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DEVELOPMENT OF AUTOMATIC LIQUID FILLING MACHINE

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DEVELOPMENT OF AUTOMATIC LIQUID FILLING MACHINE

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A report submitted in partial fulfillment of the requirements for the degree of Bachelor in Electrical Engineering (Power Electronics & Drive)

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JULY 2012

"I hereby declare that I have read through this report entitle "Development of Automatic Liquid Filling Machine" and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Power Electronics & Drive)"

Signature : .....

Supervisor's Name : Dr. Abdul Rahim Bin Abdullah

Date : 27/6/2012

I declare that this report entitle "Development of Automatic Liquid Filling Machine" is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : .....

Name : Logan Raj a/l Lourdes Victor Raj

Date : 27/06/2012

To my beloved father and mother

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First of all, I would like to thank almighty God for the strength and blessings. I would also like to express my deepest gratitude to my supervisor Dr. Abdul Rahim Bin Abdullah for guiding me through my final year project development. Knowledge and input given by him highly motivated me to successfully complete this project. The information, suggestions and ideas given by him played huge role in developing a fully functional project.

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ABSTRACT

Liquid filling machine is used in beverage and bottling industries. Some of this filling machine is commercialized as water vending machine where Reverse Osmosis water can be bought from by using money. The machine found in the market is high in price, requires complex changes in hardware and program configuration if varied liquid volume is required to be filled and most of the time; it is not fully automatic. The purpose of this project is to develop an automatic liquid filling machine. Microcontroller is used as the controller to control the automatic operation of this machine where the machine consists of conveyor system and filling station. This system is equipped with accurate flow control pump that precisely controls the volume of water pumped over a certain period of time in to the container. Microcontroller is selected as the controller because it is easier to learn and the compact size makes it easier to attach it with the system. The automatic liquid filling machine is developed to be lower in price compare to other filling machine in market. The machine is designed in such a way that the range of volume selection can be selected from the range 250ml up to 3000ml. The machine is also easy to operate and user friendly, where simple steps is needed to operate the machine. The machine controller is also portable and can be attached with conveyor system or can be left standalone. The machine has high accuracy liquid filling capability where the highest error recorded from the liquid filling result is 0.031%.

ABSTRAK

Mesin pengisi air selalunya digunakan dalam industri pembotolan air minuman berkarbonat. Mesin pengisian air juga digunakan sebagai mesin penjualan air osmosis berbalik dimana duit boleh digunakan untuk membeli air dari mesin ini. Mesin yang boleh didapati di pasaran adalah mahal, memerlukan pengubahsuaian dari segi perkakasan dan perisisan jika isipadu air yang diisi adalah berlainan dan kebanyakannya adalah separuh automatik. Tujuan projek ini adalah untuk membina sebuah mesin pengisian air automatik. Untuk mengawal pengoperasian automatik mesin ini, Microcontroller digunakan. Sistem ini juga dilengkapi dengan mesin penghantar (conveyor) dan stesen pengisian air. Sistem ini menggunakan pam air yang dapat mengawal pengaliran air di dalamnya dengan tepat untuk suatu masa yang ditetapkan dimana isipadu air yang diperlukan dapat di isi dengan tepat. Microcontroller digunakan untuk mengawal operasi mesin ini kerana ia senang untuk dipelajari dan saiznya yang kecil memudahkan ia digunakan dimana sahaja. Mesin pengisisan air yang dibina ini adalah berkos rendah jika dibandingkan dengan mesin lain di pasaran. Mesin ini mempunayai pilihan tahap pengisisan air yang bermula dari 250ml hingga 3000ml. Mesin ini juga dapat dikawal dengan mudah oleh pengguna. Pengawal mesin ini juga boleh dibiarkan berasingan dan boleh disambung dengan mesin penghantar mengikut opersi yang ingin dicapai. Daripada keputusan yang diperolehi, mesin ini mempunyai tahap ketepatan yang tinggi dimana kadar kesilapan pengisian air yang dicatatkan adalah 0.031%.

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LIST OF SYMBOLS

DC	-	Direct current
LCD	-	Liquid Crystal Display
RM	-	Ringgit Malaysia
ADC	-	Analog Digital Converter
I/O	-	Input / Output
CPU	-	Central Processing Unit
CU	-	Control Unit
RAM	-	Random Access Memory
ROM	-	Read Only Memory
EPROM	-	Erasable Programmable Read Only Memory
EEPROM	-	Electrically Erasable Programmable Read Only Memory
RPM	-	Revs Per Minute
ml	-	Milliliter
mg	-	Milligram
LED	-	Light Emitting Diode
s	-	Seconds
%	-	Percentage

