Automated Bottle-Drink Packaging Mechanism (ABd-PM): Using the Bidirectional Shift Register Mechanism was Envisaged

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Abstract - The control bidirectional shift register bottle packaging mechanism system at the initial process is static, such that the operational signals remain ignited. In this way, the system fails to respond to the mechanism and the bottles to be filled-in with drink remain static. It is in view of this that the automated bottle and drink packaging mechanism, in this study abbreviated as Abd-PM was envisaged. The Abd-PM operational mechanism is composed of the four-tier combinational logic gates. The first layer of this mechanism has the four(4) set of D-Flip-Flops, second is a four(4) set of multiplexer (MUX), third a two(2) set of demultiplexer (DMX); and fourth is a partial register Decoders-basic binary function, which utilizes the two (2) AND gates and one (1) OR gate. The ABd-PM architecture has the following major components: conveyor part; swinging bottle lifter; try rotator; electrical motors and various specialized sensors. In addition, the ABd-PM has an automated mechanism which indicates the accomplishment of a task at particular stages such as: liquid filling-in; label fixing; lead-fixing and to further packaging processes.

Keywords – ABd-PM, automated, bidirectional shift register mechanism, bottle-drink packaging mechanism, combinational logic gates, electrical motor, electrical sensors, drink filling-in, movable arm, static, try rotator

I. INTRODUCTION

Artificial A bidirectional shift register mechanism plays a vital role in the processing industry, particularly bottle and drink manufacturing factory. It's technical capacity to store and shift the data either from left to right has necessitated the filling-in of drinks into bottle at a large scale. In [1] he discussed the bidirectional shift register to have a mechanism which utelises the flip-flops in storing the data. The author further explained that its operational mechanism shift the data from one flip-flop to another. Whereas, the Fairchild Semiconductor TM Report (2000) discussed the bidirectional shift register by highlighting its mechanism of dealing with right-shift and left-shift serial inputs; parallel inputs and outputs; operating-mode-control inputs, and a direct overriding clear line.

In [2] they have illustrated the mechanism of the bidirectional shift register illustrating particularly the implementation of a 4 x 1 multiplexer connected to a set of four (4) flip-flops, similarly fitted in a cascading manner. Furthermore, in [3] he pointed out that, the design of bidirectional shift register can also be modified to be built one shift direction either right or left depending on the user's desirous application.

A. Problem Statement

The bidirectional shift register mechanism used in the bottling companies in the filling in of drinks in bottles had one major challenge which is being in static mode. This is where, when the bottle is fitted on the tray the signal for fitting in the bottle remains on and the signal for filling the drink remains on similarly signal for pasting remains on and signal for fixing a cover or top remains on as well. The failure of these signal of consequently not going off makes the system static as there are no indication to show the accomplishment of respective tasks. The static-ness makes the system fail to operate as it was intended to push the bottle at every task being placing the bottles, filling in the drink, pasting the label and many more operations as already alluded. A complete automated proto type mechanism is demonstrated in figure 1 where it demonstrates from the setting of the empty bottle, filling in a drink, pasting the label, fixing the cover and pushed for further processing as demonstrated in Figure 1.

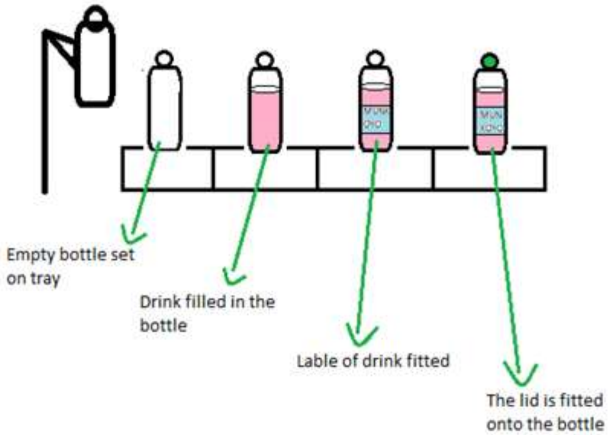

Figure 1. Prototype of the ADPM

II. LITERATURE REVIEW

In the field of automated packaging, various technologies have been employed to enhance the efficiency of filling, labelling, and packaging processes. One of the key technologies is the shift register mechanism, which is widely used in digital circuits and automation systems. He [1] explained the operation of bidirectional shift registers, which allow data to shift in both left and right directions using flip-flops. This mechanism is particularly useful in industries such as beverage manufacturing, where sequential operations are required in automated systems for filling bottles with drinks.

