scale production of bottled items. Also, this same equipment but of small size will come in handy for domestic usage .

This report consists of entire details of the method of making and assembling the "AUTOMATIC LIQUID FILLING MACHINE" along with the programming of controlling component i.e, Arduino nano.

KEYWORDS: Arduino, automatic, production , conveyer.

1. INTRODUCTION

When it comes to mass production, the basic need which the production method should achieve is continuity and less time.
Our project is an Arduino based machine that offers both with additional perks like Automation, cost effectiveness, easy to operate with less man power.

It is a small prototype which represents a large-scale machine capable of filling container of any shape and size with desired liquid at a fast rate continuously.
The prototype in this project is capable of filling 10 bottles of 100 ml capacity in 5 mins.

Time is a very valuable thing. The less time it takes to produce something, more efficient and profitable the process is. With the help of automatic liquid filling machine, the time required to fill containers can be considerably reduced with automation.

2. PROJECT AIM

The aim of the project is to design and construct a liquid filling machine that will automatically fill the containers on a conveyer belt with desired liquid in series with the help of Arduino.

The objective is to implement a low cost, reliable and scalable liquid filling system that can be used for various applications ranging from large scale industries to domestic usage.

3. ΔΕΣΧΡΙΠΤΙΟΝ ΟΦ ΠΡΟΘΕΧΤ

This project is one of the important Arduino projects. Arduino based liquid filling machine to fill any shape of containers with desired liquid in continuous manner.

The containers are placed on a conveyer belt which is wrapped around two pulleys attached to a wooden frame through support of bearings.

One of the pulleys is powered or rotated by a 12V DC motor. This leads to movement of the conveyer which transport the containers from one point to another. At a particular junction, an ultrasonic sensor is fitted along the way of conveyer belt which detects an incoming container. This detection is output signal of ultrasonic sensor

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which is sent to the Arduino nano. The Arduino stops the motion of conveyer belt on receiving the signal from ultrasonic sensor by controlling the driving motor such that the detected container stops just below a pipe. This pipe is connected to a 5V submersible pump which is present in liquid reservoir. After the container has stopped moving, Arduino actuates or starts the pump which draws the liquid from the reservoir and fills the container. The pump remains active for a particular time till the container is filled. As the container is completely filled, the pump stops and Arduino actuates the driving motor so the next container comes into the filling position. The driving motor has an external DC power source of 12Vso it is connected to Arduino using a relay switch.

4. LIST AND DESCRIPTION OF COMPONENTS REQUIRED

The list of components required are :-

1. Arduino Nano
2. Conveyer Belt
3. Pulleys (x2)
4. DC Pump
5. Relay Module
6. Battery
7. Ultrasonic Sensor
8. DC Motor (100 rpm)
9. Bearings (x4)
10. Male, Female Wires
11. Gears

Arduino nano

IMAGE 1

- Arduino is an open-source hardware and software company, project and user community that designs and manufactures single board microcontroller kits for building digital devices. Its products are licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public (GPL), permitting the manufacture of Arduino boards and software distribution by anyone. Arduino boards are available commercially in preassembled form or as do-it-yourself (DIY) kits.
- Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards ('shields') or breadboards (For prototyping) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers can be programmed using C and C++ programming languages. In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment (IDE) based on the Processing language project.

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Technical Specification of Arduino Nano (Table 1)

Microcontroller	ATmega328P – 8 bit AVR family microcontroller
Operating Voltage	5V
Input Voltage for Vin Pin	7-12V
Analog Input Pins	6 (A0 – A5)
Digital I/O Pins	14 (Out of which 6 provide PWM output)
DC Current on I/O Pins	40 Ma
DC Current on 3.3V Pin	50 mA
Flash Memory	32 KB (2 KB is used for Bootloader)
SRAM	2 KB
EEPROM	1 KB
Frequency (Clock Speed)	16 MHz

Conveyer belt

IMAGE 2

- A conveyor belt is the carrying medium of a belt conveyor system (often shortened to belt conveyor). A belt conveyor system is one of many types of conveyor systems. A belt conveyor system consists of two or more pulleys (sometimes referred to as drums), with an endless loop of carrying medium—the conveyor belt—that rotates about them. One or both of the pulleys are powered, moving the belt and the material on
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the belt forward. The powered pulley is called the drive pulley while the unpowered pulley is called the idler pulley.

