Embedded Based Automated Conveyor System for Food Processing Using Arduino

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Abstract. In Recent days manufacturing-based industries playing a crucial role in this fast-developing world. Conveyor system is a machinery that serves an important role in processing and transportation of products in manufacturing units. Hence, these are widely used all around the world extensively. Using conveyor system has many advantages both productivity wise and labour cost wise, this approach is best suited for large scale rather than small and medium scales. Due to its maintenance, operational cost it is restricted to large scale only. The conveyor model that we are proposing is designed specifically for small scale units. Having this Arduino based the working of this model is simple and easy to implement. We use this model to fill empty bottles that are placed on conveyor belt. The bottles that are to be transported goes through three stages (1) detection stage, (2) filling stage and (3) dispatch stage. To drive the conveyor a DC gear motor is installed to the axel of the conveyor. The speed can be regulated by microcontroller (Arduino mega 2560). This motor speed is regulated by L298N voltage driver module. Motor speed is depended on the position of the bottle on the conveyor belt. if it is not in ultrasonic sensor range the speed would be maximum or else the motor stops rotating until the bottle is filled. The best part of this system is the load cell that is used to measure the volume of liquid poured into the bottle so that the bottle is filled accurately.

Keywords: Arduino IDE · Serial monitor · Load cell · L298N driver module

1 Introduction

Our aim is to design a system which is affordable to small scale manufacturers and even to reduce the manpower with Arduino based conveyor system [1]. It is the technology of today which is developing and transforming in every aspect of our daily life. As most conveyor systems are automated it can increase the manufacturing efficiency by 15% with reduce in power consumption and fuel and it also minimizes the manpower and increases the productivity rate by more than 10%. It won't require much labour and saves money for the owners. This system can produce accurate results. The realization

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is done without much complexity at circuitry level and body structure as well. The /hardware components required are ultrasonic sensors for detection of object, DC motor (main motor) mounted directly to the axle for driving the conveyor belt, the LCD for displaying results and a load cell to measure the weight of the filled bottle. L298N, HX711 are Motor driver module and Load cell amplifier respectively. Arduino IDE is a software environment where all these hardware components are programmed and even it monitors the functioning of the system. The operation of the system starts with rotation of conveyor belt where the bottles are placed upon it at START end, Ultrasonic sensor placed at filling section detects the bottle presence and turns off main dc motor, to fill the bottle/container the pumping motor turns ON and pours the liquid into the bottle from above using a pipe until the desired volume is poured in the bottle. The verification of desired volume filled in a bottle is measured using a load cell placed under the wooden platform just below the bottle stops for filling. After filling is done, the bottle/container slides down to the destination end. Number of bottles/containers filled can be seen on LCD display.

2 Existing Model

The existing conveyor model is based on PLC (Programmable logic controller) is an industrial system that could do more work and can transport heavy loads. It can control the manufacturing processes, such as machines and robotic devices. These systems range from medium to larger with lots of input and output. These systems can also be connected to other PLC and SCADA systems. The major problem with this existing system is high maintenance and occupies more space which is not suitable for a small scale. Debugging and modifying the program requires a technician to do the job and takes considerable time to resolve issues [2]. The embedded system that is used in the existing model requires powerful coding and instruction sets, which makes it tough to get it repaired if any technical problems arise while operating. As small scale and mini factories look for simplicity to run their business this existing PLC may not satisfy them. The PLC hardware has digital electronics with memory that can be programmable to store commands and Information to implementation of various operations such as logical operations, arithmetic, and Iterative. The existing model has its advantages on a commercial scale but for small scale it is not feasible.

3 Proposed Model

The proposed system is an embedded system which satisfies the needs that are drawbacks of previous systems. The proposed model uses conveyor turn. The ultrasonic sensor placed at filling section detects the presence of bottle near it and Arduino IDE helps in monitor and operate the hardware components present in the system. We prefer Arduino over PLC because it has flexible enclosure design for IC's present in the microcontroller of Arduino [3]. The cost of Arduino is much affordable compared to PLC and comparing them in area wise Arduino is smaller and hence it is extremely mobile and portable. The motor we use for rotation of axle is a 12 V,120 rpm gear motor which serves best for ease transportation of bottles and also it can be interfaced with Arduino without much effort. The three stages in the process are

I) Detection Stage:

The main motor turns on and makes the belt rotate. We use L289N driver module to amplify/elevate the voltage that is the input for main motor which makes rotation easier. If we don't use driver module its harder to make the of it and turns off main dc motor so that the bottle stops.