The bidirectional shift register mechanism is known for its reliability and flexibility in automation processes. In [4] he discussed its application in data management, highlighting its ability to handle both serial and parallel inputs/outputs, which are crucial for manufacturing systems that need to manage multiple tasks in parallel. Additionally, they [(2] introduced a new low-power and high-speed bidirectional shift register architecture, which can be advantageous in manufacturing settings where energy efficiency and speed are critical. They illustrated how multiplexers (MUX) and flip-flops can be integrated to improve system performance, providing a foundation for its integration into bottle packaging systems.

He [3] provided a deep dive into the shift register synthesis, including how the design could be modified to accommodate specific user requirements, such as the direction of shift operations. This aspect is essential for packaging systems, where tasks like drink filling, labelling, and capping are sequential and need to be managed efficiently.

III.METHODOLOGY

The methodology for the Automated Bottle-Drink Packaging Mechanism (ABd-PM) involves several key stages. The approach begins with understanding the bottling process and how to automate it using digital logic components. The ABd-PM system architecture is demonstrated in Figure 2.

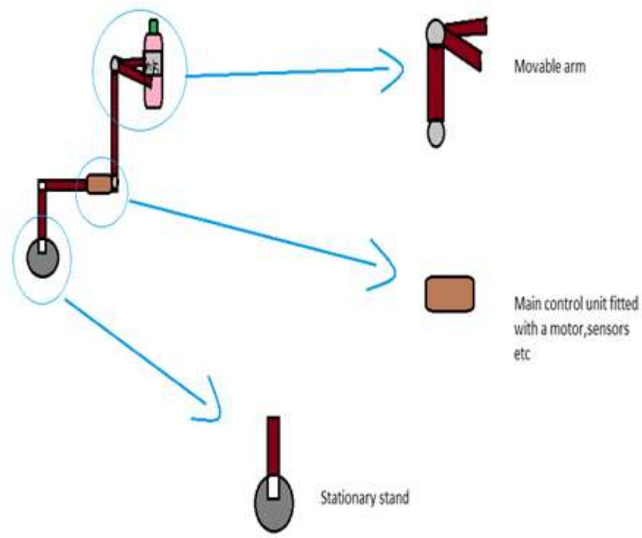

Figure 2. Abd-PM System Architecture

The ABd-PM Architecture demonstrated in Figure 2 houses the functional components such as the movable arm which picks the empty bottle and places it on a convey tray where the process of filling-in the drink takes place. The architecture has an electrical motor which powers the entire conveyor system tray rotator, a bottle lifter and other functional components. This electrical motor provides all key mechanical motion and control of the whole system. The whole of this control system has a programmable logic controller which is used to manage the machines operations. It coordinates the movements of different components, monitors sensors, and controls timing and sequencing of operations. Some of the key functions of the PLC is to drive the movable arm as discussed earlier it picks the empty bottles place them on the rotating tray. As already mentioned, the ABd-PM has a series of electrical sensors such as the photoelectric which uses light beams to detect the presence, absence or position of the bottle in this system. Furthermore, they can detect bottles on the conveyor, verify bottle placement on the tray, or monitor the rotation of the tray. Others are the proximity center which can be used to sense the presence of bottles as they pass through specific points in the machines process. Others are ultrasonic sensors that are used to measure the height of bottles to ensure proper spacing around the bottles on the tray. Whereas the encoder sensors provide precise feedback to control the rotational movements

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of the tray accurately. The pressure sensor is used to monitor pneumatic or hydraulic systems in the machine. They can measure air pressure levels, ensuring the proper operation of grippers or actuators. The discussed sensors control the D-Flip-Flop to respond either active low at an accomplishment stage or actively low to give a signal for another action, whereas the actively high shows that the bottles action is still pending. At a pending level the feeding of the bottle into the tray or movement is stored or stopped until the D-Flip-Flop(s) is/are active low as at this stage the movement of these bottles continue as discussed earlier on.