- There are two main industrial classes of belt conveyors; Those in general material handling such as those moving boxes along inside a factory and bulk material handling such as those used to transport large volumes of resources and agricultural materials, such as grain, salt, coal, ore, sand, overburden and more.

Pulley (X2)

- A pulley is a wheel on an axle or shaft that is designed to support movement and change of direction of a taut cable or belt, or transfer of power between the shaft and cable or belt. In the case of a pulley supported by a frame or shell that does not transfer power to a shaft, but is used to guide the cable or exert a force, the supporting shell is called a block, and the pulley may be called a sheave.
- A pulley may have a groove or grooves between flanges around its circumference to locate the cable or belt. The drive element of a pulley system can be a rope, cable, belt, or chain.

DC pump

IMAGE 3

- A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action, typically converted from electrical energy into Hydraulic energy. Pumps can be classified into three major groups according to the method they use to move the fluid: direct lift, displacement, and gravity pumps.
- Mechanical pumps serve in a wide range of applications such as pumping water from wells, aquarium filtering, pond filtering and aeration, in the car industry for water-cooling and fuel injection, in the energy industry for pumping oil and natural gas or for operating cooling towers and other components of heating, ventilation and air conditioning systems.
- And we are using a DC Motor Pump in our project for pumping water or any liquid from a tank to the bottle which is to be filled. This DC Pump basically works on a principle of a centrifugal pump and due to centrifugal action water or any liquid is pumped to the bottle.

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Relay module

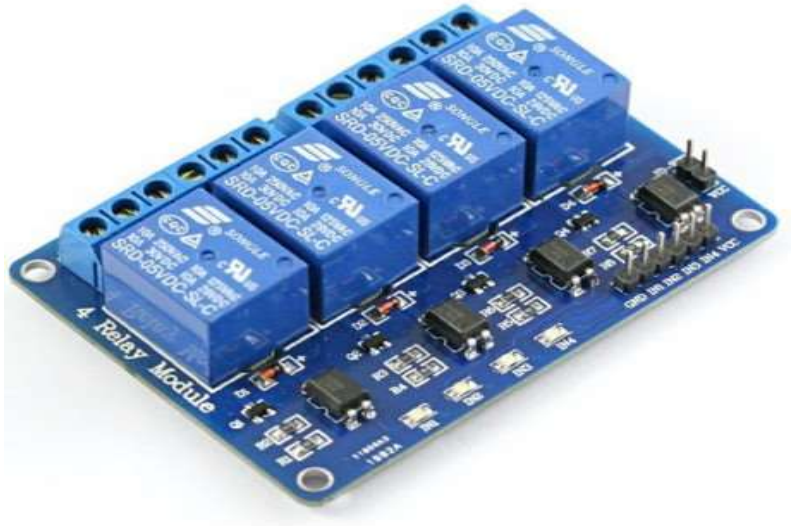

IMAGE 4

- A 5V 4-channel relay interface board, and each channel needs a 15-20mA driver current. It can be used to control various appliances and equipment with large current. It is equiped with high-current relays that work under AC250V 10A or DC30V 10A. It has a standard interface that can be controlled directly by microcontroller.
- When the signal port is at low level, the signal light will light up and the optocoupler 817c (it transforms electrical signals by light and can isolate input and output electrical signals) will conduct, and then the transistor will conduct, the relay coil will be electrified, and the normally open contact of the relay will be closed. When the signal port is at high level, the normally closed contact of the relay will be closed. So you can connect and disconnect the load by controlling the level of the control signal port.

Battery

IMAGE 5

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- The nine-volt battery, or 9-volt battery, is a common size of battery that was introduced for the early transistor radios. It has a rectangular prism shape with rounded edges and a polarized snap connector at the top. This type is commonly used in walkie-talkies, clocks and smoke detectors.
- The nine-volt battery format is commonly available in primary carbon-zinc and alkaline chemistry, in primary lithium iron disulfide, and in rechargeable form in nickel-cadmium, nickel-metal hydride and lithium-ion.

