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Syrup powder bottling control system

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Abstract: Pharmacy is the art of preparing dispensing drugs. This is done by series of processes including the chemical processes for preparation of the drug and other ones dealing with its manufacturing such as: cleaning, filling, tableting , labeling and packing etc.
The production starts in the old ages with grinding some medical plants and mixing them to be given for people suffering from illness . After the industrial revolution the drugs factories started to be built. These factories are controlled with electromechanical systems. Here relays, contactors, mechanical timers , hydraulic systems and motors are used . This control system needs many people to monitor the production processes which will add cost and it is time consuming .To solve this, a computerized control system is needed to speed up the processes, reduce the faults and manpower. This is done by introducing sensors, feedback circuits and microcontrollers and robotic systems. This paper introduces a design based on using microcontrollers for the drug production process. A production flow is build to automate the whole operations

Keywords: drugs , robotic , control system , sensors , microcontroller

a. INTRODUCTION

The history of pharmacy and pharmacology dates back to medieval times. In 9th century specialization in drugs production occurred and gradually was spreading all over the world. Chemists started preparing medicines and prescribes them . in 19th century pharmacist compounded prescription and manufacture them. Pharmacy is the art of preparing dispensing drugs .The word is related to Greek pharmakon (Remedy) or the Egyptian term Pharmaki.

Automation in manufacturing, are systems or methods in which many of all of the processes of production, movement, and inspection of parts and materials are automatically performed or controlled by self operating machinery. The electronic devices replace human beings in doing routine or repetitive work.
Automation is an integral part of modern society. Numerous applications are all around us .The first major breakthrough in the development of control systems came with the invention of electrically powered machines That led to systems of relays controlled machines which had worked faster and more safely. Here so-called automatic machines or processes were controlled either by analogue electronic circuits, or circuits using switches, relays, and timers (as classical control systems) .Relay circuits performed their job very well, but they required large amount of space and huge amount of energy. Also relays were a little bit slow. Adding to their drawbacks relays took long time to install, troubleshoot and modify .
In fully automated pharmaceutical production systems a simple robotic application is a robotic arm that can be used for transferring powder bottles or tablets containers. The complexity of these systems can range from simple bottles feeders to large systems capable of performing complex tasks .The introduction of robotic fingers for existing industrial arms that are capable of gripping and moving bottles or tablets boxes made feasible the integration of modular unit automation .

II. METHODOLOGY

The paper is dealing with syrup powder production control . The production of syrup filling bottles includes; feeding , cap closing , labeling , packing and storing .The paper also includes an error detection and correction of processes faults.
Initially the containers are fed through the chain to be counted by the counter in the microcontroller and the count is displayed on the screen of the LCD. The bottles are sensed through optical sensor by the controller for their safety and availability, if not an alarm will be activated and the process will be stopped. The robot takes the broken bottle off the feeding chain and bottles will be available for another process to be started.
Then the bottle is transferred to the filling station .When it is located and sensed by a sensor, the filling hoper will be released, and the bottle will be filled to the required amount .During this time the powder container will be agitated by a shaker. When the filling level is sensed by another sensor, then the powder will be stopped by closing the hoper valve and the bottle is transferred to the closing station .When the cap is put on it, the bottle will be transferred to labeling station to make labeling. All these processes are checked by optic sensors and

monitored on the screen of the LCD . An alarm is produced for any malfunction .The bottles will be counted for each container to be packed and stored or transferred outside.

III. SYSTEM LAYOUT

The aim of the hardware and software design is to automate the syrup powder filling operations..The electronic devices required to construct the system are a personnel computer, microcontroller , sensors ,solenoid valves, plus interconnection links and lab link cables. The block diagram of the hardware implementation of the entire system is shown in Figure (1) below.