A. ABd-PM Mechanism

The ABd-PM mechanism shown in Figure 3 was designed and implemented using a combination of D-Flip-Flops, multiplexers (MUX), demultiplexers (DMX), and decoders. The D-Flip-Flops store data and signal the completion of each task in the packaging process. The system utilizes a bidirectional shift register mechanism, which ensures that each operation, such as filling, labelling, and capping occurs in a precise and sequential manner. This mechanism coordinates the flow of tasks, ensuring smooth transitions and preventing overlap between operations. The implementation of Figure 3 indicates that when the D-Flip-Flop labelled zero(0) has its execution completed, then it goes off or active low to signify that the action is accomplished and in this way the process goes to the next D-Flip-Flop labelled 1. At this stage, the D-Flip-Flop labelled one(1) is active high symbolizing the process of filling-in the drink into the bottle. Once the filling-in is completed, then the D-Flip-Flop one (1) goes off, to let the system push the bottle to the next D-Flip-Flop labelled two (2) which made active high and the label is pasted. Having finished pasting the label, the D-Flip-Flop labelled two (2) goes off to let the system take the process to the next D-Flip-Flop labelled three (3) for fixing of the top-cover. Once the top-cover is fixed, the D-Flip-Flop labelled three (3) goes off and the bottle is shifted for further packaging. Therefore, at this juncture the automation of the ABd-PM system accomplishes the filling in of drinks of many bottles in a factory. The architecture given in Figure 3 gives a complete mechanical implementation industry for instance where drinks are filled in the bottles.

Overall, each operational step is controlled by the state of the flip-flops. Once a flip-flop's task is completed (e.g., filling the bottle with liquid), the system moves the bottle to the next flip-flop, which triggers the next task (e.g., labelling). The flip-flops signal when a task is finished by switching from active high to active low, ensuring that each stage of the process occurs in a timely and controlled manner.

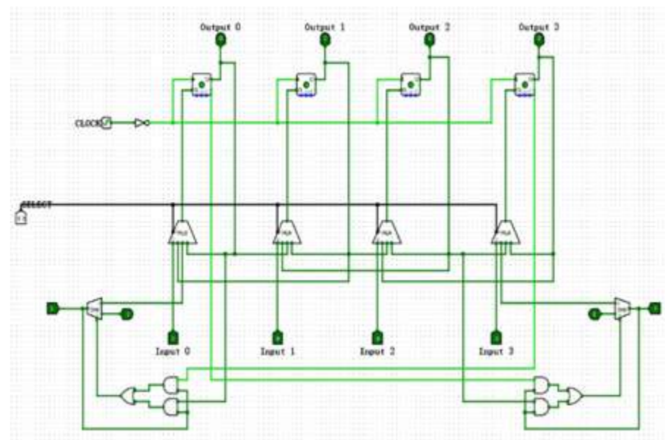

Figure 3. Automated Bidirectional Shift Register Mechanism

IV. RESULTS

The implementation of the Automated Bottle-Drink Packaging Mechanism (ABd-PM) has shown promising results in automating the tasks of filling, labelling, and capping bottles. The system was able to achieve a number of key outcomes. Some of these achievements includes the ABd-PM increased efficiency which significantly reduced the time required for each task in the bottling process. Bottles were automatically moved from one station to the next, completing each stage without delays caused by human intervention. In addition, system attained accuracy and reliability such that the sensors used in the system were highly accurate in detecting bottle positions, ensuring that each task was performed with precision. The PLC successfully coordinated the timing and sequencing of operations based on real-time sensor feedback. Furthermore, the system achieved scalability where it was able to handle varying production volumes. By adjusting the speed of the conveyor system and fine-tuning the timing of sensor feedback, the ABd-PM was able to maintain consistent performance even during peak production periods. Lastly but not the least, the system adopted energy efficiency, where the use of a low-power bidirectional shift register architecture, as described in [2] they contributed to the overall energy efficiency of the system. The electrical motors and sensors consumed minimal power while delivering high performance.