Ultrasonic sensor

IMAGE 6

- Ultrasonic transducers and ultrasonic sensors are devices that generate or sense ultrasound energy. They can be divided into three broad categories: transmitters, receivers and transceivers. Transmitters convert electric signals into ultrasound, receivers convert ultrasound into electrical signals, and transceivers can both transmit and receive ultrasound.
- Ultrasound can be used for measuring wind speed and direction (anemometer), tank or channel fluid level, and speed through air or water. For measuring speed or direction, a device uses multiple detectors and calculates the speed from the relative distances to particulates in the air or water. To measure tank or channel liquid level, and also sea level (tide gauge), the sensor measures the distance (ranging) to the surface of the fluid. Further applications include: humidifiers, sonar, medical ultrasonography, burglar alarms, non-destructive testing and wireless charging.

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DC motor (100RPM)

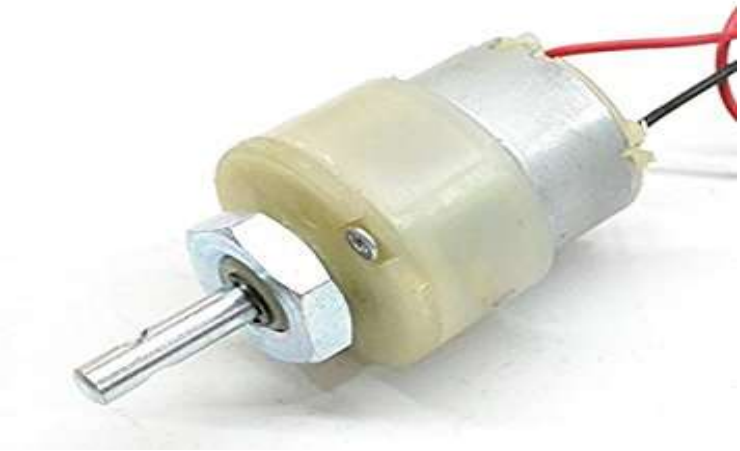

IMAGE 7

- A DC motor is any of a class of rotary electrical motors that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current in part of the motor.
- In this project we are using a high torque DC Motor of 100rpm which is going to be used to drive the conveyer belt's pulley. A slow and steady movement of conveyer is required for preventing the bottle to fall, for this reason a low speed motor is used in our project.

Bearing (x4)

IMAGE 8

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- A bearing is a machine element that constrains relative motion to only the desired motion, and reduces friction between
  moving parts. The design of the bearing may, for example, provide for free linear movement of the moving part or for free rotation around a fixed axis; or, it may prevent a motion by controlling the vectors of normal forces that bear on the moving parts. Most bearings facilitate the desired motion by minimizing friction. Bearings are classified broadly according to the type of operation, the motions allowed, or to the directions of the loads (forces) applied to the parts.
- A ball bearing is a type of rolling-element bearing that uses balls to maintain the separation between the bearing races. The purpose of a ball bearing is to reduce rotational friction and support radial and axial loads. It achieves this by using at least two races to contain the balls and transmit the loads through the balls. In most applications, one race is stationary and the other is attached to the rotating assembly (e.g., a hub or shaft). As one of the bearing races rotates it causes the balls to rotate as well. Because the balls are rolling they have a much lower coefficient of friction than if two flat surfaces were sliding against each other.
- Ball bearings tend to have lower load capacity for their size than other kinds of rolling-element bearings due to the smaller contact area between the balls and races. However, they can tolerate some misalignment of the inner and outer races.

Male, female wires

- These wires are basically used in our project to connect different components like Arduino Nano ,Relay Module and Motor or DC Pump.

Gears

- The gears are used to transmit torque from a driver to any shaft. And in our project for transmitting torque from DC Motor (100rpm) to pulley of conveyer belt.