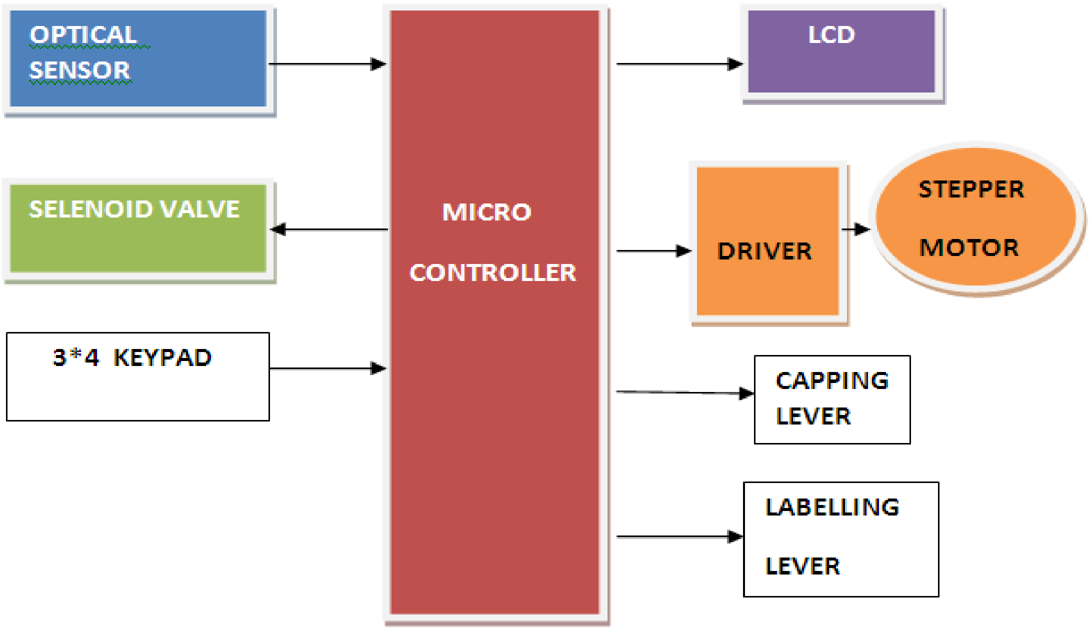

Figure (1) Block diagram of the system

The input system consists of sets of electronic blocks. Each set consists of an electronic device dedicated to perform a specified task.
The hardware components are :

- Personnel computer (PC) :
  A PC furnished with parallel ports is used for programming the microcontroller.
  Lab links :
  Lab links are sort of cables that connects the computer port to external electronic devices .They are used for programming the microcontroller.
- Microcontroller :
  Atmega 32 microcontroller captures data acquisition from the sensors .It controls the solenoid valves, levers and drives the stepper motors.

- Stepper motor :
  A five wires stepper motors will be used .One wire is for power supply to the stepper motor and the other four wires are connected to the windings of the stepper motor . Equation (1) gives the step angel of the stepper motor.

$$\text{Step angle} = \frac{360 \text{ Degrees}}{200 \text{ Steps / revolution}} = 1.8 \text{ Degree / Step} \quad \text{..........(1)}$$

- Twelve keys matrix keypad:
  The keypad is connected to the ATmega 32 microcontroller .It represents data entry to the microcontroller .
- LCD :
  LCD is used to display the data entry and the real time data during the system processing.
- Solenoid valve :

(It is used as an inlet for filling the bottles .
- Driver (ULN2803):

It is used as driver to the stepper motor. Its driving output current equals 500 mA..
- Capping lever:

It is a push pull lever for capping the bottles.
- Labelling lever:

It is a lever for sticking labels on the bottles.

IV. METHODOLOGY AND APPROACH

The production of syrup filling include bottling (feeding) , cap closing , labeling , packing and storing operations . Figure (2) shows a sketch of the block diagram for the different stages of the drug production processes summery.

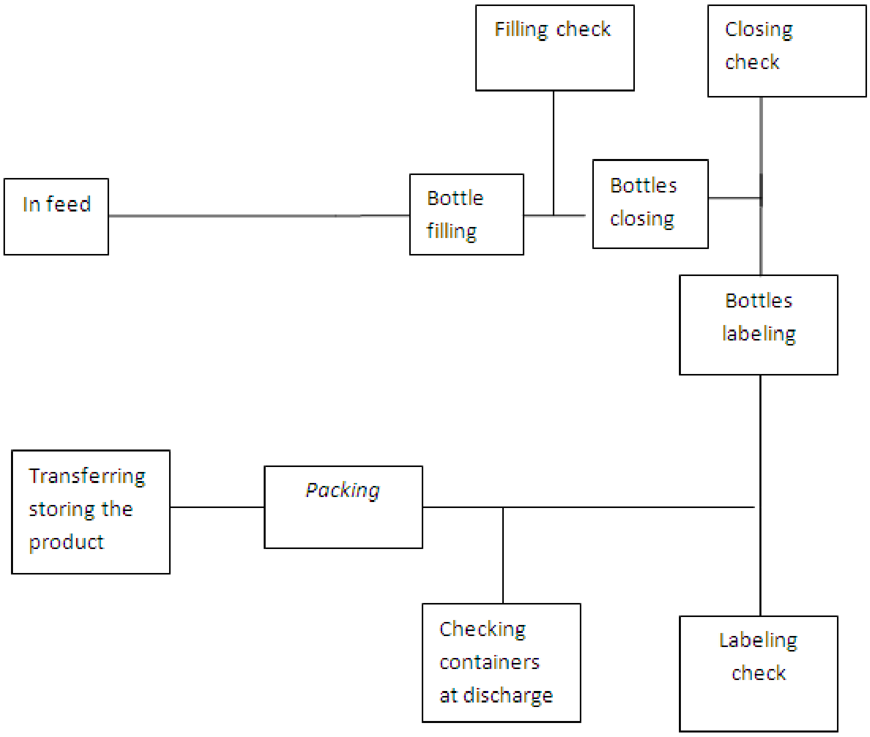

Figure (2) General outline drug production pipeline

V. PROGRAMMING

To achieve an automation procedure for the syrup powder production , we need to go through the following steps:

- Step one is developing a Bascom program in the microcontroller .
- Step two is downloading the (.Hex) file into the microcontroller using Pony prog program.