CHAPTER 1

INTRODUCTION

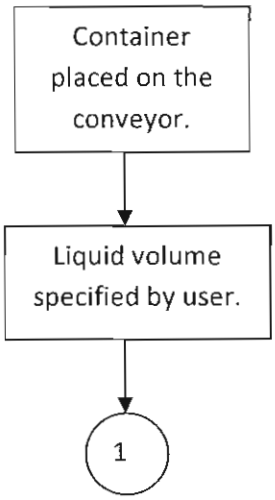
1.1 Project Background

Normally, liquid filling machine is a system used in industries to control the filling of liquid and beverages in a container or bottle automatically where only two inputs is needed [1]. The inputs are quantity of container and the type of liquid required to fill in the container. This system is in usage for a long time. The filling machine is programmed to fill a fixed volume of liquid in a container or bottle. Major changes are needed to be made in the machine structure and programming if different volume of liquid are required to be filled. Other than industrial application, liquid filling machine are also used in water vending machines. These machines are commercialized lately where Reverse Osmosis water can be bought from these machines by using money [2]. The amount of water filled in a bottle depends on the amount of money paid.

This project concentrates on controlling the liquid flow to fill a container. The liquid flow is monitored where it can fill an empty container with liquid automatically without human intervention. The filler automatically fills the container with liquid according to the volume given by the user. Accurate flow control pump is used to accurately fill the liquid volume into the container for a specified time and the filling time is controlled by Microcontroller. In addition this project is also included with conveyor system which carries the container to the filling station and out of the filling station. The conveyor system is also controlled by the Microcontroller.

There are few article reviews done in the development of the project. Those article reviews give more understanding and knowledge on the development of the machine. First article review talks about the important components required to design a fully working liquid filling machine. The second article review talks about the importance of simulation in development of liquid filling machine to achieve the expected result. Then, third article review talks about what is a conveyor system and the essential components required to design a conveyor system. The pricing of the liquid filling machine in the market are explained in fourth article review. Finally, the previous project that was developed is explained in details in the last article review.

The working principle of the project is in few steps below. First step involves placing the container on conveyor. Then the second step is to set the liquid volume desired by user. Third step is the conveyor moves the container to the filling station. Once the conveyor stops, the liquid is filled into the container according to the user requirements which is the fourth step. Finally, once the container is full, the conveyor moves again carrying the filled container to the collecting bay. The block diagram below illustrates the whole liquid filling task process:



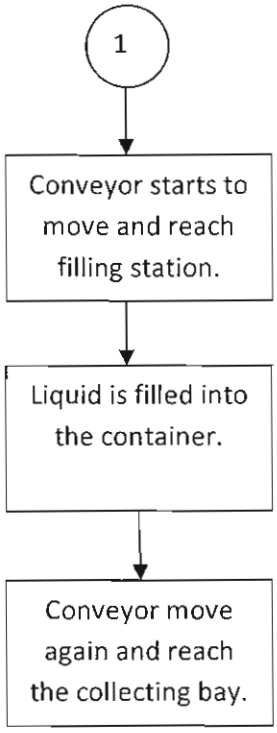


Figure 1.0: Liquid filling task process

1.2 Problem Statements

The problem statements for this project are most of the liquid filling machine in the market are not fully automatic. This machine requires human intervention to operate properly. This machine also needs constant supervision from the user. The machine such as water vending machine requires the user to stop the machine once the desired volume of liquid is achieved. There are fully automatic liquid filling machine in the market but there is a major obstacle that stops the machine to be used in normal application. The major obstacle is the price of the machine which is very expensive. Only beverage industries can afford this type of machine. Other than that, the existing machine requires major changes in structure and program if the machine is required to fill different volume of liquid at a time.

1.3 Project Objectives

The objectives of the project are:

a) Design the automatic liquid filling system with low cost so that this machine can be applied in small scale industries and also restaurants.
b) Design a system that can fill the container with liquid accurately where the specified volume desired by the user can be achieved with the smallest error possible.
c) Develop a user friendly system by using microcontroller as the controller so that everyone can operate the machine with ease and no instruction is required to operate the machine.
d) Design a conveyor system controlled by microcontroller to prove that this machine can be applied in industry.

1.4 Project Scopes

The scopes of this project are:

a) Design and development of automatic liquid filling machine that can fill the liquid desired by the user accurately with minimum error possible.
b) Design and development of conveyor system to be integrated with liquid filling machine to show that this machine can be used in beverage industries.
c) Using Microcontroller (PIC16F877A) which is compact in size and easy to be programmed as the controller to control the operation of the liquid filling machine and conveyor system.
d) Do simulation of the system by using Proteus before the development of actual automatic liquid filling machine hardware to detect any design problem and to make sure the design works as desired.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Reference and understanding is gained from various source such as books, journals, internet and previous projects. These materials are used as the main source for this entire project. In this part, two journals and current automatic filling machine project is reviewed.