II) Filling Stage:

To fill the bottle/container the pumping motor turns on which flushes the liquid into it from top using a pipe until the desired volume is fallen into it. If the desired volume is filled or not is measured using a load cell which is fixed inside the wooden platform just below the filling area.

If the measured volume is less than desired volume the filling process continues until measuring volume by load cell reaches the desired volume.

III) Dispatch Stage:

And this is the last stage of the process, after filling is done the bottle/container the main motor turns on so that they move to the destination end. Total number of bottles/containers filled till that moment can be seen on led display.

All these stages are controlled by Arduino 2560 board, which will give instructions to the hardware according to the situation. To fill a bottle, it must undergo all these stages. Above all stages the filling stage is complicated as there involves many sensors co-ordination to make sure absolute volume is poured into the bottle. The load cell plays a major role in filling the bottle perfectly, care must be taken while calibrating the load cell as a small error in it would cause volume mismatch and system might become faulty. To make it flawless, calibration must be made with standard Arduino code before we set the calibration value. The speed of the conveyor belt varies with the weight present on the conveyor belt. Depending on the number of bottles on the belt the speed of the main motor is increased. If the weight is less the speed is reduced than the normal speed, if the weight is heavier the speed is increased to meet the optimal speed or constant belt speed.

4 Implementation

4.1 Block Diagram:

The above Fig. 1 represents a block diagram in which [4], When the conveyor starts the belt moves until the bottle reaches the premises of ultrasonic sensor. If ultrasonic sensor detects the bottle, it turns off the main motor and this will begin the filling process by turning on pumping motor. If the measured volume equals to the desired volume filling process stops and conveyor starts moving to send bottle to the destination end. This process continues if bottles are placed on conveyor belt.

4.2 Flow Chart:

The above Fig. 2 represents the process flowchart which depicts the whole process of the system in which each of the decisions are made by the controller depending on the parameters like motor and volume. This process of filling is a loop process in which the