V. DISCUSSION

The ABd-PM represents a significant advancement in the automation of bottle-drink packaging systems. By utilizing a bidirectional shift register mechanism, the system automates the sequential processes of bottle filling, labelling, and capping. This method overcomes the problem of static systems, where tasks are not correctly signalled or completed due to continuous operation without feedback. With the use of

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flip-flops and the ability to shift between active high and active low states, the system ensures that each operation is only triggered once the previous task is completed.

One key advantage of this system is the integration of multiple sensors, which help maintain precise control over the process. Though not highlighted on the architecture, the system as the programmable Logic Control (PLC), which acts as the brain of the entire unit. Furthermore, it can monitor sensor feedback to determine the position and status of the bottles, ensuring smooth transitions between tasks. The use of a conveyor system coupled with the mechanical arm and tray rotator enhances the overall speed and efficiency of the packaging process.

Furthermore, the proposed system can be scaled up to accommodate high throughput in manufacturing settings, making it suitable for large-scale drink bottling plants. The automation not only improves efficiency but also reduces human error and operational downtime, which are common issues in manual packaging systems.

Despite the promising capabilities, challenges related to system complexity and maintenance remain. Integrating different sensors and ensuring their proper calibration can require significant effort. Additionally, ensuring the reliability of electrical components, particularly in high-speed environments, will be crucial for long-term system functionality.

VI. CONCLUSION

The Automated Bottle-Drink Packaging Mechanism (ABd-PM) was developed to address the challenges of automating the packaging process in beverage manufacturing. The ABd-PM leverages a bidirectional shift register mechanism, which employs a set of multiplexers (MUX), D-Flip-Flops, demultiplexers (DMX), and decoders to coordinate the sequential tasks involved in packaging. This system enables the automated filling of drinks, labelling, capping, and other related processes, improving both efficiency and reliability in production.

The architecture of the ABd-PM, as illustrated in Figure 3, consists of several key functional components that contribute to its operation. These include an electrical motor that powers the conveyor system, a movable arm that positions the bottles on the tray, and various sensors that monitor the positions of the bottles and the completion of each task. These sensors, including photoelectric, ultrasonic, proximity, and encoder sensors, provide real-time feedback to ensure precise operation at each stage of the packaging process.

The system operates in a sequence controlled by the D-Flip-Flops, which store the status of each task. As each task, such as filling, labelling, or capping, is completed, the corresponding D-Flip-Flop switches from active high to active low, signalling the completion of that task. This transition allows the bottle to move seamlessly to the next station for the next task. The bidirectional shift register mechanism ensures that each operation occurs in the correct order, preventing tasks from overlapping and ensuring smooth workflow from start to finish.

The use of a PLC further enhances the automation process by managing the system's operations. The PLC coordinates the movement of the bottles, monitors the sensors, and ensures that each stage of the process is executed at the right time, reducing human intervention and minimizing the risk of errors.

The ABd-PM offers significant advantages over traditional manual or semi-automated packaging systems, including higher throughput, greater accuracy, and improved scalability for large-scale production. By automating each task in the packaging sequence, the system not only boosts efficiency but also reduces operational costs and downtime. The system's modular design makes it adaptable to different production requirements, and its integration of energy-efficient technologies ensures a sustainable approach to high-speed packaging.

In conclusion, the Automated Bottle-Drink Packaging Mechanism (ABd-PM) successfully demonstrates how automation and digital logic can revolutionize the bottle packaging process. By integrating a bidirectional shift register mechanism with an intelligent control system, the ABd-PM significantly enhances the productivity and efficiency of beverage manufacturing, paving the way for more advanced automation systems in the industry.

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