5. TECHNICAL SPECIFICATION FOR THIS PROJECT

a) Controller or main processing circuit- In this project Arduino nano is the main controlling unit.
b) Frame – it is made out of wood consisting of a base with four supporting stands mounted on it. The four stands have a hole inside which bearings are fitted. The bearings support two pulleys on which a conveyer belt is wrapped. The frame also has arrangements for placing motor, reservoir, ultrasonic sensor and Arduino circuit on it.
c) Input device- ultrasonic sensor is the device which gives input signal to Arduino.
d) Output device- DC motor and submersible pump are the two devices which receives the output signal from Arduino.
e) Relay – a relay switch is used to provide external 12V power source to driving motor.

Torque and power calculation

- Suppose the liquid to be filled is water.
- Volume of a container =100ml= 0.0001 m^3
- Weight of a container = density of water * volume of container* g
  1000 kg/m^3 * 0.0001 *9.81=~1 N
- The prototype is made to carry 3 such containers at a time.
  Weight of 3 containers=Product weight(G)=3N
- Diameters of both the pulleys ,D=0.12m
- Contact angle, ø=180^0
- Centre distance , a= 0.75m
- Total length of conveyer belt=2a+πD=1.876m
- Speed of motor =100RPM
- Coefficient of friction between belt and pulley, μ=0.25
- Weight of belt,M=3.5kg/m * 1.876m* 9.81=64.41N
- Drive factor , K=1 (for wrap 180^0 screw take-up lagged)

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So, Effective tension on belt, P=μ(G+M)=16.85 N
Slack side tension, P_2=P*K=16.85 N
Tight side tension, P_1=P + P_2= 33.7N