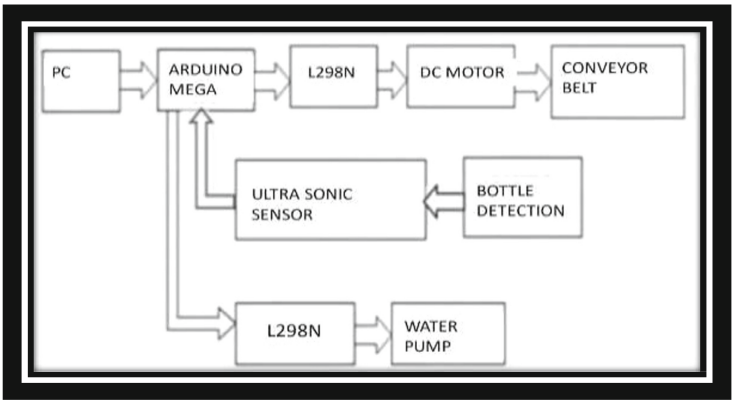

Fig. 1. Block Diagram

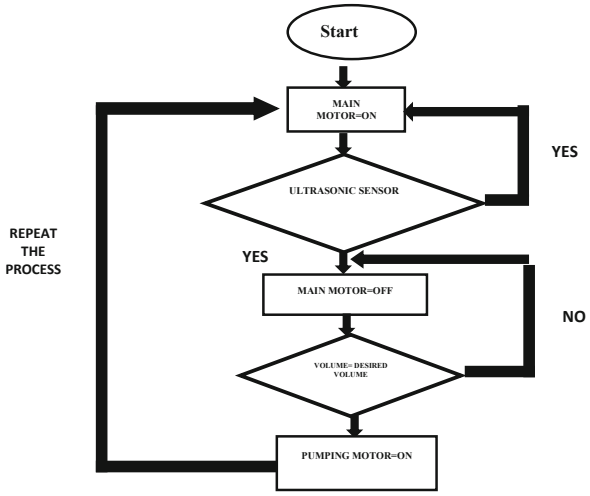

Fig. 2. Flow chart

steps will repeat for every single bottle placed on the conveyor. Having a loop ensures errorless conduction of filling the bottles. The main motor turns on and makes the belt rotate. We use L289N driver module to amplify/elevate the voltage that is the input for main motor which makes rotation easier. If we don't use driver module its harder to make the of it and turn off main dc motor so that the bottle stops [5]. To fill the bottle/container the pumping motor turns on which flushes the liquid into it from top using a pipe until the desired volume is fallen into it. If the desired volume is filled or not is measured using a load cell which is fixed inside the wooden platform just below the filling area. If the measured volume is less than desired volume the filling process continues until measuring volume by load cell reaches the desired volume. And this is the last stage of the process, after filling is done the bottle/container the main motor turns on so that they move to the destination end. Total number of bottles/containers filled till that moment

can be seen on led display. When the conveyor starts the belt moves until the bottle reaches the premises of ultrasonic sensor. If ultrasonic sensor detects the bottle, it turns off the main motor and this will begin the filling process by turning on pumping motor. If the measured volume equals to the desired volume filling process stops and conveyor starts moving to send bottle to the destination end. This process continues if bottles are placed on conveyor belt.

5 Results

5.1 Working Kit

The Below pictures shows the project kit when the system is ON.

Figure 3 shows the working kit which contains Arduino microcontroller, LCD display, ultrasonic sensors and a load cell. These hardware components are interfaced according to the pins selected by the user.

Figure 4 shows the connections made to the microcontroller with L298N Motor driver and the hardware components required for its operation. Since peripherals are

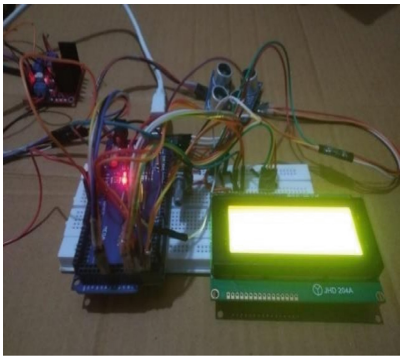

Fig. 3. Working kit

Fig. 4. Arduino connections

Fig. 5. Load Cell

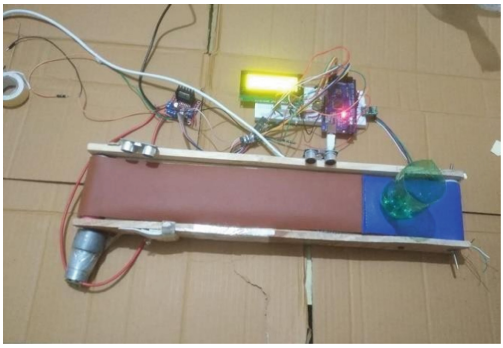

Fig. 6. Top view of prototype

many it is difficult to interface with limited pins care must be taken while connecting them.

Figure 5 represents the Load cell that is placed under the platform where it stops for filling and measuring the liquid volume. Load cell is driven y HX711 driver module to amplify I/O signals.

Figure 6 shows the top view of the system where we can see the conveyor belt connected to the motor and also the bottle is placed at the beginning of the belt. The LCD displays the progress of filling. Ultrasonic sensors controls the process flow coordinating with Load cell.

The working kit contains L298N motor driver, DC motor, Ultrasonic sensors, LCD display, Arduino Atmega2560, HX711 load cell module and load cell. The Arduino is the controller, so all the modules, display and motors are connected to the I/O pins.

5.2 Bottle Filling

Filling the bottle automatically involves steps to be followed so that there will be no errors and ensures us the desired operation.

Here we can see the bottle at three different positions in this model, when

(a) Bottle moving to the filling section
(b) Pumping motor filling the bottle
(c) Bottle moving towards the destination end

A prototype is an early version of a product that has been produced to test a theory or procedure. The prototype shown in the above image has all necessary parts and is interfaced to the ESP8266 microcontroller.

Figure 7 shows the bottle placed in the start end. The ultrasonic sensor present nearby will detect the moving bottle upon reaching its surroundings. The ultrasonic sensor controls the main motor ON/OFF based on the bottle's position.