The algorithm is ;

Start

Feed :

… Rotate the stepper motor 7 steps for bottle feeding.

Filling:

… Open solenoid valve .

…. Delay 3 seconds.

… Close solenoid valve .

Capping:

… Activate the push pull lever .

…. Delay 2 seconds.

… Deactivate the push pull lever .

Labeling:

… Activate the labeling lever .

…. Delay 3 seconds.

… Deactivate the labeling lever .
Packing:
… Rotate the stepper motor 7 steps for bottle packing.
… If (keypad input = *) then go to terminate.
Go to feed.
Terminate:
End

VI. RESULTS

Equation (2) below gives the total time (T_{total}) taken for filling a single bottle with syrup powder.

$$T_{total} = T_{feed} + T_{fill} + T_{cap} + T_{label} + T_{packing} \qquad \ldots\ldots\ldots\ldots(2)$$

Where:
T_{feed} = time of feeding the bottle (seconds).
T_{fill} = time of filling the bottle (seconds).
T_{cap} = time of capping the bottle (seconds).
T_{label} = time of labeling the bottle (seconds).
$T_{packing}$ = time of packing the bottle (seconds).

By implementing the system design , it is found that the resultant time (T_{total}) per one bottle is :

T_{total} = 7 seconds + 3 seconds + 2 seconds + 3 seconds + 7 seconds = 22 second

For increasing the productivity , we need to speed up the five intervals in equation (2).It is found that speeding up the operation results in malfunction of the system .The optimum timing recorded is equal (22 seconds) for a bottle to be filled and packed. Figure (3) shows the characteristics curve of timing versus productivity for the system speed operation.

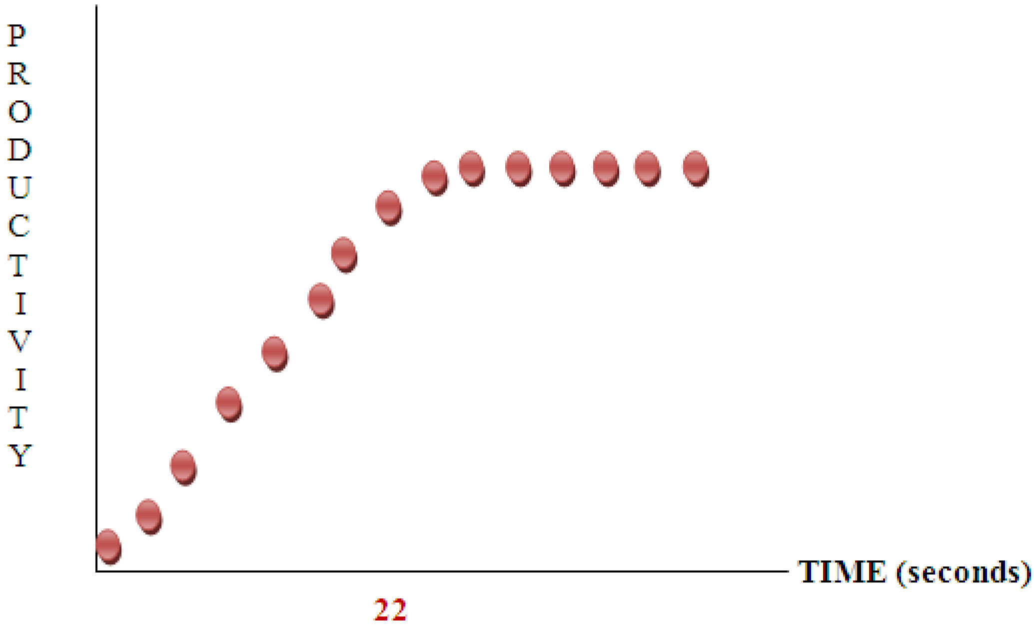

Figure (3) timing versus productivity for the system speed operation

VII. CONCLUSION

Production automation is the application of certain regulations for the system depending on the complexity of the process being controlled .A variety of approaches being used according to the systems being used. In drug production ,we need to go through a series of precise steps to accomplish the operation. This paper suggested a design based on using a microcontroller for processing . The microcontroller performs processing in the system. The processing is sequential and repetitive for feeding , bottling ,filling , capping and packing operations.

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