2.2 Research on System of Liquid Automatic Filling

This paper introduces a design of automatic liquid filling system and clarifies the working principle and hardware structure of the system. The focus of this paper is to analyze principle and method on the usage of temperature measurement circuit and the ultrasonic technology in detecting liquid flow. This system has the function of real-time flow detection, temperature regulation and automatic transmission of packaging film, parameter setting and displaying.

There are seven parts in this liquid automatic filling system which are; detection part, heating wire control part, control of solenoid valve, liquid flow measuring, length control of packaging film, keyboard control panel, parameter input and display control section and C8051F020 MCU.

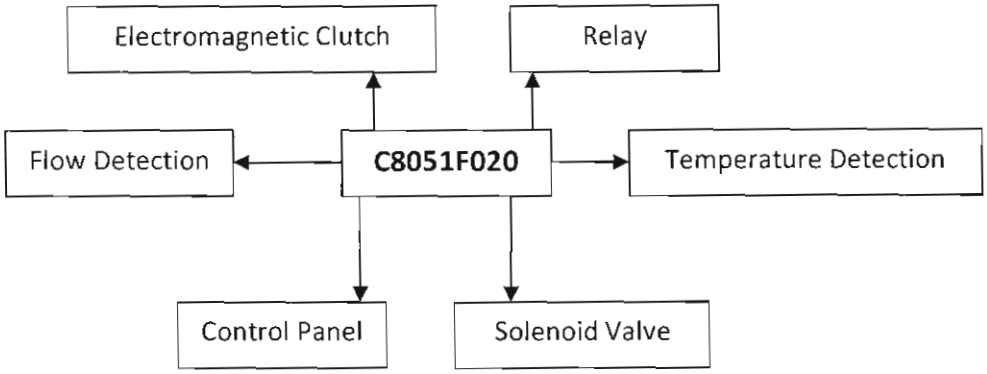


Figure 2.0: Automatic Liquid Filling Equipment System

The pre-heating process is the first process done. The power of the heating wire is turned on and this heating wire is used to seal the packaging film. The temperature detection part will make real time data accusation the temperature data is sent to microcontroller. The actual temperature and preset temperature is compared by microcontroller and decision is made. The decision is either to continue heating or stop the heating. Once pre-heating is done, the liquid filling begins.

The liquid is filled when once the packaging film is delivered and the liquid flow is measured. The flow detection device sends the analog signal to microcontroller for monitoring purpose. Once the desired value reached, solenoid valve which control the liquid flow will be closed. For the flow detection part, the flow is measured from outside of the pipe by using ultrasonic technology which calculates the flow data according to the relationship between transmission and time [3]. The principle of transmission time flow detection is shown in figure below:

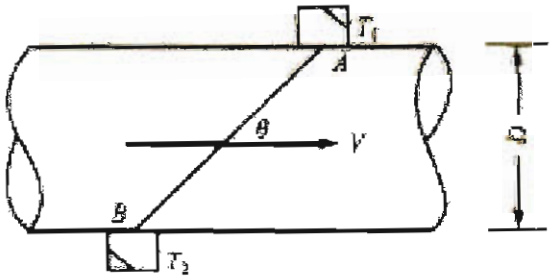


Figure 2.1: Principle of Transmission-time M

2.3 Simulation-based Analysis and Productivity Improvement of a Fully Automatic Bottle-filling Production System: A Practical Case Study

Simulation study is done to improve the productivity of a fully automatic bottle filling system. Detailed analysis of the system was done to increase its overall productivity. Simulation model of the current system is developed to understand its limitation and problems. The performance measures are analyzed and the improvement and changes that can be made to the actual system were proposed. Other than that, the optimization study on the parameters is conducted to find the values that lead to productivity increase. In addition, statistical technique used to optimize uptime and reduce machine failure by using down time analysis. Simple actions were suggested that could bring considerable increase in efficiency productivity and profitability of the system.

Rockwell Arena software was used to instigate the performance of a fully automatic bottle-filling productivity in this study. The purpose is to analyze it's throughout reliability, lead time and efficiency. The model is then used to suggest the improvement that can be made to the actual system.

There are seven main stations and four different type of conveyor in the system that is under study. The first station is the blow molding machine which is used to blow empty bottles. The bottles are then conveyed to labeling machine by air conveyor 1. Then air conveyor 2 receives the bottles and conveys them to third station which is the filling station. The labeled bottles are rinsed, filled and capped. Belt conveyor is used to convey the bottles to the Vario Packer machine [4]. The process is simplified as shown in the figure below.