Figure 8 shows the bottle getting filled. The pumping motor sends the water into the bottle until it reaches the desired amount of volume. A load cell is placed underneath the bottle to help us to calculate volume. The volume of the bottle is fixed and can be changed with the application of the system.

Figure 9 shows the filled bottle moving towards the destination end [6]. The ultrasonic sensor placed at the end will help us in alerting if the bottle reaches the end of the platform. In this model we connected the ultrasonic sensor pins to the 8 digital pins of controller. For the load cell 4 pins are connected in which2 were connected to the digital and 2 to the

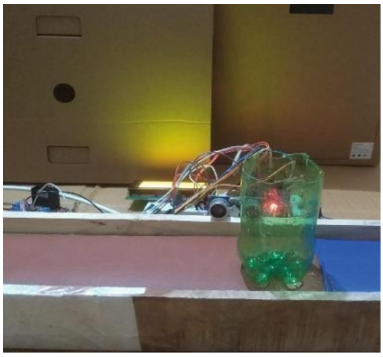

Fig. 7. Bottle Detection

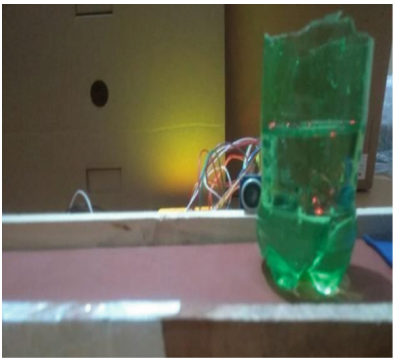

Fig. 8. Bottle Filling

Fig. 9. Bottle Dispatching

PWM/Analog pins. For LCD display we used bread board to make the connections and used potentiometer to control the brightness of LCD screen. Those 8 output pins of LCD display are connected to the digital slots available in the controller. In the above images we can see the results of filling the bottle where the bottle undergoes all three stages. Pumping motor will pump the liquid into bottle. Considering both load cell instructions and ultrasonic sensor instructions the controller makes decisions and controls the main motor speed and pumping motor.

5.3 LCD Display

LCD shows the status of process and gives instructions to the user to start the process of filling (Fig. 10).

The LCD display shows the process flow it displays a 'WELCOME' message at the beginning of the process. It reminds the user that the it is full or not by a message 'TANK IS FULL'. After that it displays 'PLACE THE BOTTLES' to ensure the user places the bottles on conveyor. When the bottle reaches the ultrasonic sensor, it displays the message 'FILLING' to let know the user that the bottle is being filled [7]. The LCD

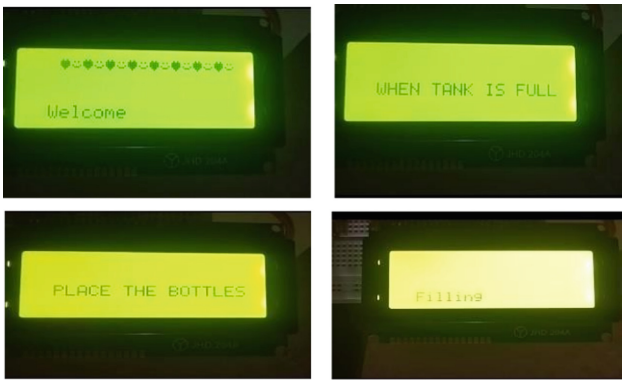

Fig. 10. LCD Display

displays the filling status of the bottle and details about the number of bottles filled and total amount of volume left in the tank.

6 Conclusion

In this fast-growing world, small-scale business plays a major role in contributing in one's nation development. Using a conveyor system improves 15% of productivity in a workplace. But most small-scale manufacturing units rely on labour as they are unable to afford a conveyor or bear high maintenance to keep them working for longer years. This ARDUINO based energy efficient conveyor system helps us to save a large amount of energy which is wasted in the PLC conveyor systems or other controller-based belt conveyor systems. Using ARDUINO IDE, we observed that the automatic filling operation is efficient and has low maintenance cost. The power consumption of Arduino is comparably lower than it uses up in PLC as it uses 12V dc source for its operation whereas PLC requires wide range of voltage levels for operation. The estimated cost for Arduino is affordable and much lower than a PLC and also the maintenance of PLC is needed quite frequently.

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