Torque, T= P*D/2= 1.011 Nm

Power= 2πNT/60 =10.58 W

6. PROGRAM CODE

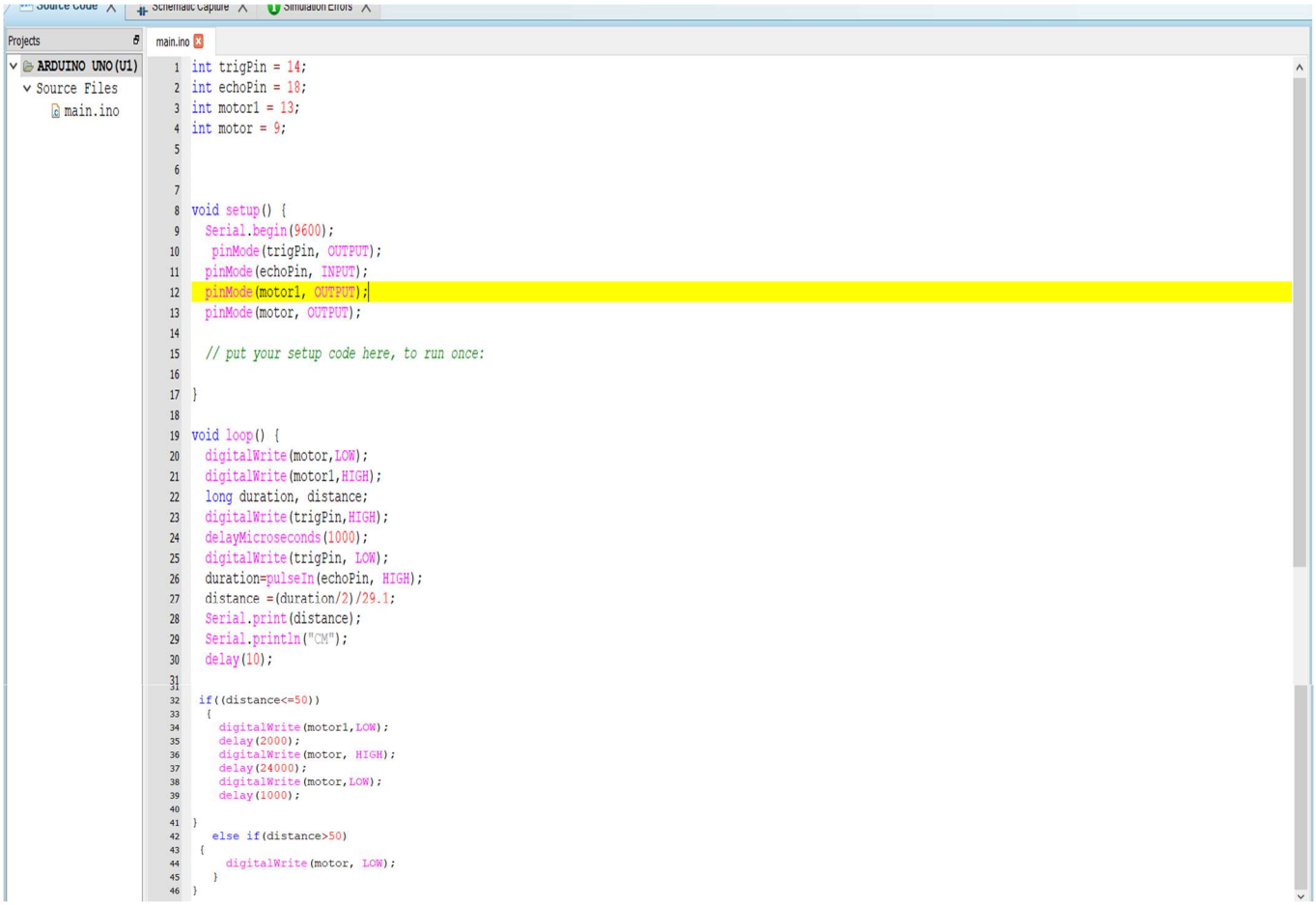

IMAGE 9

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7. CIRCUIT DIAGRAM

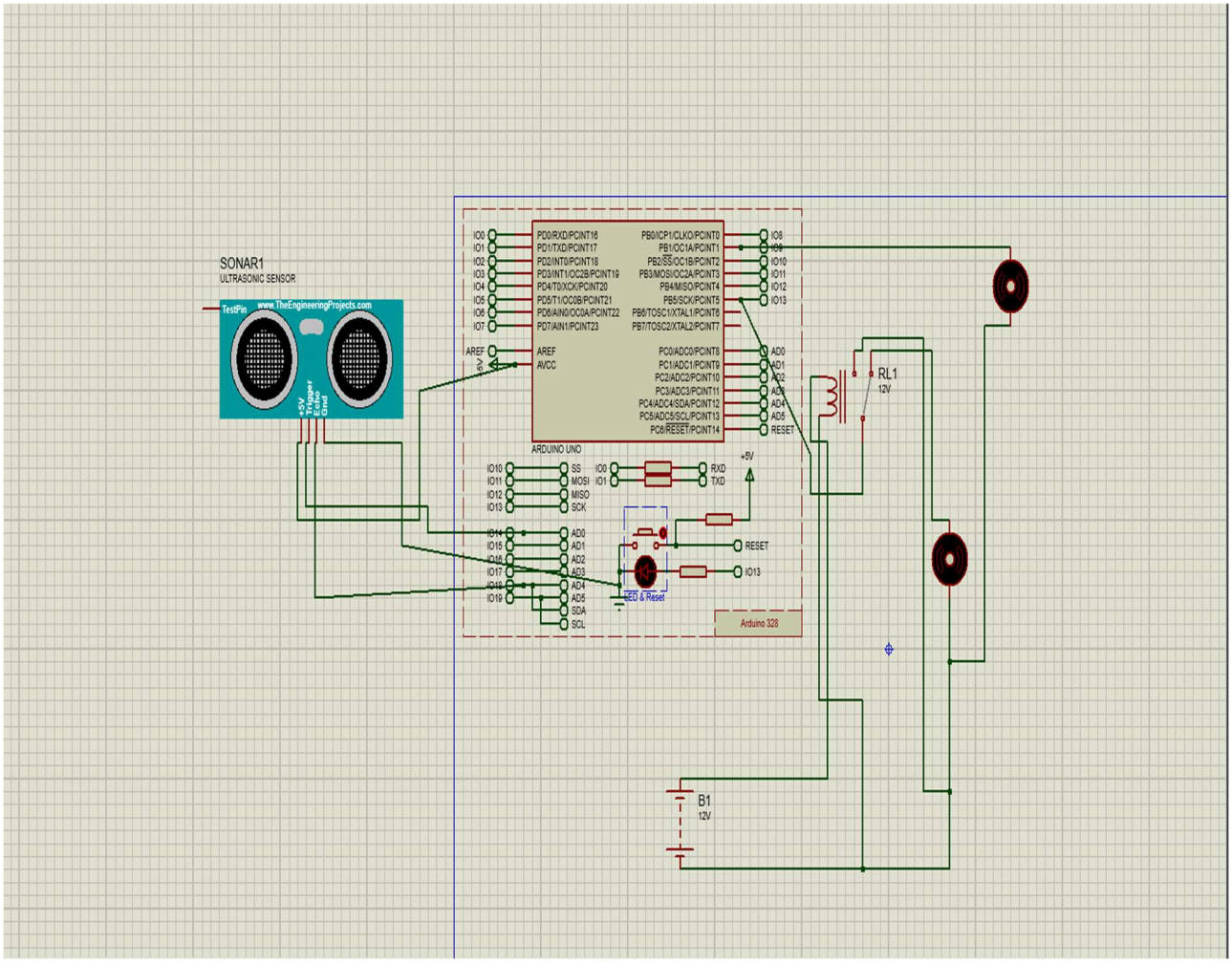

IMAGE 10

8. PROS OF AUTOMATIC LIQUID FILLING MACHINE

A. Easy and convenient operation

- Just put an empty bottle on the conveyer belt and on the other end the bottle is filled as per the quantity assigned to the machine.

B. Automated machine

- There is no need to stop the conveyer belt at the moment when the bottle comes under the valve ,instead a sensor senses the bottle and fills it up.
- Also the time needed to fill the bottle is predefined in the microcontroller.

C. Cost efficient

1. There is not much cost of the Automatic Liquid Filling Machine as compared to Manually operated liquid filling Machine.

D. Modular

2. Extra heads can also be fitted if required without any difficulty and hence suitable for mass production.

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9. CONS OF AUTOMATIC LIQUID FILLING MACHINE

A. Versatility
For different shape and size of bottles time needs to be varied in microcontroller programming which is a little time consuming.

B. Require#es an operator
An operator is always required to put the bottle onto the conveyer belt which might not be affordable.

10. ΑΠΠΛΙΧΑΤΙΟΝ ΑΡΕΑ

- *For Pharmaceutical products like Syrups, Multi-Vitamins tonic, cough syrup, and for Injections*
- *This machine can used in Bottled Mineral water, Glucose bottles and many more bottles.*
- *For many kind of Food products and various vegetables sauces, Chinese sauces this machines is used.*
- *Other Than Pharmaceutical uses Automatic Liquid Filling Machines can be used in paints, stains, sealants, various agricultural products, Flammables like solvents/diesel/petrol, petroleum and other automotive products.*