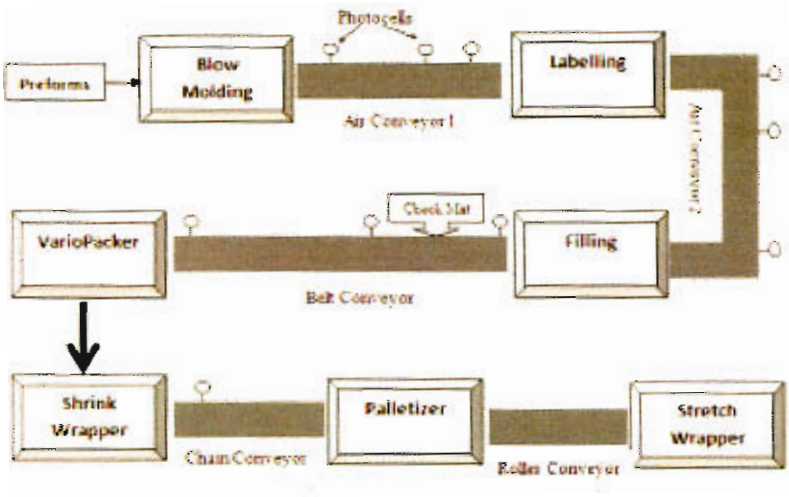


Figure 2.2: System layout

Design a simulation model for a complex system requires good understanding of the system. During the simulation, some assumption are made to try to imitate the model as real system as possible. This model allows the understanding of the actual system and to determine the bottleneck stations. The results gained from the model are used to suggest the changes and upgrade that could be made for current system for further improvements.

2.4 Conveyor design

Conveyors supply a reliable means when bulk material needed to be transported continuously. This device is the most economical if the handling rate and total quantity warrant is concerned. The lifting and conveying machine can be divided into two categories. The categories are intermittent motion and continues motion. Intermittent motion consists of cranes and lifts. Continues motion includes conveyors, pneumatic and hydraulic means. Conveyors are used to convey different types of bulk and unit loads along horizontal and slightly inclined paths. It also used for transporting articles between different types of operation in production lines. Conveyors can be categorized into many types. Those types are chute conveyor, wheel conveyor, roller conveyor, chain conveyor, belt conveyor, slat conveyor, bucket conveyor, screw conveyor and pneumatic conveyor [5].

In this project, the type of conveyor chosen is chain conveyor. Chain conveyor is a machine with a moving chain. The parts involved are conveyor bed where the size chosen according to the requirement. The figure below shows the conveyor bed.

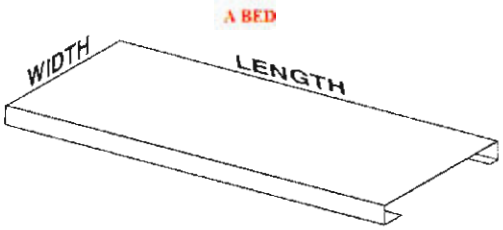


Figure 2.3: Conveyor bed

A pulley is like an iron pipe which is placed at each end of the bed. Each pulley has steel shaft through it. The shaft turns on a bearing and the pulley turns with the shaft. Bearing uses little steel balls that allow the different piece of metal attached together through it to turn freely. Figure below shows the shaft and bearing.

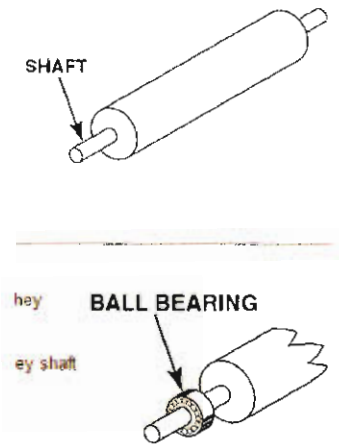


Figure 2.4: Shaft and bearing

Motor is used to drive the pulley. A spocket is put on the drive pulley shaft. Spocket is metal steel with teeth on the outside. This is used to turn the chain which allows the pulley to turn and thus it can carry material placed on it in horizontal or slightly inclined paths. The figures below show the motor configuration that drives the conveyor and the spocket [6].

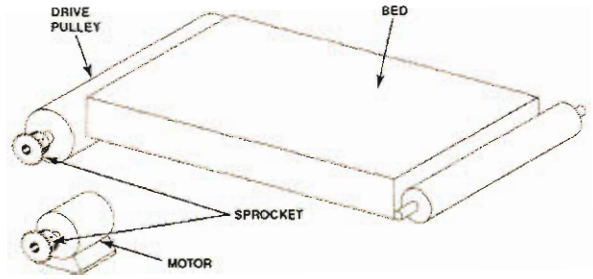


Figure 2.5: Motor configuration in conveyor

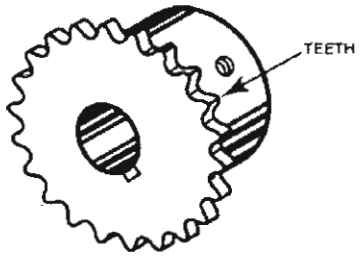


Figure 2.6: Spocket