11. ΛΙΘΥΙΔ ΦΙΛΛΙΝΓ ΜΑΧΗΙΝΕ ΟΦΦΕΡΣ ΜΟΡΕ ςΕΡΣΑΤΙΛΙΤΨ

It is common to get companies using multiple bottles for a single product.

Other companies, on the other hand, have multiple products.

Liquid fillers can be used by a manufacturer to handle all the bottles and products.

There are liquid filling machines with adjustments for shifting from one bottle type to another.

Those that go a long way to address the differences in product viscosity.

12. ΦΥΤΥΡΕ ΣΧΟΠΕ

Using appropriate pump, jet nozzle & solenoid valve in which case precise timing is would increase productivity.

Anon-intrusive water level sensor could be used instead of timing valve.An extended capping section could be introduced.

Another sensor could be used in the beginning which can sense the bottle and start conveyor belt automatically.

More flexibility can be introduced in nozzle positioning. The system can be redesigned to increase bottle size and productivity.

13. CONCLUSION

The system can perform the task of autonomous quality control system used in industrial production & it is most suitable for scale industry as definite process is set by programming. It also helps to understand the necessity of ARDUINO in industrial automation and also to realize the necessity of studying.

14. ACKNOWLEDGEMENT

First and foremost, I would like to take this opportunity to thank our lecturer Prof. Mahavirsinh M. Chavda for his guidance and advice on this project.

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Last but not least, I am very grateful to our university to give us a chance for using our skills and abilities to develop this kind of project

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